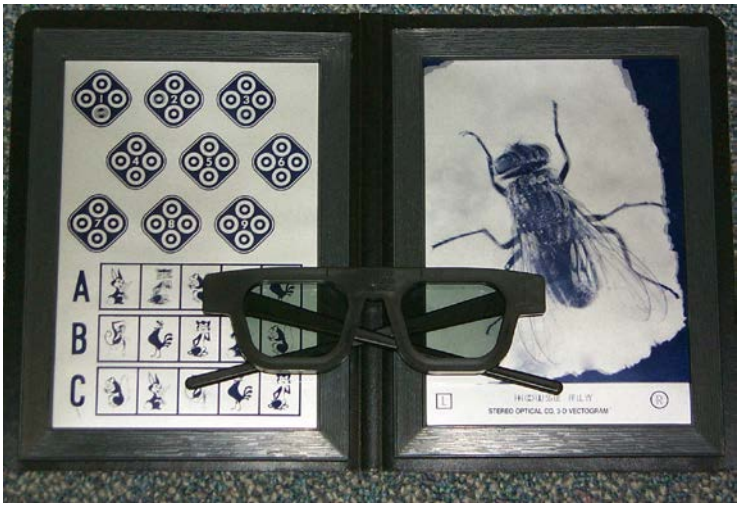
CDC 4V051

Ophthalmic Journeyman

Volume 4. Assisting the Healthcare Provider



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Material in this volume is reviewed annually for technical accuracy, adequacy, and currency. For SKT purposes the examinee should check the *Enlisted Promotions References and Requirements Catalog* to determine the correct references to study.

YOU MADE IT TO the final volume! Up to this point you've been given a lot of facts and information but relatively little on actual testing and patient care. Volume 4 covers many of the tasks and tests you'll perform on a daily basis assisting your doctor in patient examinations.

Unit 1 covers patient care tasks and testing. You'll study aseptic techniques, screening patients, documenting a case history, and various techniques for checking the patient's visual acuity (VA) to include: finger counting (FC), hand-motion (HM), light localization (LL), pinhole (PH), and Precision Vision® (PV) testing. Additionally, unit 1 discusses how to use the optec vision tester (OVT), which allows several visual function tests with one piece of equipment.

Unit 2 discusses testing pupils, performing noncontact tonometry, and testing ocular motility. Finally, you'll study some of the ancillary tests you may be asked to perform—such as the Amsler grid and confrontation field, testing for suppression and depth perception, color vision testing, and blood pressure testing. As you can see, Unit 2 covers quite a bit of material!

Unit 3 covers specialty testing and advanced clinical procedures. This includes procedures such as automated visual field testing, optical coherence tomography assessments, refractometry and keratometry, corneal topography, slit lamp operation, applanation tonometry, schirmer tear test, checking anterior chamber angle, taking ophthalmic photographs, measuring pupil size, performing pachymetry, measuring near point of convergence (NPC), and finally, administering the worth 4-dot test. This is an interesting and informative section covering the higher-level tasks now being asked of an ophthalmic journeyman.

Unit 4 discusses ophthalmic programs and aerospace optometry. We cover general contact lens (CL) —to include both the elective and medical CL programs, aircrew terminology, the aircrew CL program, the corneal refractive surgery program, and the general principles of night vision goggles (NVG). We hope you enjoy the lessons you're about to study; the information will prove valuable to you in your job.

A glossary is included for your use.

Code numbers on figures are for preparing agency identification only.

To get a response to your questions concerning subject matter in this course, or to point out technical errors in the text, unit review exercises, or course examination, call or write the author using the contact information on the inside front cover of this volume.

NOTE: Do not use Air Force Instruction (AFI) 38–402, *Airmen Powered by Innovation,* to submit corrections for printing or typographical errors. For Air National Guard (ANG) members, do not use Air National Guard Instruction (ANGI) 38–401, *Suggestion Program.*

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This volume is valued at 33 hours and 11 points.

ACKNOWLEDGEMENT

References to specific equipment, manufacturers, and/or commercial products do not imply endorsement by the Air Force and are used with permission.

Project-O-Chart

Unit	Page Number(s)	Figure Reference(s)
1	1–19, 1–20, 1–22, 1–23, 1–26, 1–48	Fig. 1–7. Manual Project-O-Chart™.
3	3–66, 3–67	

Spyder3

Unit	Page Number(s)	Figure Reference(s)
2	2–45	Fig. 2–31. Proper colorimeter (Spyder3™) placement for calibration.

Nidek TONOREF II

Unit	Page Number(s)	Figure Reference(s)
2	2–11, 2–12	Fig. 2–6. Nidek TONOREF II™ video monitor display. Fig. 2–7. Nidek TONOREF II™ chin and forehead rests. Fig. 2–8. Nidek TONOREF II™ manual measurement (no “A” box at top of the screen).
3	3–34, 3–35	Fig. 3–23. Nidek TONOREF II™ blue to yellow target alignment change.

DGH 550 Pachette 2/Pachmate

Unit	Page Number(s)	Figure Reference(s)
3	3–60, 3–61	Fig. 3–44. Pachmate® handheld pachymeter and calibration box.

Tono-pen XL (Medtronic and Reichert Inc., Reichert Industries)

Unit	Page Number(s)	Figure Reference
2	2–14, 2–15, 2–16, 2–17, 2–28, 2–62	Fig. 2–9. Tono-pen®. Fig. 2–10. Tono-pen® with case and supplies. Fig. 2–11. Tono-pen®, remove battery cover with stylus. Fig. 2–12. Tono-pen® held as a pencil.

Humphrey Visual Field Analyzer

Unit	Page Number(s)	Figure Reference(s)
3	3–11, 3–12, 3–15, 3–18, 3–19, 3–20, 3–27, 3–30,	Fig. 3–9. Example of a Humphrey® Visual Field Analyzer. Fig. 3–10. Front and side views of Humphrey® Visual Field Analyzer.

Opti-Free

Unit	Page Number(s)	Figure Reference(s)
4	4–20, 4–21, 4–52	

Precision Vision

Unit	Page Number(s)	Figure Reference(s)
1	1–29, 1–30, 1–31, 1–33, 1–34, 1–49, 1–50,	Fig. 1–12. HC VA. Fig. 1–14. The PV® low-contrast chart currently used by the USAF. Fig. 1–15. Example of an HC PV® recording form.
4	4–43, 4–44	

Humphrey ATLAS Corneal Topography system

Unit	Page Number(s)	Figure Reference(s)
3	3–36, 3–37, 3–39	

AOSEPT

Unit	Page Number(s)	Figure Reference(s)
4	4–17, 4–18,	Fig. 4–16. AOSEPT® lens holder and cup. Fig. 4–17. How to use the AOSETP® solution.

Ultrazyme

Unit	Page Number(s)	Figure Reference(s)
4	4–20	

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

Page

Unit 1. Patient Care

IN THIS UNIT we'll discuss some of the more common tasks and tests you'll perform in your clinic. We'll cover everything from testing vision, pupil reaction, eye pressure, ocular motility, depth perception, to color vision testing. You'll learn about performing asepsis, taking case history, administering laser eye exams, and obtaining blood pressure (BP) measurements. There is a lot to know and this information is very valuable and relevant to your day-to-day duties.

1–1. Aseptic Technique

The term "aseptic technique" conjures up a vision of a healthcare provider decked out in the appropriate mask, gloves, and gown. Yes, it's true, surgical situations require the use of aseptic techniques, but so does the normal clinic routine of screening patients. This includes washing your hands between patients and properly cleaning used handheld instruments following each patient.

As an ophthalmic technician, you're required to perform sound aseptic techniques. Aseptic techniques are an integral part of all patient treatment programs, from patient screening to foreign body (FB) removal. Aseptic techniques are categorized as medical or surgical. Some treatments require the application of both.

In this section, we examine some of the principles inherent in both techniques, the rationale for the techniques, select terminology, and commonly used methods and supplies.

The following table defines terms and definitions associated with medical and surgical asepsis. Some of the terms are very close in meaning, so read them carefully.

Surgical Asepsis Terms and Definitions	
Term	**Definition**
Asepsis	The state of being free of infection; the absence of disease-producing microorganisms.
Antiseptic	An agent or substance that arrests or retards the growth of organisms, but does not necessarily destroy them. Antiseptics are intended for people.
Bactericide	A substance destroying bacteria, but not necessarily spores. Spores are the reproductive elements of lower organisms. Bactericides are also called germicides.
Clean area	An area free of pathogenic (disease-producing) microorganisms.
Disinfectant	A substance destroying pathogens, but not usually spores. Disinfectants are used on inanimate objects.
Disinfection	The process of destroying pathogens.
Medical asepsis	Methods and practices designed to prevent or limit the spread of pathogens. Medical asepsis is also considered a cleaning technique.
Sterile	Absence of all microorganisms, including spores.
Sterilization	The process of destroying all microorganisms and spores.

Surgical Asepsis Terms and Definitions	
Term	**Definition**
Surgical asepsis	Methods and practices that keep objects and areas free of microorganisms. Surgical asepsis is also considered a sterile technique.
Nosocomial	An infection developing while the patient is receiving healthcare—usually as an inpatient. Exogenous nosocomial infections are acquired from other persons, while the endogenous variety stems from microorganisms harbored by the patient.

601. Applying clinical infection control procedures

Universal precautions were defined in 1985 by the Center for Disease Control and Prevention (CDC) to prevent transmission of bloodborne pathogens (e.g., human immunodeficiency virus [HIV] and hepatitis B virus [HBV]) to healthcare workers. Blood and certain fluids from all patients should always be considered potentially infectious for HIV, HBV, and other bloodborne pathogens as stated in the universal precautions.

Universal precautions apply to blood and other bodily fluids containing visible blood, semen, and vaginal secretions. Nasal secretions, sweat, tears, saliva, and vomit are not covered under universal precautions unless blood is visible.

Hospitals have developed exposure control procedures including the use of personal protective equipment (PPE) based on universal precautions. Some of the protective gear you'll likely use includes gloves, masks, and protective eyewear.

Prevention

Prevention refers to the measures you take to keep patients and other personnel from acquiring infections. Control refers to the measures you take to keep infections from spreading. Because the measures you take to prevent or control infections are often the same, we generally consider prevention and control as a single function.

Medical service-wide prevention and control measures include the following:

- Immunization programs.
- General health measures.
- Restricted access to high-risk areas.
- Work restrictions for sick staff members.
- Health and safety education of personnel.

Each area of the hospital also has specific practices and measures to prevent and control infections. A detailed discussion of all hospital-wide measures is impractical for this text; therefore, you should learn and follow the local policies and guidelines applicable to your military treatment facility (MTF). Some specific measures for prevention and control of infection apply to all facilities and all personnel. These measures are divided into two categories: standard precautions and transmission-based precautions.

Standard precautions

The CDC has issued standard precautions (combined from the formerly named universal precautions and body substance isolation precautions) that apply to the following:

- Blood.
- Non-intact skin.
- Mucous membranes.
- All body fluids, including secretions and excretions.

As you can see, this means standard precautions are mandatory for all surgical procedures and for most patient contact. You must use standard precautions daily, so make sure you fully understand what they are and where they apply. Standard precautions are discussed in the following table.

Standard Precautions	
Application	**Description**
Hand washing	• Wash your hands after touching blood, body fluids, secretions, excretions, and contaminated items, even if you were wearing gloves. • Wash your hands after removing your gloves, between all patient contacts, and whenever you may potentially transfer microbes to other patients or areas. • Use an ordinary cleansing agent (soap) to wash your hands unless specific circumstances require you to use an antiseptic. Local infection control policy determines the agent you use.
Gloves	• Wear clean, nonsterile gloves when touching blood, body fluids, secretions, excretions, and contaminated items. • Put on fresh gloves before touching mucous membranes or non-intact skin. • Remove your gloves immediately after use and before touching noncontaminated items or surfaces. Also, put on fresh gloves before going to another patient. • Remember to wash your hands when changing the gloves.
Mask, eye protection, and face shield	Wear a mask and eye protection or a face shield to protect the mucous membranes of the eyes, nose, and mouth during patient care activities likely to generate splashes or sprays of blood, body fluids, secretions, and excretions.
Gown	• Wear a gown (a clean, nonsterile gown is adequate for noninvasive procedures) to protect your skin and prevent the soiling of your clothes during activities likely to generate sprays or splashes of blood, body fluids, secretions, or excretions. • Select a gown appropriate for the activity and amount of fluid likely to be encountered. • Remove a soiled gown as promptly as possible, and wash your hands to avoid transfer of microorganisms.
Patient care equipment	• Handle used patient care equipment contaminated with blood, body fluids, secretions, or excretions in a manner preventing exposure or contamination of clothing, patients, and other environments. • Do not use reusable equipment to care for another patient until it has been cleaned, decontaminated, and reprocessed. • Discard single-use items properly.
Linen	Handle, transport, and process used linen soiled with blood, body fluids, secretions, or excretions in a manner preventing exposure or contamination of clothing, patients, and other environments.
Bloodborne pathogens	1. Use mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation in areas where the need for resuscitation is predictable. 2. Take care to prevent injuries when using needles, scalpels, and other sharp instruments or devices; handling sharp instruments after procedures; cleaning used instruments; and disposing of needles. • Never recap used needles or otherwise manipulate them using both hands, or any other technique involving directing the point of a needle toward any part of the body. Use a one-hand “scoop” technique or a mechanical device designed for holding the needle sheath. • Do not remove needles from disposable syringes by hand; do not bend, break, or otherwise manipulate used needles by hand. • Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers located as close as practical to the area of use. • Place reusable syringes, needles, and other sharp items in a puncture-resistant container for transport to the reprocessing area.

In addition to these standard precautions, additional precautions must be taken for some patients depending on the circumstances.

Transmission-based precautions

The CDC has also issued transmission-based precautions for use on patients who are known or suspected to be infected by epidemiologically important pathogens transmitted by airborne, droplet, or contact routes. These patients are generally kept isolated from other patients, and staff and visitors must take special precautions to prevent spreading of the illness. The disease or conditions necessitating these precautions usually prevent these patients from being candidates for elective surgery, but you may come across these conditions in an emergency. Use the following table to help you understand transmission-based precautions.

Transmission-Based Precautions	
Precaution	**Description**
Airborne precautions	Airborne precautions apply to patients with illnesses, such as measles, chicken pox, and tuberculosis (TB). These patients are usually kept in an isolation room with negative air pressure. Staff members susceptible to measles or chicken pox (i.e., they have not been immunized) should avoid contact with patients with these illnesses. All staff members and visitors should wear surgical masks in the presence of TB patients. During transport, the patient should wear a surgical mask to reduce spreading the microbes. If procedures must be performed on these patients, the doors must remain closed and traffic should be greatly restricted. Opening or closing the doors and staff moving around the room generates air currents and disperses the microbes. If possible, the procedure is performed when other patients are not in the same suite (e.g., at the end of the day). Anesthesia providers should take special precautions in selecting the equipment and ventilation method to reduce airborne microbes and equipment contamination.
Droplet precautions	Droplet precautions apply to patients with illnesses transmitted through droplets generated by talking, coughing, sneezing, etc. Illnesses in this category include meningitis, pneumonia, sepsis, and many others. All staff members and visitors should wear surgical masks when within 3 feet (ft.) of the patient. During transport, the patient should also wear a surgical mask. In surgery, most of the precautions for airborne microbes also apply for droplet precautions.
Contact precautions	Contact precautions apply to patients with illnesses that may be transmitted via direct or indirect contact. Fortunately, most of the conditions falling into this category are rare. However, these precautions should be used for patients with herpes virus and some antibiotic-resistant strains of infection. Generally, contact precautions are the same as standard precautions, except they apply to all patient contact, rather than to only blood, body fluids, secretions, and excretions. The precautions include the following: • Hand washing is essential. • Wear a gown, mask, and gloves when in the presence of a patient. • Avoid transporting the patient; if patient transport is necessary, take precautions to prevent contact with other staff, patients, or visitors. • Properly handle and decontaminate all patient care equipment and supplies after use. Use disposable or patient-dedicated equipment when possible.

602. Applying clinical aseptic procedures

Whether in a small or large clinic, you must help prevent infection by eliminating microorganisms. Infections, trauma, and surgeries all require maximum asepsis. So how can you help eliminate and contain the spread of microorganisms? Washing your hands is the first thing that comes to mind. In addition to personal hygiene, ensure equipment is cleaned regularly. This not only applies to patient equipment, but all equipment throughout the clinic, including all instruments.

Cleanliness

A clean area is one free of pathogenic organisms. Dust, dirt, and debris can harbor many harmful organisms. Periodically cleaning all equipment with a disinfectant ensures a sanitary patient environment. Of particular importance are the handheld instruments, screening equipment, and exam

chairs. These objects are very susceptible to spreading microorganisms. Clean each of these items after every screening, whether or not the patient appears infected.

Handwashing

Handwashing is the single most important aspect of medical aseptic technique because your hands are the primary "tool" you use when screening patients. To prevent the spread of microorganisms between you and your patients, you must wash your hands after every patient contact.

Proper aseptic technique is easy when treating a patient identified with an existing infection, but often we let down our aseptic guard with the daily, routine patients. Wash your hands before and after any screening or procedure, before and after eating, and after touching any contaminated article. Your hands are your best tools. Like any fine piece of equipment, they should be clean and well kept. Additionally, keeping your fingernails trimmed makes it easier to keep the subungual (under the nail) area clean.

While handwashing does not remove all organisms from the skin, it does remove a substantial majority of them and weakens those left behind. By washing your hands just before and immediately after working with a patient, you dramatically reduce the chances of passing on an infection or being infected yourself. Handwashing is even more effective when the fingernails are kept short. Large amounts of infectious organisms often hide under the fingernails. Less fingernail material means fewer organisms as it's easier to get warm soapy water under what fingernail is left.

Effective handwashing removes microorganisms by mechanically scrubbing them away as you rub your hands together, diluting the organisms by rinsing them away with water, and actually killing many organisms when an antibacterial soap is used.

Figure 1–1. Handwashing.

While it may seem funny to tell you how to wash your hands properly, this is just what we're about to do. Refer to figure 1–1 as we discuss each step.

1. Turn on the faucet and wet your hands with the warmest comfortable water temperature.
2. Use an antibacterial soap.
3. Lather up and scrub for at least 20 seconds. Clean your fingers and fingernails particularly well as they are most likely to harbor infectious organisms.
4. Rinse your hands and forearms.
5. Use a paper towel to dry your hands.
6. Use the same paper towel to turn the faucet off, making sure not to touch your clean hands to any surface of the sink/bathroom.

The following are some helpful handwashing hints:

- Avoid splashing and spraying water.
- Avoid wearing intricate jewelry on the hands and wrists.
- Chipped nails and nail polish tend to collect soap and lotion.
- Short, rounded fingernails provide little opportunity for bacteria.
- Always consider the sink and faucets to be contaminated, which is the reason for using a paper towel to turn off the water.

What we have described is the ideal cleanup, but any handwashing you can do is better than nothing. If you do not have antibacterial soap, wash your hands anyway. It will help. If you do not have any soap, rinse and rub your hands together under water. It does help.

If you do not have access to a sink, there are various antibacterial hand soaps available that you can use. Some contain alcohol and hand emollients so they kill germs without leaving your hands dry and flaky. A good example is a foaming antibacterial hand cream. You rub it thoroughly on your hands, and then it just evaporates so no hand towel is required. This is not ideal, but it's better than nothing. Handwashing is very important because it dramatically reduces direct and indirect-contact transmission infections.

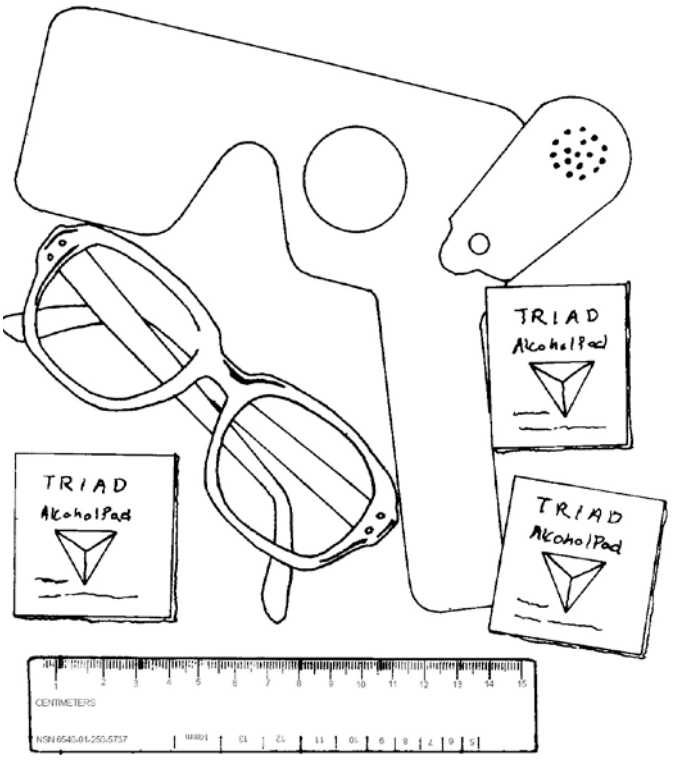


Figure 1–2. Nondisposable items.

Instrument and equipment cleaning

In the eye clinic, any instrument exposed to a patient is considered contaminated. When you take a pupillary distance (PD), the ruler is contaminated. When you check vision, the occluder is contaminated. When you fit spectacles, the fitting frame is contaminated. These things have merely made contact with the skin of the patient, but they must be considered potentially infectious. Wiping down these items with an alcohol pad before and after each use is essential. Alcohol is a rather mild disinfectant, but it does the job on these types of nondisposable instruments (fig. 1–2) since they do not actually make contact with a person's body fluids.

Use alcohol pads to wipe out the chin cup and forehead knobs (or straps) of the noncontact tonometry (NCT), fundus camera, visual field (VF) machine, slit lamp, and so forth. It's a quick and easy thing to do, and it helps prevent the spread of infection.

Disinfecting applanation tonometer tips

If applanation tonometer tips make direct contact with patient body fluids, they must be disinfected. Alcohol is not a strong enough disinfectant to get the job done for an item having contacted potentially infectious body fluids. Besides, alcohol is not good for tonometer tips. The tips are plastic, and alcohol breaks down plastic over time, especially if the tips are left to soak in the alcohol.

The preferred disinfectant for applanation tonometer tips is a solution of one part household bleach to 10 parts water (1:10).

After using the applanation tonometer, remove the tip from the holder and place it in a container where it can be soaked in the diluted bleach mixture. To allow the tonometer tips enough time for disinfection, they must be left in the diluted bleach mixture for at least 10 minutes. This means your doctor needs two or three tonometer tips so you can thoroughly disinfect one or two tips while using a fresh one on each patient. Before using a tip after it's disinfected, rinse it thoroughly with sterile saline and wipe it dry with a fresh 2″ × 2″ or 4″ × 4″ sterile gauze pad.

Area cleaning

Accomplish area cleaning at least daily using an approved hospital cleaning disinfectant. Whatever disinfectant is approved for use in your hospital, use it to wipe down counters, chairs and armrests, doorknobs, and other areas a patient or contaminated material may have contacted. Use your best judgment about how often you should do a thorough area cleaning. The end or beginning of each day should be a minimum.

It's wise to wipe down areas infectious people have contacted as soon as possible. If you are really pressed for time, at least wipe high-contact areas off with an alcohol pad until you can come back and do the job right with an approved area cleaning disinfectant. It may seem like a lot of work, but just think how much work you save by taking precautions to avoid infecting the healthy patients coming into your clinic.

Medications

Contamination of medications can lead to common-vehicle transmission of infectious organisms because many people can be infected from one source. This is a real danger in clinics. To minimize infections due to medication problems, follow these simple rules:

- Discard contaminated vials and bottles immediately.
- Monitor the expiration dates of all medications, and throw away all medication past its expiration date.
- Train all personnel before they can administer any medications. If you have Red Cross volunteers working in your clinic, keep in mind they have not received the same level of training you have.
- Medications opened are only considered good for a maximum of 90 days after the medication's safety seal is broken. Obviously, if the manufacturer's expiration date comes up before the end of 90 days, the drug is expired and must be thrown away. It's not necessary to wait 90 days after opening a medication to throw it away. If it looks bad, throw it away earlier. A good rule of thumb is if you do not want the drops to be used on you, do not use them on your patients.

You should always contact your local pharmacy section for detailed information on your clinic's specific medications. Air Force Instruction (AFI) 44–102, *Medical Care Management,* and AFI 44–108, *Infection Prevention and Control Program,* are also beneficial resources.

Practicing asepsis is more than just good housekeeping. Take the time to ensure precautions are in place to keep you, your doctors, and your patients free from possible infections. You cannot do your job if you are home with an adenovirus (ADV). The extra cleaning might seem like a lot of work at first, but you can see practicing good asepsis is not time consuming at all when compared to the risk of infection.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

601. Applying clinical infection control procedures

1. In relation to standard precautions, describe prevention and control of infections.

2. What two categories of precautions were combined under the CDC's standard precautions?

3. Using standard precautions as a reference, when should handwashing be done?

4. According to standard precautions, when is a mask and eye protection worn?

5. What should be used for performing mouth-to-mouth resuscitation according to standard precautions?

602. Applying clinical aseptic procedures

1. What is the single most important means of preventing the spread of infection?

2. How does effective handwashing help remove microorganisms from the skin?

3. What disinfectant is used to clean items that do not make contact with a patient's bodily fluids?

4. What is the preferred disinfectant for applanation tonometer tips?

1–2. Case History, Patient Screening, and Visual Testing

Case history is one of the most underrated tools in medicine today. If technicians are thorough while asking patient information during a case history, they can narrow down the possible problems much quicker and give the doctor a better starting point. A good case history can save you and your doctor a lot of time.

603. Taking a case history and performing a visual screening

After meeting and greeting the patient, perform a case history. The case history is one of the most important steps in any medical treatment. A good case history gives you and your doctor the clues needed to quickly assess and accurately care for the patient. Good case histories lead to good healthcare. A bad case history wastes time and money and usually leads to less than the best healthcare.

In about 50 percent of cases, a good case history taken by a sharp technician can help the doctor correctly assess what a patient's problem is before beginning the examination. This saves initial exam time as the doctor has a good idea of the patient's needs. The examination is quickly focused on the patient's reason for coming in. The patient then feels he or she is being taken care of in a quality manner.

The type of history helps determine the proper Evaluation and Management (E/M) code that can be used. This, in turn, determines how much money the clinic can recoup for the examination. Is the exam geared to a specific problem, a detailed exam, or a comprehensive exam? At the time of this writing, you can find specific coding guidance at the following website: www.health.mil/About-MHS/Defense-Health-Agency/Resources-and-Management/Medical-Coding-Program-Office.

Review the patient's ocular and medical history

If you are fortunate enough to have access to the patient's health record, you can gain some insight on possible answers to the questions required for a good case history. For instance, if a family history of high blood pressure (HBP), heart disease, diabetes, cataracts, and so forth, was established at last year's exam, it's a safe bet the same family history applies this year.

If the record contains prior eye exams or medical exams having a bearing on today's visit, make a note of it. If it's a paper medical record, you could flag the record by folding back the appropriate page or by adding a yellow sticky to bring attention to any items of interest. If it's an electronic medical record, you could print the applicable exams or reference in your case history the dates of the exams you feel the doctor would benefit from reviewing.

However, this review does not negate the need to confirm your findings with the patient. There may have been something incorrectly reported in the past, or there could be a new development since his or her last visit, which could affect today's results. Worse yet, the last technician could have recorded something incorrectly. Bottom line—do not let easy answers take the place of a thorough case history. The questions still need to be asked and the answers confirmed. With that said, let's get ready to complete a case history from scratch.

The case history you take in your clinic is probably not exactly the same as the case history taken in another clinic. This is okay. Each doctor has his or her own likes and dislikes concerning case histories.

Case history checklist

Using a checklist is a good way to ensure you cover everything while taking a case history. You might want to keep the following checklist handy for future reference to help you remember what to do or obtain.

1. Establish rapport.
2. Chief complaint (CC).

3. Last eye examination (LEE).
4. Last dilated fundus exam (DFE).
5. Spectacles or contact lenses (CL) worn.
6. Name and date of latest prescription (Rx).
7. Current health.
8. Medications taken.
9. Medication allergies.
10. Common allergies.
11. Patient medical history.
12. Family medical history.
13. Patient ocular history.
14. Family ocular history.
15. Job duties and off-duty hobbies.

Establishing rapport

You can define rapport as "a relationship of mutual trust or emotional affinity." If you can establish rapport with a patient early on, then case history, visual screening, and the exam itself goes much easier.

Your first interaction with a patient is extremely important. Be friendly and show a genuine interest in the patient. Do not act rushed or stressed out. This makes the patient uncomfortable and affects the amount of information you can gain during the case history. You want the patient to trust and like you.

You should smile, be polite and sincere, and show a positive attitude during the screening. Do not be phony. Think to yourself, "This is a nice person who needs my help," and act accordingly. If you can truly establish a positive first impression, you have made a big leap in making your job easier.

History of present illness—CC

The most important information derived from a case history is the *CC.* This is the reason the patient came to your clinic. Most people do not just wake up and say, "Gosh. I think I'll go to the eye clinic today for no reason whatsoever." They made an appointment or walked in to your clinic for a specific reason. Your job is to find out specifically why the patient came to the clinic.

The question, "So, what brought you into the clinic today?" is good, but invariably you get some comedian who says, "My Ford!" (Ha Ha). A good question to start with might be, "How can I help you today?" or "Are you having trouble with your distant and/or near vision, or was there some other reason you came in today?" This usually prompts the patient to describe the reason or purpose of his or her visit.

While the patient explains the purpose of the visit, just listen for a few moments. Do not start writing or typing just yet. Get the whole picture first, and try to get the patient to narrow down the problem before you start documenting the CC. This saves you from stating one thing, only to have the patient refine or redescribe the complaint better later, forcing you to line out what you have already written and rewrite something else.

Paraphrasing

One good technique is to paraphrase back to the patient what you heard. The patient may say, "I seem to see these specks floating around in my vision, and they seem especially bad when I'm reading." You could paraphrase it like this, "So, you notice floaters in your vision that seem worse while reading?" You have essentially repeated back what the patient told you, only you have trimmed and reworded it slightly to define the complaint a bit better.

The patient confirms either you are correct or if you missed a part of the complaint which was important or relevant to the situation. That's okay. Your goal is to record the patient's CC in the manner the patient intended. Sometimes it's easy, and sometimes it may take a lot of back and forth phrasing and paraphrasing until you get it just right.

The easiest CC is "I am just here for a routine exam." At a minimum, still ask the patient specifically how his or her distant vision and near vision are and if there are any eye problems he or she would specifically like the doctor to address. Do not be lazy and try to lead the patient into not giving a CC by saying "So, are you here just for a routine exam today?" The patient may sense this is what you want to hear and just agrees with you for that reason. Try to find out whether the patient truly has any visual complaints he or she wants addressed, even if they are minor.

A patient coming to an appointment with a specific problem may not willingly state his or her primary concern as it may "sound silly." If the patient does not state his or her problem clearly, he or she is left secretly hoping that the doctor notices the issue during the routine exam. If the doctor does not find "the problem," the patient might leave and figure you and your doctors are incompetent because you "obviously couldn't take care of such a simple problem." The only thing is, THE PATIENT NEVER TOLD YOU OR THE DOCTOR WHAT PROBLEM HE OR SHE FELT THEY HAD. The point is, try to encourage patients to open up to you and tell you what is on their mind. It makes helping them easier.

Questioning

This is where you review the history of present illnesses. If the patient has a complaint, you need to get as much information about the patient's condition as possible.

Let's assume the patient described a problem, such as "decreased vision." Now you have to narrow down the complaint with additional questioning. Your goal is to determine the (1) *severity*, (2) *location*, (3) *onset*, (4) *cause*, and (5) *duration* of the problem.

One good way to pin these things down is to use What? Where? When? Why? and How long? type questions.

1. Near vision or distant vision decreased? (*What* is the problem? The quality and *severity*.)
2. Is it in the right eye (OD), left eye (OS), or both? (*Where* is the problem? The *location*.)
3. When did you first notice the problem? (*When* did the problem begin? The *onset*.)
4. Do you have any idea why your vision may have decreased? (*Why* did the problem occur? This could lead him or her to tell you about a new medication he or she is on, an eye trauma he or she had, etc. The *cause*.)
5. How long have you had the problem or how long does the problem last? (*How long* gives an idea of how chronic or severe the problem may be. The *duration*.)

These questions help you regardless of the problem, whether it's visual disturbances, traumas, eye infections, or headaches. You need to think like a detective and ask the patient questions that help you and your doctor pin down the problem.

When using the direct questioning method, keep in mind you should always be courteous, congenial, and professional in your approach. Some of the information you're trying to uncover may be of a personal nature and difficult for the patient to talk about. Always remember to hold the information obtained in the strictest of confidence and reveal it only to personnel with a *need to know*. For these reasons, it's best to take the case history in private. You're more likely to elicit the information you need if the patient feels no one else is overhearing what is discussed. Privacy often leads to greater disclosure.

Once you have recorded the CC and pinned down as many of the details as you can, you're ready to move on to reviewing the patient's personal and family medical history. Just asking questions about the patient's eyes, last exam, and allergies covers two of the Health Care Financing Administration

(HCFA) requirements for a detailed exam. Things like HBP, diabetes, iritis, or medications all qualify towards an extended exam. Again, all this helps with coding and reimbursement. After all, you're not doing more work, just ensuring your documentation reflects exactly what you and the doctor did to get credit.

LEE

You simply want to know the last time the patient had an eye exam. A day ago? A few months ago? A couple of years ago? Never? It can make a difference in your approach with the patient, the tests performed, and the length of the exam required.

Last DFE

Most doctors like to perform a dilated exam on routine patients every two to four years and more frequently for patients with glaucoma, diabetes, HBP, high myopia, macular degeneration, or other problems leading to optic nerve or retinal changes. Finding out when the last DFE was helps the doctor determine if a patient needs a DFE this visit.

Spectacles or CLs worn

Does the patient wear CLs? If so, are the contacts soft, rigid gas permeable (RGP) CLs, or hard? If they are soft, are they daily wear, extended wear, or disposable? It makes a difference on the tests performed. You should not do NCT on a patient wearing an RGP or hard CL. The doctor does not want fluorescein in the eyes of a patient still wearing soft contact lenses (SCL). If the patient wears CLs, he or she is more at risk for eye infections, neovascularization of the cornea, and corneal edema. Consider all these things when screening a patient.

If the patient is wearing spectacles, ask if they are for distant vision only (DVO), near vision only (NVO), or habitual (full time) wear. Are they a bifocal or a trifocal? If a multifocal, are they a standard straight-top segment, double D segments, or a progressive add lens (PAL) type segment. Again, the type of spectacles, how they are worn, and the patient's complaint may all be interrelated. Additionally, you need to know what type of spectacles the patient is wearing so you can perform your tests with he or she wearing (or not wearing) the appropriate correction.

Date of latest Rx

It's important to know the date of the patient's last Rx for spectacles or CLs. If the patient just received new spectacles or contacts six months ago and is already complaining of a decrease in vision, there may be an underlying problem. Common causes can include diabetes, a thyroid issue, or, if the patient is female, even pregnancy. If the patient has not changed his or her SCLs in over a year, the lenses may be covered with deposits causing decreased visual acuity (VA). The patient may have had an eye exam last year but no update to his or her glasses or contacts. As you can see, details are very important when getting the patient's history.

Current health

Simply ask the patient how he or she feels, in general, about his or her current health. Does the patient feel he or she is doing *poor*, *fair*, *good*, or *excellent*? Specifically you need to ask about pain in and around the eyes. What's the severity of the pain on a scale of 1 to 10? When it comes to pain, this line of questioning is a requirement of The Joint Commission (TJC), which accredits healthcare organizations. The answer also gives you and the doctor a feel for the patient's physical, as well as mental, well-being. If the patient reports being in poor health but does not have any significant ocular or medical history, you might conclude the patient is depressed or is in need of a general medical examination. It may affect the doctor's approach to the patient.

Medications taken

You need to know what medications the patient is currently taking. Yes, birth control pills are a medication. Yes, drugs bought without a prescription at the drug store can affect the chemistry of the body and affect vision. You need to know *all* the meds a patient is taking—prescription or otherwise. If the patient has all his or her medications written down, it's helpful, but you still need to document

the medications on the exam form. Simply passing along the patient's list to the doctor is not enough. You must annotate the patient's medications in the medical record so there is a documented history that you asked and that your clinic was aware of what the patient was taking.

In addition to knowing what medications the patient is taking, you need to know the reason the patient is taking it. Are the meds for HBP, gout, asthma, diabetes, or some type of infection? It matters, some medications have multiple uses and for more than one type of problem. You and the doctor need to know *why* the patient is taking a particular medication.

Finally, you need to know *how long* the patient has been taking a particular medication. If the patient has been on steroids for two years, it's significant. Does the patient have an infection and just started taking antibiotics yesterday? This may affect which medications the doctor may use or prescribe for the patient. Another consideration, some patients fail to make follow-up appointments with their doctor. Without proper follow-up care, a patient may end up taking the medication long after it was intended. This is a definite problem because some medications can build up in the body to toxic levels. Knowing how long a patient has been on a certain medication can help you and your doctor make these types of assessments.

Medication allergies

You need to know what medications have caused the patient to have an allergic reaction in the past. This is so you or the doctors do not inadvertently give the patient something that could cause harm. Many ophthalmic antibacterial drugs contain sodium sulfacetamide, and these medications would not be appropriate for a patient who has had a reaction to sulfa drugs in the past. If the patient's paper or electronic medical record indicates an allergy, do not rely solely on that source. Ask the patient directly what drugs he or she is allergic too. If the patient replies, "nothing I know of" or "none," record "NKDA"; this stands for "no known drug allergies." Do not put "NDA" (which means "no drug allergies") since you do not know for sure if there is a potential existing drug to which the patient may be allergic.

Common allergies

Find out if the patient has allergies to things other than medications. If he or she is complaining of gritty, itchy eyes, the patient's problems could be related to allergies. Is it spring? Maybe the patient is reacting to pollen. Is it fall? Maybe the patient is reacting to juniper or mold.

Did the patient just start having symptoms of gritty, itchy eyes recently? Did he or she just get a new pet? Though the patient may not have thought he or she was allergic to pets, a new dog or cat may very well be the problem. Another "hidden" problem can occur in the fall when people start using their home furnace again after months of nonuse. The dust and debris initially coming out of the air ducts can easily cause allergic reactions until the heater has run a few days. Try to keep these kinds of things in mind when questioning patients about allergies and comparing their answers to their complaints.

Another type of allergy you should specifically ask about are reactions the patient may have had in the past—things like latex rubber, alcohol pads, or medical tape. It happens! Have you ever put an eye patch on someone and then taken it off the next day and noticed a rash on his or her face? This is an allergic reaction. So, if your patients tell you about these types of allergies, write them down. It's important.

If the patient reports he or she does not have known allergies, you can record "NKA." This stands for "*no known allergies*." Again, do not just write "no allergies" since there may be something the patient is allergic to but has not yet encountered.

Past family and/or social history

At this point, you need to find out whether the patient has, or direct family members have or have had, any of the following health problems:

- Cancer (CA).

- Diabetes mellitus (DM).
- HBP.
- Heart disease (HD) (arteriosclerosis, angina, etc.).
- Other medical problems (e.g., stroke or thyroid problems).

Social history would cover things like smoking, drinking, or even the type of employment and hobbies.

You can phrase the question, "Have you, or anyone in your immediate family, ever had . . .?" Ask for each category individually and await the reply. For instance, ask about HBP and then wait until you get the patient's response. Then ask about DM and wait for the patient's response before going to the next question, and so on. If you just ask, "Did anyone have HBP, DM, HD, or CA?" the patient probably feels overwhelmed and confused and just says "NO" even though there really is some patient or family history in at least one of the categories. If you rush the patient, it shows in the accuracy of your case history.

If the patient has (or has had) any of the medical conditions listed above, you want to know when (month and year) or when the problem was diagnosed. If a family member has (or has had) any of the conditions listed, the date of diagnosis is not critical. You're just trying to establish the potential genetic predisposition the patient may have to the condition.

NOTE: If the patient or a family member has (or has had) CA, you need to know the specific type.

To annotate the history, use the following abbreviations outlined in the table below.

Family History Abbreviations	
Family Member	**Abbreviation**
Patient	Self
Mother	M
Father	F
Brother	B
Sister	S
Maternal Grandmother	MGM
Paternal Grandmother	PGM
Maternal Grandfather	MGF
Paternal Grandfather	PGF
If patient is not sure which family member had the problem	UNK

NOTE: The reason you need to determine maternal (mother's side of the family) or paternal (father's side of the family) when describing the grandparents is many medical problems are sex linked, meaning they are more likely to be passed on from the female or male members of a family.

Patient and family ocular history

You also need to explore the patient's and family's ocular history for the following:

- Cataracts.
- Glaucoma.
- Crossed eyes (strabismus or STRAB).
- Any other eye diseases, such as keratoconus, retinitis pigmentosa, pars planitis, etc.
- Macular degeneration (often abbreviated ARMD for "age-related macular degeneration" or ARM for "age-related maculopathy").

Again, if the patient has (or has had) any of these conditions, you want to know the date (month and year) he or she had or was diagnosed with the condition. If the patient's family members had any of these conditions, just noting who has or had it is fine. The date the family member received the diagnosis it is not critical. You're just trying to establish possible genetic predisposition.

Finally, you need to establish if the patient has had any eye injuries or eye surgeries. It's not necessary to note whether the patient's sister had a corneal abrasion when she was 7 or the patient's paternal grandfather had cataract surgery when he was 87 years old. This is because these things are not genetic. Do you think the patient may get a corneal abrasion because the sister had one when she was 7? While the fact the paternal grandfather had a cataract is important to the patient's ocular history, the fact he had cataract surgery at age 87 is not.

Patient's job duties and off-duty hobbies

Before you finish the case history, find out what type of work the patient does. No, not just the job title, but what the patient actually does. Does the patient drive a lot or use computers all day? Read gauges or sort AF Forms on shelves 30 inches away? You're trying to find out how the patient is using the eyes in his or her occupation. This can help you and the doctor find out why the patient is getting headaches at the end of the day. Maybe he or she is wearing driving spectacles while working on the computer all day. On the other hand, if the doctor knows the patient spends a lot of time on the computer, he or she may suggest a Rx specifically for computer work. This would definitely be beneficial to the patient.

You also need to know the patient's hobbies for the same reason—you want to know how the patient is using his or her eyes. Does the patient shoot skeet? Repair cars or garden? Read or knit? Each of these activities has different demands on the eyes. Knowing this information can help you and the doctor provide better care for the patient. If you know the patient works on cars, maybe you could suggest spectacles with comfort cables—they would stay in place while the patient is upside down, looking under a dashboard, or trying to find a loose wire.

Recording the case history

Record the case history and the subsequent exam in the "SOAP" format that is listed in the table below.

SOAP Format	
S—Subjective	In this area, you record what the patient reports to you verbally. Record the patient's case history and subjective things you cannot see or verify empirically (patient's feelings or impressions).
O—Objective	This is the place you record the things you can see or measure. The patient's Rx, NCT readings, BP, etc. The doctor's examination findings are also recorded in the objective section.
A—Assessment	This is where the doctor records his or her assessment of the patient's condition, based on the subjective and objective information gained. The doctor's professional judgment and training comes into play at this point. The assessment is a "wrapping up" of all the information gained through questioning and testing of the patient. Think of it as being the diagnosis for the patient.
P—Plan/Prevention	This is the plan of care—what is to be done, based on the assessment made. Will the patient take eye drops for the next two weeks? Order spectacles for NVO? Follow-up for dilation in six months? The plan addresses these kinds of questions. Prevention is where counseling can occur.

Figure 1–3 shows an example of a written case history documented using the SOAP format.

HEALTH RECORD — **CHRONOLOGICAL RECORD OF MEDICAL CARE**

DATE: 17 Jun 2017

SYMPTOMS, DIAGNOSIS, TREATMENT TREATING ORGANIZATION (Sign each entry)

CC: 24 y/o B/M c/o ↓ DVA & NVA IN OD x 1 WK.

SUBJECTIVE: NVA - OK. PROBLEM IS MOST NOTICEABLE @ NIGHT. NO KNOWN POSSIBLE CAUSES. NO RECENT TRAUMA. NO OTHER COMPLAINTS.

AGE: 24 LEE: 1 YR DATE OF LATEST RX: 1 YR DATE OF LAST DILATED EXAM: 3 YR HEALTH: (E) G F P

MEDS: TAGAMET - HEART BURN X 1 WK (PRN) MED ALLERGIES: PCN, SULFA

PMHx & FMHx: HBP F, MGM HD PGF (ARTERIOSCLEROSIS) OTHER ALLERGIES: CATS
DIA S, M CA M - BREAST F - PROSTATE

POHx & FOHx: GLAU MGF CATARACTS MGM; MGF HOBBIES:
CROSSED EYES ϕ EMPLOYMENT:

OTHER EYE DISEASES: PGM HAS ARMD. SISTER IS A KERATOCONUS SUSPECT

POHx ONLY: EYE SURG, INJ ϕ - SURGERY; PT HAD CORNEAL ABRASION IN OD BY A BRANCH @ AGE 9 y/o. EYE PATCHED W/ NO RECURRENT PROBLEMS.

CL Rx:	POWER	BC	DIA	OTHER
OD	-2.00	8.7	14.5	BLUE "VISI-TINT"
OS	-1.75			

CL TYPE: D/W SOFT AVG WEAR TIME: 12 HRS AGE OF CL: 1 YR
BRAND: CSI WEAR TIME TODAY: 5 HRS LAST CL EXAM: 1 YR

SOLUTIONS (BRAND? HOW OFTEN?)
CLEANER: CIBA X DAILY ENZYME: CIBA X WEEK

DISINFECTANT: CIBA X DAILY LUBRICANT: B&L X PRN

OBJECTIVE: PRESENT Rx: OD (OC's @) OS ADD OD OS PD /

DVA	CC	SC	NVA	CC	SC	PINHOLE TEST:	EOMS:
OD	20/		OD	20/		OD 20/	
OS	20/		OS	20/		OS 20/	PUPILS:

COVER TEST DIST: CC SC NEAR:

BP / mmHg NCT OD OS mmHg @ mmHg @ Hrs

NOTES:

PATIENT'S IDENTIFICATION (Use this space for Mechanical Imprint)

RECORDS MAINTAINED AT: Your base

PATIENT'S NAME (Last, First, Middle initial)		SEX
PEETE, RODNEY T.		M
RELATIONSHIP TO SPONSOR	STATUS	RANK/GRADE
S	AD	SSGT (E-5)
SPONSOR'S NAME	ORGANIZATION	
	123 CES	
DEPART./SERVICE	SSN/IDENTIFICATION NO.	DATE OF BIRTH
AF	20/123-45-6789	07 NOV 75

CHRONOLOGICAL RECORD OF MEDICAL CARE — STANDARD FORM 600 (REV. 5-84) Prescribed by GSA and ICMR FIRMR (41 CFR) 201-45.505

Figure 1–3. Example of a written case history.

The following are some words of advice about recording case histories:

- PUT THE DATE ON THE EXAM FORM.
- If you make an error while recording the case history, line through the error once and initial by it. Do not scribble it out.
- If you get the case history from someone other than the patient (i.e., a parent or another provider), note this fact on the exam form somewhere.
- Treat the case history as the medical and legal document it is. Do not write it in pencil or erasable ink. Do not make snide comments on it. Redo the case history on another form if you make many mistakes. The case history is a reflection of you and your clinic.

- If you ask a question and the patient responds, write down what you asked and what the patient said. If you asked how the patient's distant vision is and he or she said it was fine, you need to record that. Some people mistakenly believe they only have to write things down if there is a problem. This is not true. You asked the question and he or she answered. Record the information. Medically and legally, it's important to do so.

604. Measuring visual acuity

One of the basic functions of the eye clinic is to measure patients' VA. You must perform this task with a high degree of accuracy and professionalism. Accurate measurements are extremely important for proper patient treatment and medical and legal reasons.

Overview

VA is a measure of the resolving power of the visual system; it's a measure of an individual's ability to receive, transmit, and interpret visual images. In simpler terms, VA is a measure of how well the eye gathers light (fig. 1–4), how well the nerves in the visual pathway transmit information to the brain, and what the brain does with this information.

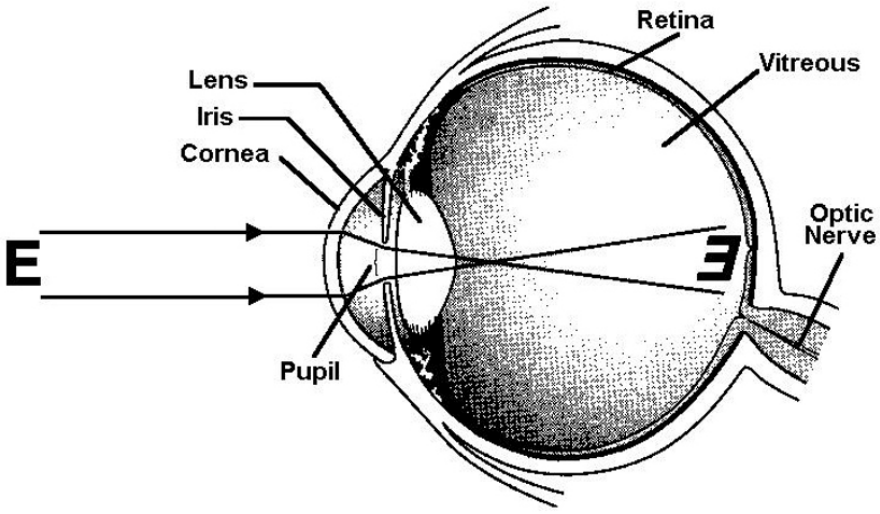


Figure 1–4. Receiving an image.

Visual efficiency, on the other hand, refers to seeing comfortably without eyestrain. Some people, even though they have 20/20 vision, do not have *comfortable* vision.

Routine VA tests in the eye clinic are usually done using form vision tests. The design of form vision tests keeps all factors constant, except target size (which affects the number of visual receptors stimulated). With form vision, acuity is based on the smallest recognizable object, usually a familiar letter, seen correctly at a specific distance under constant illumination. Form vision includes detection, discrimination, and recognition of the letter or object being used as a test target.

The most common test targets of a VA chart are the Snellen letters, which are letters of the alphabet specifically designed for taking VA measurements. The Snellen letters consist of five components and have a specific construction (height and width).

Physiology of VA

Record VA in the form **20/X** (Snellen notation) where **20** is the test distance in feet and **X** represents the smallest line the patient can read. What 20/20 (emmetropic vision) ultimately means is the patient can read the 20-ft. letter at a distance of 20 ft. You can reduce the fraction 20/20 to the whole number **1**. Translated, this means the eye can discriminate a figure composed of elements as small as **1 minute of arc**.

The 20-ft. letter subtends (extends from one endpoint to another) 5 minutes of arc at the eye and is assumed to have five components (fig. 1–5). Therefore, if the letter is divided into its five components, each component subtends 1 minute of the arc (20/20 = 1 minute of arc). In essence, a person who can read the 20/20 letter can detect the 1 minute of arc separation between each component of the letter.

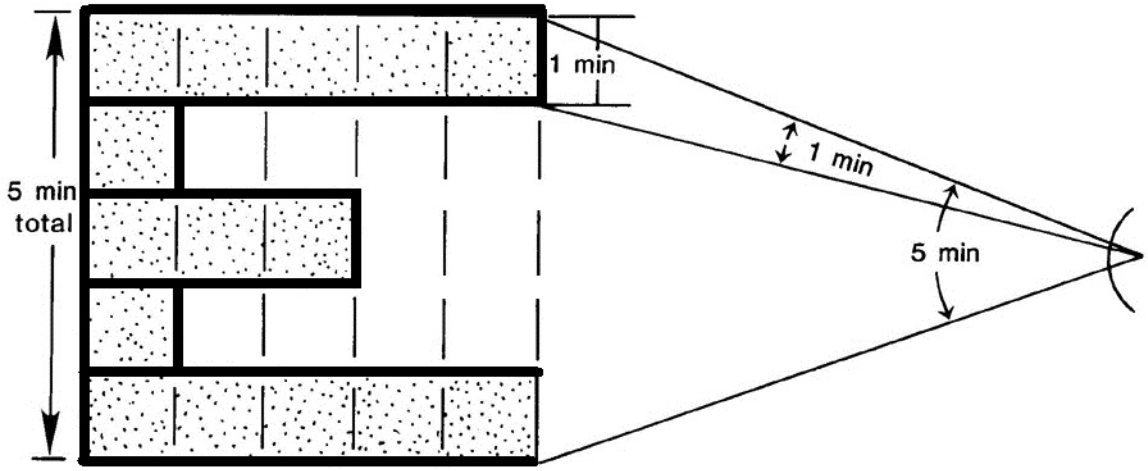


Figure 1–5. The letter "E" subtends 5 minutes of arc.

Think about a patient with 20/200 vision. He or she needs a letter having a separation of each letter component of 50 minutes of arc at 20 ft. As you can see, this is quite a difference. This is poor vision when you consider it in those terms. The 20/200 letter is 10 times as large as the 20/20 letter. This means a person with perfect (20/20) vision could see the 20/200 letter from 200 ft. away. This is because a letter's size denotes the distance at which that letter subtends 5 minutes of arc, and a person with perfect vision can see a letter as small as 5 minutes of arc total size (each component subtending 1 minute of arc). The 20/20 letter subtends 5 minutes of arc at 20 ft. The 20/100 letter subtends 5 minutes of arc at 100 ft. The 20/200 letter subtends 5 minutes of arc at 200 ft. You can see this concept in figure 1–6.

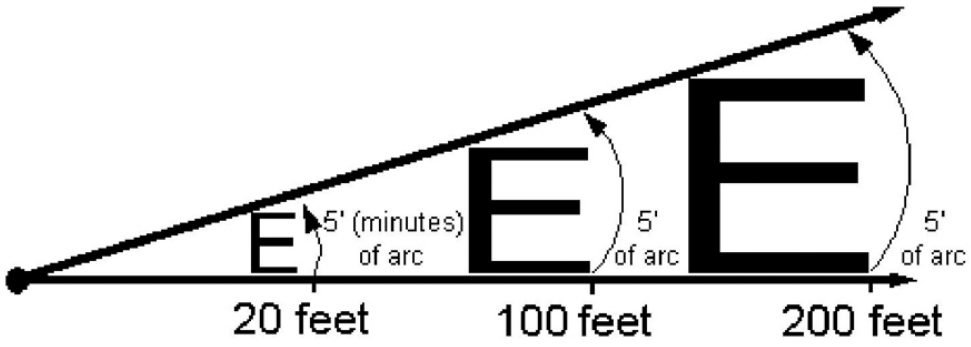


Figure 1–6. 5 minutes of arc and distance relationship.

If the patient has less than average VA, 20/40 for example, he or she can read the 40-ft. letter, but it can't be further than 20 ft. away. In other words, he or she can see an object 20 ft. away, while an individual with perfect vision could see the same object placed 40 ft. away.

Look at it mathematically:

- The reciprocal of 20/40 is 2, and each component of the 20/40 letter subtends 2 minutes of arc at the eye (at 20 ft.). In essence, this means the entire 20/40 "E" subtends 10 minutes of arc (five components per letter multiplied by 2 minutes of arc per component) at 20 ft. It's

twice as large as the 20/20 letter. However, when from 40 ft. away, the 20/40 letter would only subtend 5 ft. of arc because of the greater distance.

- A patient who has better than average vision, 20/10 for example, can read the 10-ft. letter at 20 ft. He or she can see at 20 ft. what the average person with 20/20 vision would have to move up to 10 ft. to see. The reciprocal of 20/10 is 0.5, and the components of the 20/10 line subtend 0.5 minutes (or 30 seconds) of arc at the eye from 20 ft. away. It follows the entire 20/10 "E" would subtend 2.50 minutes of arc (5 × 0.5), making the 20/10 "E" half the size of the 20/20 "E."

Measuring distance vision with the Project-O-Chart™

One of the instruments used to measure VA is the Project-O-Chart™ (fig. 1–7). This instrument is essentially a slide projector with special ophthalmic slides, supplied with the instrument. It projects a letter or object onto a specialized screen. Lens tubes for the projector are specially designed for either a 15- to 20-ft. room or a 10- to 14-ft. room.

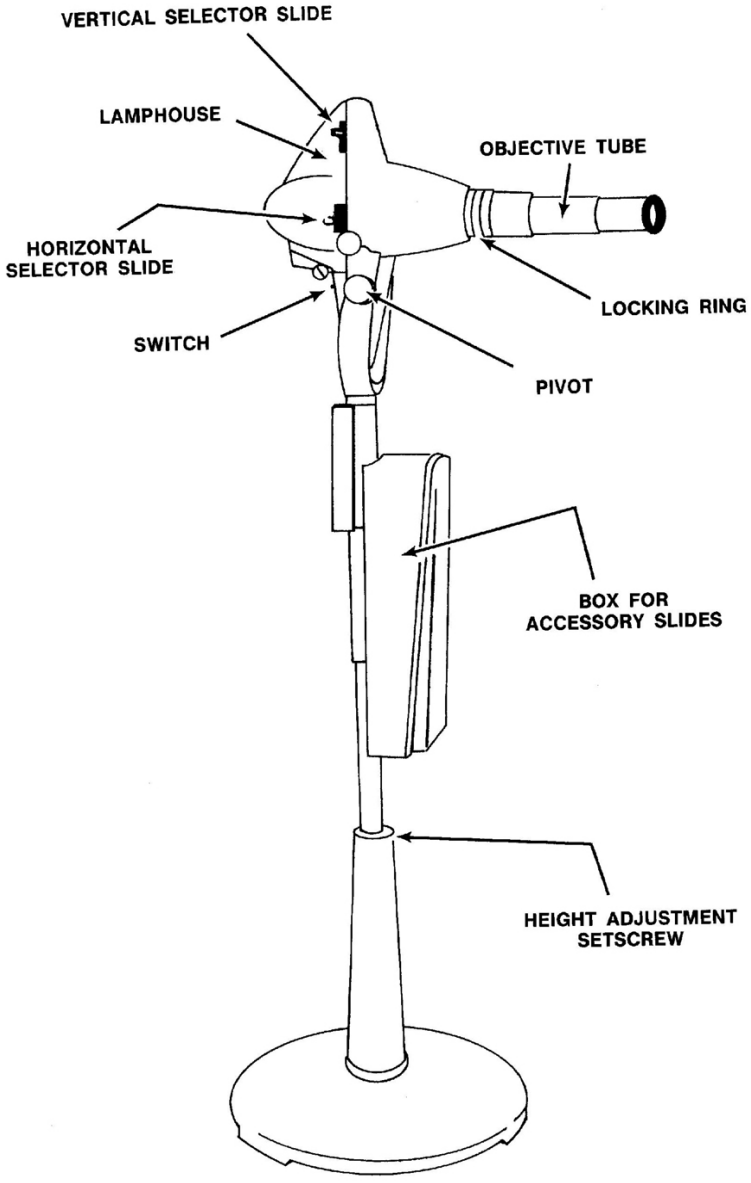


Figure 1–7. Manual Project-O-Chart™.

The manual and auto (fig. 1–8) projectors do the same thing, project letters. However, the auto projector does not have the correct slides to perform suppression testing. Therefore, make sure no one gets rid of the old manual projector just because the clinic has the automatic ones.

Figure 1–8. Auto projector.

Project-O-Chart™ use

To accurately project a properly sized letter, the Project-O-Chart™ must be positioned correctly. The projector tube should be on the same horizontal plane as the reflective screen. The proper size of the projected letter is assured by calibrating it in the following manner:

1. Place the Project-O-Chart™ 1–3 ft. in front of the patient, regardless of the test distance (this is so you can change the letters and still keep an eye on the patient). Remember to have the instrument on one side or the other of the patient and not directly in front of his or her line of sight. Plug the instrument into a 115 alternating current (AC) outlet. Insert a standard projector slide and project a 20/200 letter onto the reflective screen.
2. Measure the distance from the screen to patient's eyes. Ideally, the patient is 20 ft. from the viewing screen.
3. Loosen the lock screws to both the large and small barrels (lens tubes). Now place the test distance template supplied with the projector against the reflective screen. Then move both barrels in and out until the 20/200 letter is in sharp focus and the appropriate height for the test distance. Tighten the lock screws when the 20/200 letter is the correct height and in focus.

If your clinic no longer has the 20/200 letter-sizing template (fig. 1–9) that came when the equipment was ordered, use a PD ruler and set the 20/200 "E" to the size shown in the table below:

20/200 "E" Measurements Based On Test Distance	
Chair to screen distance	**20/200 "E" height**
20 ft.	88 millimeter (mm)
15 ft.	66 mm
10 ft.	44 mm

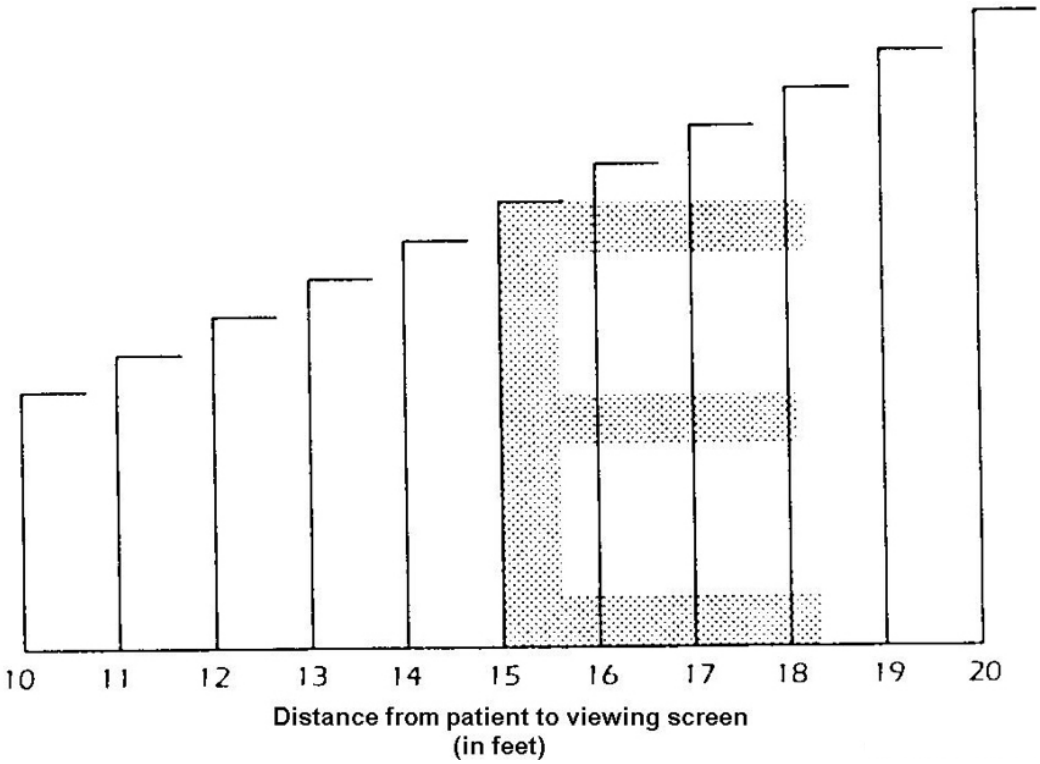


Figure 1–9. 20/200 letter-sizing template. (NOTE: Illustration not to scale).

Calculation of intermediate test heights

Referring to the table above, the 20/200 "E" is 88 mm high when the patient's eyes are 20 ft. from the screen, you can calculate the height for any test distance by simply solving for the unknown. For example, if you want to know the height the 20/200 letter when a patient is 17 ft. from the eye chart, you set up the calculation as shown below:

$$\frac{20\text{ ft.}}{88\text{ mm}} = \frac{17\text{ ft.}}{\text{X mm}}$$

Now you want to solve for X. You do this by cross-multiplying the terms as shown:

$$\frac{20\text{ ft.}}{88\text{ mm}} \times \frac{17\text{ ft.}}{\text{X mm}}$$

So, 20 times X equals 88 times 17 (88 times 17 equals 1496). Your equation would now look like this:

$$20X=1496$$

Now you want to get X by itself on one side of the equation. You can do this, in this example, by dividing each side by 20, as shown:

$$\frac{20X}{20} = \frac{1496}{20}$$

Once you have done this, you would end up with X = **74.8**.

Now you know you need to resize the 20/200 "E" to make it 74.8 mm tall when the test distance is 17 ft.

There is another way to calculate the proper height of the 20/200 "E" for distances of less than 20 ft. For every foot of distance, multiply by 4.4 mm. In the example we just did for a 17-ft. test distance,

you would multiply 17 times 4.4, which would equal 74.8 mm. If you could only get the patient 15 ft. from the eye chart, you would multiply 15 times 4.4 and come up with a 20/200 "E" height of 66 mm. You just need to remember it's 4.4 mm for each foot of test distance.

Horizontal and vertical selector slides

On the Project-O-Chart™ (fig. 1–7), use the horizontal selector slide to view letters in a full square chart, a split red/green screen, or a vertical line of letters. Use the vertical selector slide to isolate a vertical line of letters; use the horizontal selector slide to isolate a horizontal line of letters. When used together, the horizontal slide and the vertical slide can isolate a single letter on the chart.

Maintenance

Clean the glass slides, lenses in the focusing tube, and screen by wiping them off with a soft, dry, clean cloth. Never use rubbing alcohol. Never attempt to remove the lenses from the focusing tube. Never touch the Project-O-Chart™ screen; the oil from your fingers leave permanent marks on the screen. A dirty screen and/or dirty slides cause the letters on the screen to appear blurred, increasing the likelihood of erroneous VA readings.

When replacing bulbs, follow these steps:

1. Unplug the Project-O-Chart™.
2. Press the release button near the top of the lamp house.
3. Allow the lamp house section to swing back on its hinges.
4. Remove the inner lamp house by pulling the top back towards you until the spring slips have disengaged, then lift it out.
5. Depending on the model in your clinic, the light bulb may have a bayonet socket removed by pressing down, twisting counter-clockwise, then lifting it out. Other models allow you to pull the bulb straight out. Check your owner's manual and do not attempt any further disassembly!

> **CAUTION**: If the Project-O-Chart™ is on when a bulb goes out, both the bulb and the housing will be extremely hot. If you must replace the bulb immediately, use a towel or lots of tissue when removing the housing and old bulb to prevent burning yourself.

6. Get a new bulb. Use a cloth or tissue when handling the new bulb, so you do not get oils from your fingers on it. Oil on the bulb causes hot spots and reduces bulb life dramatically. If you do accidentally touch the new bulb with your fingers, wipe it clean with an alcohol pad and dry it with a tissue.
7. Install the new bulb. Wrap the top of the bulb with tissue or a cloth. This serves two purposes: (1) protecting your hand in case the bulb breaks on installation and (2) preventing finger oils from getting on the bulb. Again, the installation may vary based on your particular model. Insert the bulb into the socket, push down, and then rotate the bulb clockwise a one-fourth turn. If your unit allowed you to remove the bulb by pulling straight out, it makes sense installation is just pushing the new bulb straight in. Now, reassemble the Project-O-Chart™ in reverse order of disassembly, plug it back in, and turn it back on.

The supply custodian for your clinic is responsible for maintaining an adequate supply of replacement bulbs for the Project-O-Chart™. A two-week supply is desirable since the bulbs blow out without warning. Bulbs always seem to burn out during your busiest times so have plenty of spares on hand.

Administering VA tests

Every patient seen in your clinic must have a VA test. It's simple to do and provides a wealth of information about the visual status of the patient. VA testing can tell you if a patient is nearsighted, farsighted, or dramatically astigmatic, all of which are forms of ametropia (i.e., refractive error). VA

testing can tell you if a patient is presbyopic, and it can indicate how problematic a patient's cataract is. VA testing may reveal indications of retinal damage or damage to more posterior structures in the visual pathway. The list goes on and on. VA is so essential to any eye exam that it's vital you know how to measure VA correctly.

Testing consideration

Vision is usually tested monocularly (one eye at a time), with the eye not being tested occluded. Generally, the right eye is tested first, unless there is a specific reason to start with the left. Getting into the habit of beginning all tests with the right eye (not just VA tests) helps you establish a consistent routine. This way, if interrupted during a test, it's easier to remember where you left off when you resume testing.

For VA testing, the patient needs to wear the appropriate Rx for the given test distance. This means reading spectacles are worn for near visual acuity (NVA) testing, driving spectacles are worn for distant visual acuity (DVA) testing, or the habitual Rx is worn for both tests if the patient normally wears spectacles all the time. If you are testing a patient's NVA and the patient wears a multifocal, make sure he or she is looking through the lowest segment while reading the near point card. If your doctor wants you to measure the patient's VA both with correction ($\overline{cc}$) and without correction ($\overline{sc}$), test the patient $\overline{sc}$ first.

If your patient is a child, it's a good idea to test his or her best eye first at the distance he or she sees best. If the child favors the right eye and complains of not being able to see the board at school, test his or her near vision first, starting with the right eye. You do this because children tend to become frustrated easily, so by allowing them to start with what they can see, you can keep their attention longer. Also, remember to use the appropriate chart based on the child's ability. An object chart might be a good choice for a two- or three-year-old, whereas a seven-year-old should be able to use the Snellen letter or number chart.

Charts and notations used

Snellen-type charts, whether they are composed of letters, numbers, characters, or objects, are the most commonly used charts for both distance and near vision testing.

If you test a patient at **18 ft.**, adjust the Project-O-Chart™ letters to be slightly smaller, since the patient is slightly closer to the letters. This gives the letters the same appearance they would have had if the patient had been at 20 ft. This being the case, still record the vision obtained as **20/X** even though the test distance was actually 18 ft. The smaller letter sizes compensated for the missing 2 ft. of test distance. The Snellen charts for DVA and NVA usually have lines ranging in size from as small as 20/10 to as large as 20/400: the larger the number, the bigger the letters on the chart. A patient who sees 20/200 needs to be 20 ft. away to see a letter a person with normal vision (20/20) could see from 200 ft. away. You know it must be a big letter when you think of it this way!

You generally perform near-point acuities with a Jaeger acuity card or a reduced Snellen acuity card (fig. 1–10). The proper distance for NVA testing is printed somewhere on the near point card. Check for this measurement prior to administering the test. No matter what the test distance, use Snellen notation for recording the vision, 20/**X**. Snellen notation is the conventional way to record VAs. Therefore, a near point card held at 14 inches while testing, in which the patient sees the 14-inch line, would not be recorded as "14/14" but would be translated as "20/20" instead. What if the patient saw 14/28? Record the patient's vision as "20/40."

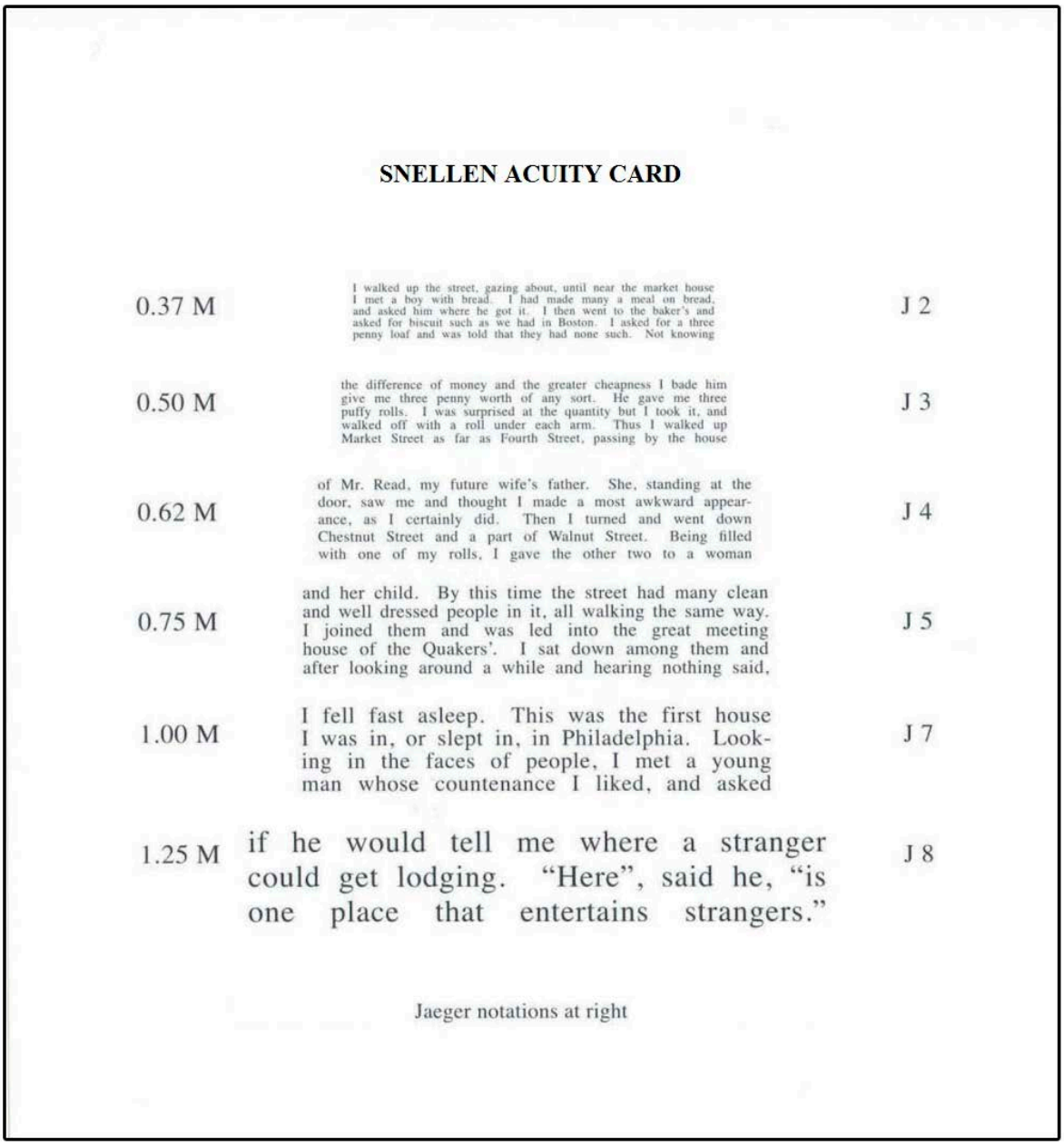


Figure 1–10. NVA card with Snellen numbers.

The way you convert to the Snellen equivalent is simple really. Set up a math formula and then solve for X. Let us use our "14/28" visual acuity as an example.

$$\frac{14}{28} = \frac{20}{X}$$

Now cross multiply:

$$\frac{14}{28} \times \frac{20}{X}$$

Therefore, 14 times X equals 28 times 20 (28 times 20 equals 560). Your equation would now look like this:

$$14X = 560$$

Now you want to get X by itself on one side of the equation. You can do this in this example, by dividing each side by 14, as shown:

$$\frac{14X}{14} = \frac{560}{14}$$

$$X = 40$$

Now, you can see a VA of 14/28 is the same as 20/40. Using this mathematical method, you can convert any "non-Snellen" acuity to standard Snellen notation.

In addition to the Snellen letter and number charts used for testing literate adults and older children, there are a number of charts made specifically for testing illiterate patients or young children. These VA charts do not require the patient to have knowledge of numbers or the alphabet. Examples of these vision-testing charts include the Tumbling E Chart, the Landolt C Chart, and the Object Chart (fig. 1–11).

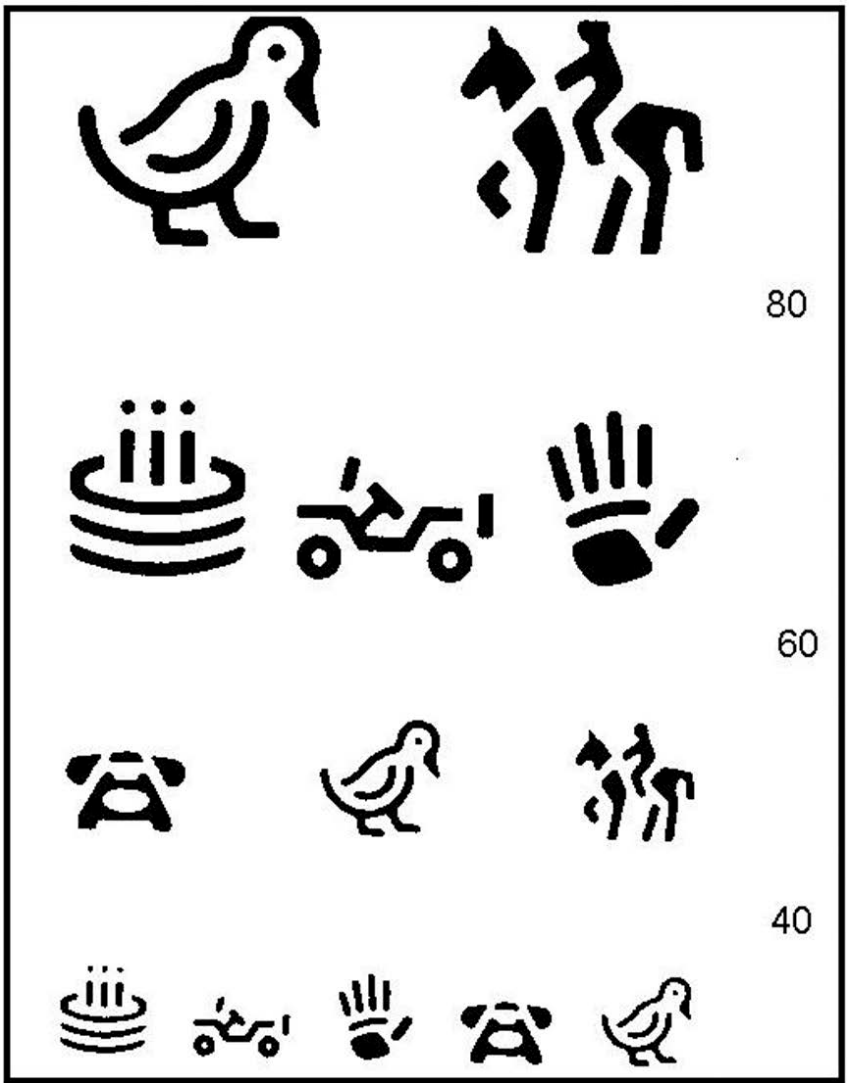


Figure 1–11. Object chart.

Step-by-step procedures

Now you can proceed with the testing. As a rule, when testing a patient's VA, whether at distance or near, you want to observe the patient, not the test chart. This way you know if the patient is trying to squint or uncovering the eye he or she is supposed to have covered.

It's very important you remind your patients not to squint. Squinting often improves a patient's vision, giving a false impression the patient can see better than he or she really can. Squinting makes the VA results inaccurate. Sometimes it helps to remind patients that VA is not a "pass or fail" test. It's just a measurement of how well the patient can see.

DVA using Project-O-Chart™

Here are step-by-step procedures for administering DVA and NVA tests. If you are using a Project-O-Chart™ type of system, turn the room lights off. If you are using the old cardboard-type of eye chart, leave the room lights on.

1. Have the patient cover his or her left eye with the occluder. Remind the patient not to squint.
2. Expose lines 20/20 through 20/40 or 20/50 of the Project-O-Chart™.
3. Ask the patient to read the smallest line possible without squinting. If the patient is unable to read the largest line shown, adjust the chart so the largest line previously shown is now at the bottom of the chart, with larger lines above it.
4. Give the patient credit for any line in which he or she gets 50 percent (or more) of the letters on the line correct.
    - *Example 1:* If a patient gets three letters correct on the 20/30 line, which contains six letters, give him or her credit for seeing the 20/30 line, and then ask him or her to attempt the next smaller line. If the patient cannot see any of the letters on the 20/25 line, record the patient's VA as $20/30^{-3}$. The "30" indicates the patient read *at least* 50 percent of the 20/30 line and the "$^{-3}$" indicates the patient missed three of six letters on that line.
    - *Example 2:* A patient reads all of the letters on the 20/40 line and gets two letters correct on the 20/30 line. In this case, you would record the score as "$20/40^{+2}$"; the "40" indicates the patient read at least 50 percent of the 20/40 line. The "$^{+2}$" tells the doctor the patient was able to read two of the letters on the 20/30 line, which is noteworthy, although it's not enough to get full credit for that line of acuity.
5. Once you have measured the patient's VA in the right eye and recorded the results, have the patient switch the occluder so you can test the left eye, following the same procedures just described.

Move the patient

Sometimes, the patient cannot read even the largest letter on the chart (usually the 20/400 "E") from 20 ft. If this should happen, have the patient continue to occlude the eye not being tested and walk the patient slowly toward the chart until he or she can make out the 20/400 "E." Note the patient's distance from the chart.

For example, say you walked the patient up to 5 ft. from the chart before he or she could see the 20/400 "E." At this point, record the patient's vision as "20/400 @ 5 ft." If the patient had seen the "E" from 15 ft. away, you would have recorded the VA as "20/400 @ 15 ft." This makes it clear to the doctor how close you had to walk the patient toward the chart before he or she could read the 20/400 "E."

Do not try to compute what size the letter would have represented; doctors are not impressed when they see a vision recorded as 20/1600. The doctor just needs to know how far the patient was from the chart before actually seeing the 20/400 letter.

A final note on walking a patient toward the eye chart: do not walk the patient any closer than 3 ft. from the eye chart. If the patient cannot see the 20/400 "E" at 3 ft., it's time to sit him or her down and try the finger-counting (FC) test.

FC test

The FC test is simply where you hold up a few fingers in front of the patient's eye and see if the patient can tell you how many fingers you displayed. He or she still needs to keep the eye not tested covered. With the room lights on, hold your hand 3 ft. from the patient's eye with some of your fingers extended. Ask the patient to identify how many fingers you are holding up. If the patient does not respond, hold your hand 2 ft. away. If the patient still cannot answer, try 1 ft. away. If the patient still cannot see how many fingers you are showing him or her, move your hand to where it's only 6 inches away from the eye. Some patients may have a central scotoma, so try different areas of the VF before moving closer.

If, at some point, the patient responds with the correct number of fingers, record the results as "FC @ distance." For example, if the patient told how many fingers you held up with your hand 2 ft. from the eye, record as "FC @ 2 ft."

If the patient cannot count how many fingers you have in front of his or her eye from a distance of 6 inches, move on to the hand-motion (HM) test.

HM test

The HM test is where you move your hand (or not move your hand) in front of the patient's eye and see if he or she can tell you what you are doing. Do not move your hand so fast that the patient can feel a breeze on his or her face. If you move your hand fast and cause a breeze, the patient would be able to tell your hand was moving, not by sight, but by feeling the wind on his or her face. Move your hand slowly so you do not cause a breeze. Conduct this test at 1 ft. away from the patient's face. If the patient can tell your hand is moving at 1 ft., record HM @ 1 ft. If not, move on to the light localization (LL) test.

LL test

The LL test consists of shining a penlight or transilluminator towards the patient's eye while moving the light into different locations of the patient's field of view. You are trying to see if the patient can tell from which direction the light is shining. Turn off the room lights for this test and ensure the patient's untested eye is thoroughly occluded for accurate results. If the patient can tell you where the light is shining from, record "LL" for light localization.

If the patient could not tell which direction the light was coming from, but he or she could tell there was a light shining in his or her eye, record the results as "LP," which stands for "light perception."

If the patient could not tell there was a light shining in his or her eye, record "NLP," which stands for "no light perception."

Once you have ascertained the patient's DVA for each eye, you're ready to test the near vision.

Measuring NVA

Perform NVA with normal room lighting. If the room is dim, even with all the lights on, use a lamp shining from above the near card for extra illumination. The card itself determines the test distance for NVA testing. Some cards are for 13 inches, some are for 14 inches, and others for 16 inches. Hold the card at the test distance indicated on the card.

If the patient wears an NVO Rx, a multifocal Rx, or a habitual Rx (one worn at all times), have him or her wear the spectacles for NVA testing. If the patient only wears spectacles for driving, do not make him or her wear them for the NVA test. Some patients may tell you their glasses are only for distance. However, if they perform poorly or struggle without their glasses, have the patients try again with their glasses on. A lot of the time, the test results are better with their glasses.

Test the right eye first, so occlude the left eye. Ask the patient to read the smallest line he or she can clearly see. If he or she starts with anything larger than the 20/20 line, have him or her continue to the smaller lines until he or she reads 20/20 or just can't see the letters clearly enough to make them out anymore. Record the VA. Switch to the other eye and repeat the procedure.

NOTE: If the patient wears a multifocal, make sure that he or she is looking through the lowest segment of the spectacles for the near vision test. The patient can even lift the spectacles up a bit, if it helps him or her see through the reading segment.

Administering the pinhole test

Perform the pinhole (PH) test when a patient's best VA (BVA) is 20/40 (or worse) at distance and near in the same eye. For example, if a patient's VA in one eye (with correction worn) is 20/70 in the distance and 20/80 at near, perform a PH test on this eye. If the patient's VA (with correction worn) was 20/100 in the distance and 20/30 at near, a PH test would *not* be needed, since the near vision is better than 20/40 in this eye.

NOTE: The PH test cannot be done if the Optec Vision Tester (OVT) vision-test apparatus is being used for VA testing.

You must look at a patient's DVA and NVA for one eye before you can determine whether you need to perform the PH test. Once you have decided to perform the test, only test for improvement in the patient's *distance* vision. *Do not* accomplish the PH test for near vision. This is because if the patient's vision improved with the PH in the distance, it's a given that the vision will improve the near vision as well.

The PH test gives you and your doctor a good indication of whether a patient's decreased VA can be improved with corrective lenses or not. The test is quite simple. The patient looks through a little hole at the DVA chart. They look at an acuity line one line smaller than the one seen earlier during the DVA testing for that eye. If the patient can see better looking through the PH, it's a good indication he or she could see better with spectacles.

Put another way, if a patient has an *ametropia* (refractive problem) his or her vision should improve when looking through the PH. The smaller the line a patient can see while looking through the PH can indicate how much better his or her vision may improve with corrective lenses.

If, on the other hand, a patient's vision does not improve when looking through the PH, it's a good indication a corrective lens will not help, and the patient may have *amblyopia.* No improvement with the PH could also be due to some type of disease occurring in the eye or visual pathway. This is important information for a doctor to know before beginning an exam.

NOTE: This is the clinical definition of amblyopia: VA 20/40 *or worse* in an eye, even after applying the best correction possible to improve the vision and after ruling out all other causes. Causes of amblyopia include many things, such as long-term suppression of an eye, or a large refractive error between the two eyes that went uncorrected for too long.

To administer the PH test, instruct the patient to hold the PHs in front of the eye you are testing while occluding the other eye. Show the patient the next line smaller than the one he or she read without the PH (e.g., if the patient's DVA was 20/80 without the PH, start with the 20/70 line) and ask him or her to look through one of the holes at the chart. If the patient can read the 20/70 line, continue showing him or her smaller acuity lines until the patient cannot read any more lines or reads the 20/20 line, whichever comes first. The same guidelines used earlier for checking distant vision apply (i.e., if the patient gets half of the letters, or more, correct on an acuity line, he or she gets credit for having read that line).

The PH works to improve vision in ametropic patients because the aperture of the PH only allows a small bundle of light rays to travel straight toward the patient's fovea centralis. This effectively eliminates the dioptric/refractive errors of the eye, allowing the patient to see almost as clearly as if

he or she had the correct Rx lenses. No improvement with the PH indicates a refractive error (ametropia) is not the problem. Amblyopia or disease is preventing the eye from seeing well.

When you record the PH test, write "PH" followed by the VA. Place this notation immediately after the distance acuity measurement. For example, when performing regular VA testing on a patient, you found the right eye had a DVA $\overline{cc}$ of $20/50^{+2}$ and an NVA $\overline{sc}$ of 20/60. Using the PH, the OD could read the 20/30 line of the DVA chart. You would record this finding as "PH: 20/30." If vision did not improve, record "20/50 NIPH" to indicate "no help" or "no improvement."

Recording VA results

VA results are annotated by indicating the test distance (DVA or NVA), the eye tested (OD or OS), whether the test was done $\overline{cc}$ or $\overline{sc}$, and the measured level of acuity using Snellen notation (20/20, 20/50, 20/400, etc.) for the lines read correctly. Do not forget to include the PH test results, if performed.

Example 1:	**DVA** $\overline{sc}$	**NVA** $\overline{sc}$
	OD $20/30^{-1}$	OD 20/20 PH 20/—
	OS $20/80^{+1}$	OS 20/100 PH $20/25^{+2}$
Example 2:	**DVA** $\overline{cc}$	**NVA** $\overline{cc}$
	OD $20/200^{-2}$	OD 20/100 PH $20/50^{+2}$
	OS 20/400@15 ft.	OS 20/200 PH 20/NI

Perform contrast sensitivity testing

Another aspect of our vision of interest is contrast gradient VA (contrast sensitivity testing). This is a measure of our VA during conditions of poor contrast. An individual may have 20/20 VA when tested with the Snellen chart but still complain of poor vision. This is because Snellen acuity measures an individual's ability to see high-contrast (HC) images in a controlled environment. The contrast sensitivity test can measure the entire spectrum of contrast and images. Contrast sensitivity can evaluate vision in a more realistic manner.

Contrast sensitivity testing resembles real-life situations much better than the Snellen chart. Contrast sensitivity chart patterns have varying orientation, sizes, and contrasts. The contrast sensitivity chart used for the Aviation Corneal Refractive Surgery (CRS) Program is the Precision Vision® (PV) chart. Contrast sensitivity is important in the final VA and is much more reliable than Snellen acuity.

HC VA

Remember, the standard test of VA determines the smallest letters your patient can read at maximum contrast (black letters on a white background). However, many things we encounter in everyday life are lower in contrast (e.g., grey on white), particularly in operational settings (e.g., night, dust, smoke, fog). The ability to see low-contrast targets can decrease despite normal ("20/20") VA (fig. 1–12).

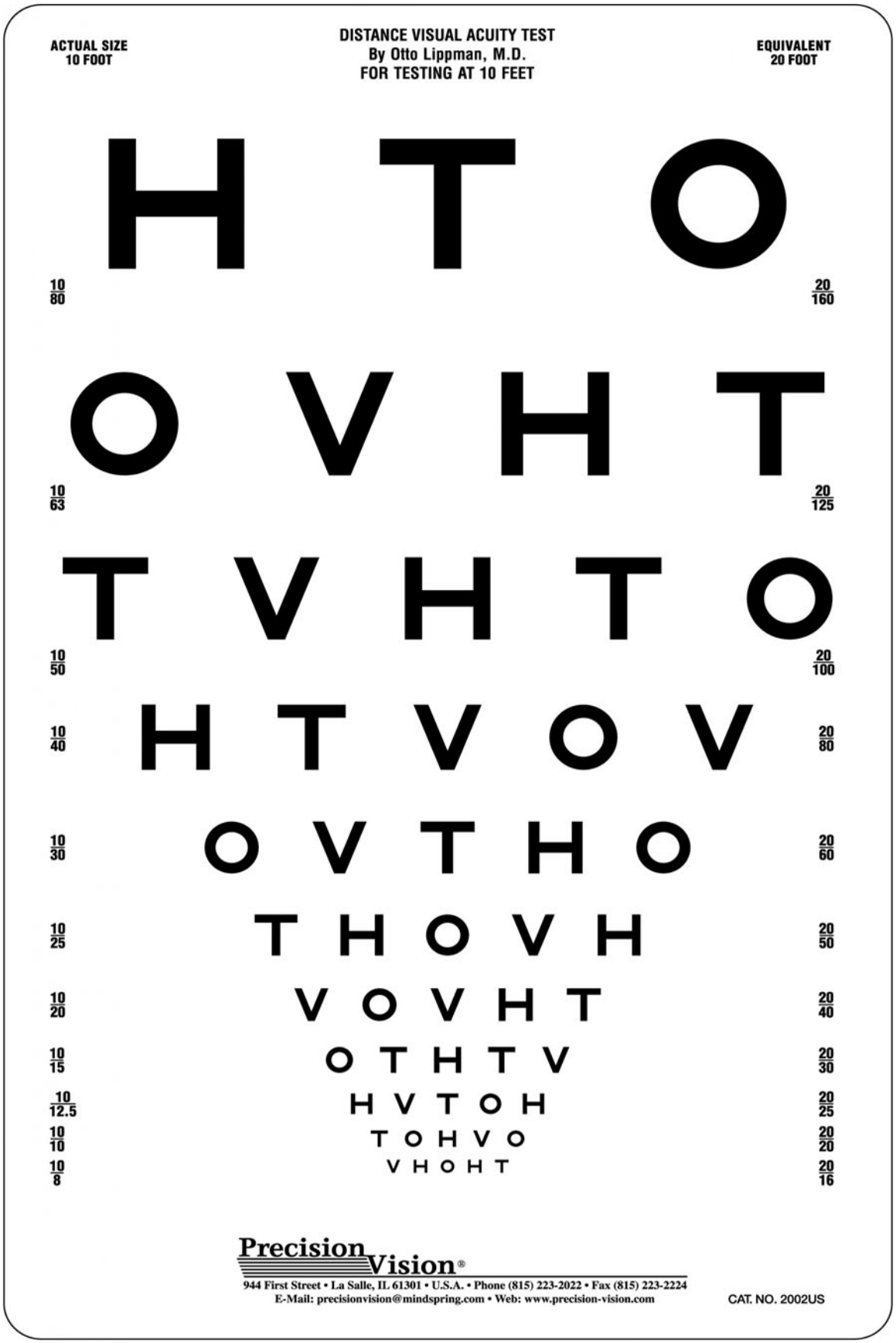


Figure 1–12. HC VA.

Low-contrast visual performance

One way to measure low-contrast performance is with contrast sensitivity, in which the target or letter size remains constant, but its contrast is decreased until it's barely seen (from black to light grey). This can be repeated for targets of various sizes to gain a complete measure of vision (fig. 1–13).

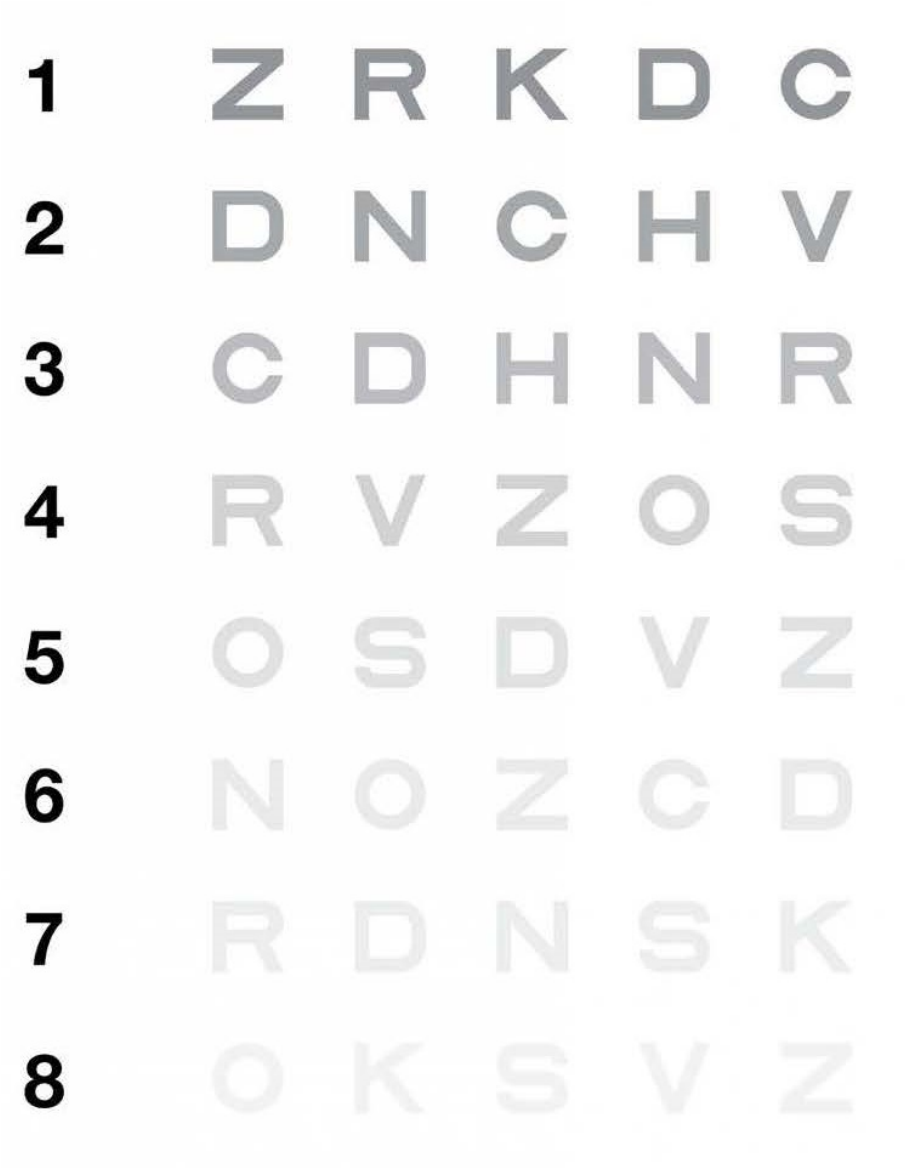


Figure 1–13. A low-contrast sensitivity letter chart.

PV® charts

The primary application of contrast sensitivity testing in AF clinics is for the refractive surgery program, which is why you'll learn specifically about the PV® chart.

Low-contrast vision also can be assessed with *low-contrast* VA, which measures VA (smallest letters you can see), but with light grey letters rather than black letters. This low-contrast VA test, available from PV® measures the ability to see low-contrast targets, providing a realistic indicator of performance (fig. 1–14).

Figure 1–14. The PV® low-contrast chart currently used by the USAF.

Using the PV® charts

The PV® chart is the only authorized contrast sensitivity chart for the Aviation CRS Program.

Chart setup

The chart itself is a 9” X 14” Illuminator Cabinet that can be mounted on a five-leg castor base. The High Contrast Visual Acuity Chart (two versions) and a 5 percent Contrast Visual Acuity Chart (two versions) are available for use.

Test lighting

A self-illuminator cabinet provides backlighting for VA charts. There are no other room lights on during testing.

Test distance

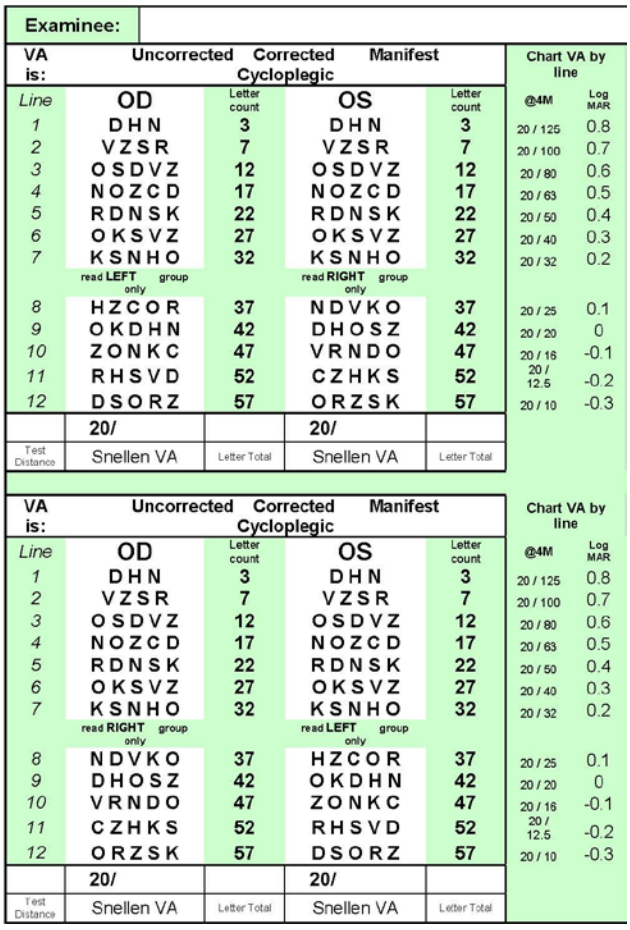
Charts are designed for a 4-meter or 13-ft. test distance (patient to chart).

If set at 4 meters, VA range = 20/10 to 20/125.

If set at 2 meters, VA range = 20/20 to 20/250.

If set at 1 meter, VA range = 20/40 to 20/500.

For consistent results, it’s recommended permanent markers be placed on the floor for chart placement. This allows quick and accurate placement if the chart is shared between offices or moved to expand minimum VA range. Another recommendation is to purchase additional charts and cabinets if used in multiprovider locations. At the time of this writing, information regarding PV® equipment can be found at: http://www.precision-vision.com.



Examinee:

VA is: Uncorrected Corrected Manifest Cycloplegic

Line	OD	Letter count	OS	Letter count
1	D H N	3	D H N	3
2	V Z S R	7	V Z S R	7
3	O S D V Z	12	O S D V Z	12
4	N O Z C D	17	N O Z C D	17
5	R D N S K	22	R D N S K	22
6	O K S V Z	27	O K S V Z	27
7	K S N H O	32	K S N H O	32
	read LEFT group only		read RIGHT group only	
8	H Z C O R	37	N D V K O	37
9	O K D H N	42	D H O S Z	42
10	Z O N K C	47	V R N D O	47
11	R H S V D	52	C Z H K S	52
12	D S O R Z	57	O R Z S K	57
	20/		20/	
Test Distance	Snellen VA	Letter Total	Snellen VA	Letter Total

Chart VA by line

@4M	Log MAR
20 / 125	0.8
20 / 100	0.7
20 / 80	0.6
20 / 63	0.5
20 / 50	0.4
20 / 40	0.3
20 / 32	0.2
20 / 25	0.1
20 / 20	0
20 / 16	-0.1
20 / 12.5	-0.2
20 / 10	-0.3

VA is: Uncorrected Corrected Manifest Cycloplegic

Line	OD	Letter count	OS	Letter count
1	D H N	3	D H N	3
2	V Z S R	7	V Z S R	7
3	O S D V Z	12	O S D V Z	12
4	N O Z C D	17	N O Z C D	17
5	R D N S K	22	R D N S K	22
6	O K S V Z	27	O K S V Z	27
7	K S N H O	32	K S N H O	32
	read RIGHT group only		read LEFT group only	
8	N D V K O	37	H Z C O R	37
9	D H O S Z	42	O K D H N	42
10	V R N D O	47	Z O N K C	47
11	C Z H K S	52	R H S V D	52
12	O R Z S K	57	D S O R Z	57
	20/		20/	
Test Distance	Snellen VA	Letter Total	Snellen VA	Letter Total

Chart VA by line

@4M	Log MAR
20 / 125	0.8
20 / 100	0.7
20 / 80	0.6
20 / 63	0.5
20 / 50	0.4
20 / 40	0.3
20 / 32	0.2
20 / 25	0.1
20 / 20	0
20 / 16	-0.1
20 / 12.5	-0.2
20 / 10	-0.3

Figure 1–15. Example of a HC PV® recording form.

VA measurement

In the following instructions, the term “aircrew” designates any member approved for surgery under the Aviation and Aviation-Related Special Duty (AASD) refractive surgery program. For these members, use the “Precision Vision Recording Form” for VA documentation.

The examination is completed monocularly (one eye at a time). Typically, this is accomplished without corrective lenses first, then with current or best correction. With visual correction in place, all aircrew should be able to perform the test with the PV® chart set at 4 meters (about 13 ft.) away. Without visual correction in place, the chart may need to be moved.

The first and second row of the current standard PV® charts consists of less than five letters. The charts have three letters on the top row and four letters on the second row. Rows 3–7 consists of five letters each (fig. 1–15).

VA scoring

Scoring of the PV® charts is different from the method used for most VA charts. Since scoring is based on number of letters correctly identified versus reaching a given row, it’s important to encourage the aircrew to call out every letter they think they can identify. The mechanics of recording the score are not critical, as long as it’s clear which letters were read correctly.

Techniques include circling the correct responses, crossing out the missed letters, or doing both. Once the member has identified all letters he or she can (at a given distance), the VA score is calculated by counting all the correctly identified letters. The recording form has a running letter count beside each chart to assist you.

The "Precision Vision Recording Form" spreadsheet, found at: https://kx2.afms.mil/kj/kx1/AFRefractiveSurgery/Pages/tools.aspx, provides an easy way to record and score an aircrew member’s results. The first tab on the PV® Recording Form spreadsheet is "Testdistance." This spreadsheet provides information about setting up the test parameters. The PV® charts were designed to be used at 4 meters (about 13 ft.). However, if you cannot set the chart at 4 meters due to room constraints, the spreadsheet allows you to calibrate the "letter count to VA" conversion. Measure the distance from the aircrew member’s eye position to the chart. You can use either feet and inches or meters and centimeters as the unit of measurement. There are three tables at the bottom of the "Test distance" tab. The purpose of these three tables is to enable you to print conversion tables for three distances; one at the farthest chart distance (typically 4 meters), the second at half the distance, and the third at one-fourth the distance. Therefore, if aircrew members cannot distinguish letters at 4 meters, the chart can be easily moved closer with predetermined tables for determining their VA.

Number of Letter Read to Equivalent Snellen VA Conversion Table										
Distance used for this table	# of letters	Snellen Acuity	# of letters	Snellen Acuity	# of letters	Snellen Acuity	# of letters	Snellen Acuity	# of letters	Snellen Acuity
	1	20 / 132	13	20 / 76	24	20 / 46	35	20 / 28	46	20 / 17
4	2	20 / 126	14	20 / 73	25	20 / 44	36	20 / 26	47	20 / 16
	3	20 / 121	15	20 / 69	26	20 / 42	37	20 / 25	48	20 / 15
Meters	4	20 / 115	16	20 / 66	27	20 / 40	38	20 / 24	49	20 / 14
	5	20 / 110	17	20 / 63	28	20 / 38	39	20 / 23	50	20 / 14
	6	20 / 105	18	20 / 60	29	20 / 36	40	20 / 22	51	20 / 13
	7	20 / 100	19	20 / 58	30	20 / 35	41	20 / 21	52	20 / 13
	8	20 / 96	20	20 / 55	31	20 / 33	42	20 / 20	53	20 / 12
	9	20 / 91	21	20 / 53	32	20 / 32	43	20 / 19	54	20 / 12
	10	20 / 87	22	20 / 50	33	20 / 30	44	20 / 18	55	20 / 11
	11	20 / 83	23	20 / 48	34	20 / 29	45	20 / 17	56	20 / 10
Table calculations based on distance entered above. Recommend 4, 2, or 1 M	12	21 / 80	High Contrast (HC) Chart # 2102						57	21 / 10

Figure 1–16. Example of the letter read to equivalent Snellen VA conversion table.

It’s recommended to set and pre-mark three test distances, so uncorrected VA can be quickly captured by easily positioning the chart. Recommended test distances are 4 meters, 2 meters, and 1 meter, but

any position may be used. The tables can be calibrated to the actual distances used. Once the tables are calibrated, VA scoring is simply counting the number of letters the aircrew member reads correctly and looking up the VA equivalent on the appropriate table (fig. 1–16).

Some examples: if the final sum of correctly identified letters is 42 (test distance at 4 meters), then the patient's VA is 20/20. If they were able to identify letters down to row 10 (potentially 20/16 if all letters were correctly read), but they misidentified three letters, their final sum would be 47-3 or 44, which is equivalent to 20/18 at 4 meters.

The other four tabs contain simulation of the PV® charts. Each tab is labeled as HC or 5 percent (5 percent low contrast), with the corresponding version numbers. You'll note that the HC tables will print as HC, and 5 percent contrast will appear lighter grey. This is to assist you in identifying the correct form. There are four representations on the corresponding PV® chart on each sheet. This allows you to repeat testing (incorrect versus correct) on the same sheet or provides you a place to correct errors. Note that the letter groups separate on rows 8–12. The aircrew member need only read the left or right group. The goal is to read all five letters on each acuity level. The chart representations alternate whether the right eye or left eye is used to read the right or left group of letters. Again, this is to allow you to quickly use the same chart for right and left eye testing. To help minimize letter memorization, the recording form assists you in alternating which eye is used to read the right or left group.

At the bottom of each recording form tab is a letter count to VA conversion table. If you are recording the results directly on the spreadsheet electronically, change the test distance to the test distance actually used. The table will calibrate to that distance and will automatically determine the VA score. If you are recording data using a preprinted form, it's recommended to set the test distance that you will most commonly use. If using preprinted recording forms routinely, it's recommended to calibrate and print the three tables on the "Testdistance" tab and have them readily available to convert letter counting to VA.

Perform glare testing

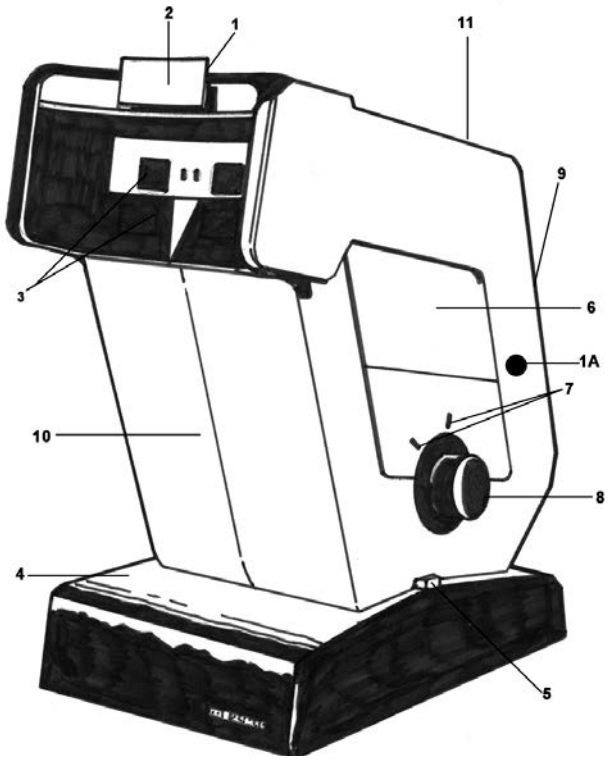
Bright light may degrade (decrease) VA considerably. Opacities in the ocular media, such as a posterior polar cataract, can have a profound effect on vision. There are a number of devices used to identify if patients are negatively affected by glare. The Brightness Acuity Tester (BAT) is probably the most common. It delivers three controlled degrees (brightness) of light when the eye is looking at a Snellen chart. Opacities in the ocular media cause vision to be degraded under bright light. The BAT provides a true VA in ambient light.

To test the patient, have him or her view the letters on the eye chart through the BAT. Then turn on the low-light setting. The BAT lights reproduce the brightness of headlights, both high and low beams, as if approaching a vehicle at night. Instruct the patient to read the letters on the chart. Record the glare test setting and the VA. Switch on the high-light setting and remeasure the patient's VA. If there are opacities, the VA drops off considerably.

605. How to use the optec vision tester

The OVT (fig. 1–17) combines several visual function tests into one piece of equipment. The OPTEC 2300 or its predecessor, the Vision Test Apparatus–Near and Distant (VTA–ND), may be used to complete USAF physical examinations.

The Department of Defense (DOD)-approved OPTEC 2300, manufactured by Stereo Optical, Inc., contains test plates specifically designed for military use on which USAF vision standards are based. The test plates provided in both the OPTEC 2300 and VTA–ND are identical. DOD-approved test plates are not available in any other Stereo Optical or non-DOD–approved instrument. The use of OVT in this lesson references the OPTEC 2300 specifically. However, the information is applicable to the VTA–ND as well.



1 FOREWARD ACTIVATOR
2 HEADREST TISSUE
3 LENS SYSTEM
4 INSTRUMENT BASE
5 ELEVATION ADJUSTMENT
6 OBSERVATION DOORS
7 FAR AND NEAR INDICATORS
8 TEST DIAL
9 ELECTRONIC CONTROL PANEL
10 INSTRUMENT BODY
11 CARRY HANDLE
1A FOREHEAD ACTIVATOR OVERRIDE

Figure 1–17. OVT.

Tests accomplished

The distant and near tests are classified into two categories—standard and alternate. The OPTEC 2300 plate set includes 17 plates (listed below). The instrument can hold up to 12 test plates at a time. Typically, the OPTEC 2300 is preset with standard test plates, the ones most commonly used for physical examinations. However, alternate plates for select tests are provided and may be used in place of the standard test plates. Alternate test plates are recommended for use when you suspect the examinee may have the standard tests memorized or is malingering. Use alternate test plates for unusual requirements or at the doctor's discretion.

Standard test plates:

Distant:

Test 1: Binocular vertical phoria.

Test 2: Binocular lateral phoria.

Test 3: Monocular VA (20/50 to 20/12).

Test 4: Monocular VA (20/400 to 20/70).

Test 5: Binocular fusion and depth perception.

Near:

Test 6: Binocular vertical phoria

Test 7: Binocular lateral phoria.

Test 8: Monocular VA (20/50 to 20/12).

Test 9: Monocular VA (20/400 to 20/70).

Binocular VA:

Test 11: DVA (20/50 to 20/12).

Test 12: DVA (20/400 to 20/70).

Test 13: NVA (20/50 to 20/12).

Test 14: NVA (20/400 to 20/70).

Alternate test plates:

Distant:

Test 3A: Monocular VA (20/50 to 20/12).

Test 4A: Monocular VA (20/400 to 20/70).

Test 5A: Binocular fusion and depth perception.

Near:

None available.

Binocular VA:

None available.

Illiterate:

Test 10: Monocular VA (20/400 to 20/20).

Required equipment

There are required items for proper test administration, such as the OVT-instrument, scoring key, OVT examination table, and the proper OVT examination environment.

OVT instrument

The owner's manual describes basic operation, parts, and maintenance. An understanding of the instrument's operation is essential for accurate assessment of visual performance.

Scoring key

A scoring key (tables of the correct test responses) is provided with the instrument. To ensure the test integrity, the scoring key should have controlled access. The scoring key (or copies) should not be available to or positioned where it could be read by the examinee. However, the key should be used by the examiner to compare the examinee's responses with the expected answers in the case of VA or depth perception testing and to convert responses to appropriate scales in the case of phoria measurements.

The OVT and VTA–ND scoring keys are interchangeable, although there may be some arrangement differences between the two cards. Before testing an examinee, be sure to match the test given with the appropriate scoring key table. If necessary, the test plates may be repositioned in the OVT to match the test sequence or to provide alternate test presentations. The test results are recorded in the member's records as appropriate.

OVT examination table

The instrument should be placed on a table 28–30 inches high with ample space below the tabletop for the examinee's legs. There should be sufficient tabletop surface area to securely support the instrument and provide workspace to record test results. An ideal examination table should allow vertical adjustment to enable optimal examinee and OVT alignment.

OVT examination environment

The examination room should have sufficient illumination to allow observation of the examinee. Normal overhead room lighting may be used during OVT testing. Care should be taken to avoid glare on the instrument from desk lamps or sunlight through windows. Place the instrument in a quiet area.

Maintenance

Proper maintenance of the OVT is essential to effectively evaluate an examinee's vision. If the machine is not clean or in proper operating condition, the examinee's results may not reflect his or her true vision. Accuracy is critical when results of this testing are to be used for flight training selection and/or continued flight duties in accordance with (IAW) USAF standards. Preventative maintenance and cleaning instructions can be found in the OVT user's manual.

Examinee preparation

Greet the patient and briefly explain the test. Determine the appropriate requirements by asking the following questions:

- Does the examinee wear vision correction?
- Are glasses or CLs to be worn for evaluation?
- If correction lens are to be worn, is testing accomplished with vision correction before or after uncorrected vision test?
- Does the examinee have any current eye conditions that may affect the test results?
    - If yes, refer to a medical provider to determine which OVT tests should be accomplished or if a referral to an optometrist/ophthalmologist is appropriate.
    - If no, proceed with the examination.

Seat the patient in front of the OVT and have the patient bring his or her chair under the table to a comfortable position. Turn on the OVT. Have the patient place his or her forehead against the headrest. Only bifocal wearers can adjust their heads during testing. Adjust the OVT to the patient's sitting height. Be sure to make the adjustment with the OVT turned on so the patient can view one of the slides while determining a comfortable viewing height. Never raise or lower the OVT when the patient's face is in contact with or close to the OVT. Make sure the patient is always facing the OVT squarely and looks through the center of the lenses. Once your patient is comfortable and in the proper position, lock the machine into position.

Testing considerations

Observe the examinee for any indication of eye movement anomalies (tropia), undisclosed CLs use, squinting, unusual head position, or malingering.

If the examinee wears spectacles

For far vision correction or full-time use; test DVA (test 3, 4) and NVA (test 8, 9) first without spectacles (uncorrected VA), and then repeat DVA and NVA testing with spectacles in place. If the examinee's spectacles incorporate a bifocal for near vision correction, allow the examinee to adjust his or her head and/or spectacle positioning to ensure the near test plates are viewed through the reading portion of the bifocal.

For near vision correction only; test DVA (test 3, 4) and NVA (test 8, 9) first without spectacles (uncorrected VA), and then repeat NVA testing with spectacles in place.

If the examinee wears CLs

Flying Class 1 and 1A patients cannot wear CLs during their physical examination. Additionally, they cannot wear SCLs for 30 days or RGP CLs for 90 days preceding their physical examination. For other physical examination classifications, CLs may be worn up to the day of testing. CLs should be removed after the corrected VAs are measured. Flying Class II or III physical examination patients cannot wear CLs while testing, unless authorized by medical waiver. If authorized, they may be worn

to determine corrected VA only. The uncorrected VA is then determined after a CL-free period of 1–4 hours.

Using the OVT in ophthalmic clinics

Testing with the OVT in ophthalmic clinics varies from one clinic to another. Most ophthalmic clinics use the OVT as a screening device. If the patient wears glasses, accomplish all tests with corrective lenses on. If the patient wears CLs, then accomplish all tests with the contacts in. Consult your supervisor or provider on which tests and procedures to use for your clinic.

Give the distant and near vision tests in the following order:

1. Test 1—distance binocular vertical phoria.
2. Test 2—distance binocular lateral phoria.
3. Test 3 or 4 (or both) —distance monocular VA.
4. Test 5—binocular fusion and depth perception.
5. Test 6—near binocular vertical phoria.
6. Test 7—near binocular lateral phoria.
7. Test 8 or 9 (or both)—near monocular VA.

Each test is briefly described below, and “testing pearls” are provided when appropriate. The examiner’s goal is to obtain the most accurate assessment possible.

Administer distance binocular vertical phoria test (test 1)

The distance binocular vertical phoria test evaluates hyperphorias. This test is a measurement of the examinee’s vertical eye alignment (one eye relative to the other). Use the following steps to perform distance binocular vertical phoria testing:

1. Set up the OVT and patient as described above.
2. Ensure the OVT is configured to illuminate internal lighting for both eyes (OU) (binocular).
3. Set the test dial to position 1.
4. Depress both “eye” selection buttons (green and orange) (fig. 1–18).

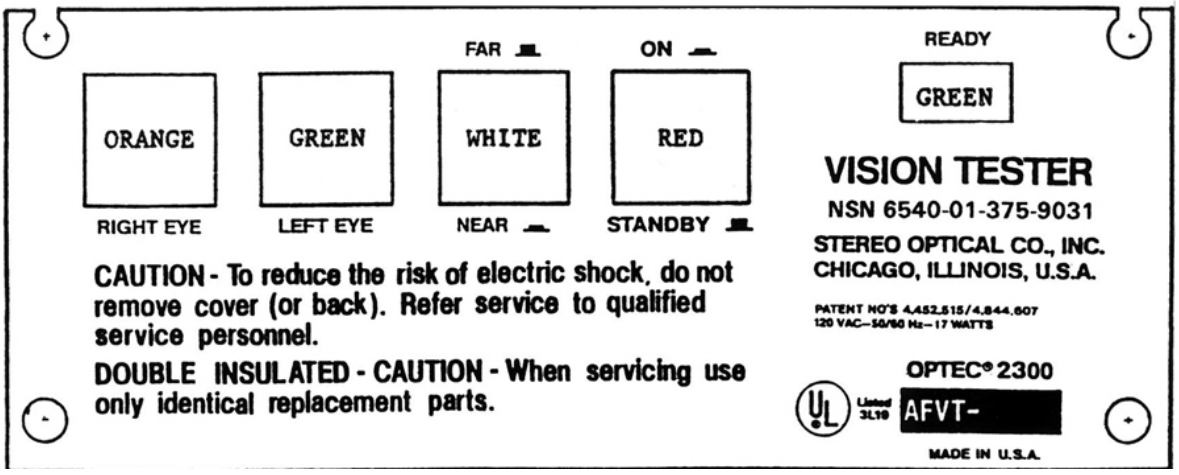
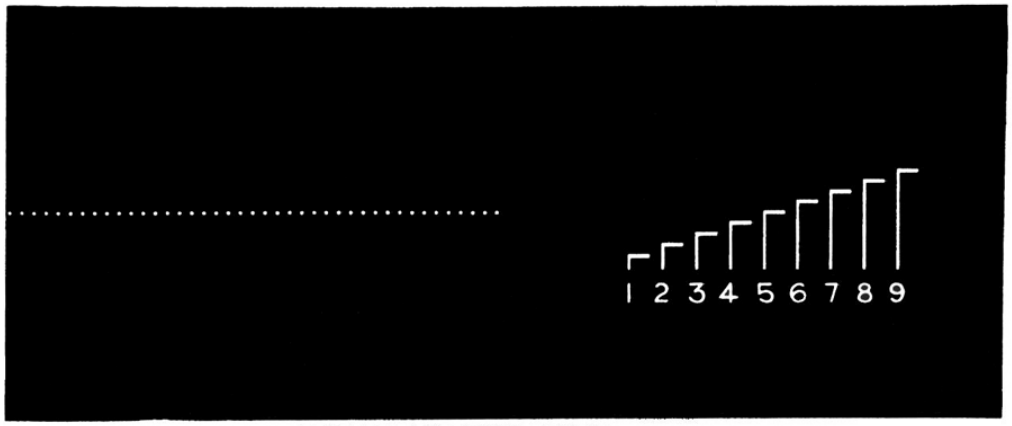


Figure 1–18. OVT control panel.

5. Ask the following questions:
   - Do you see a white dotted line?
   - Do you see a row of numbered stair steps?
   - Which stair step does the dotted line cross?

Figure 1–19 shows what the patient should see with each eye.



TEST 1 FAR VERTICAL PHORIA

Figure 1–19. Test 1, distance vertical phoria.

- If the patient says "no" to the first or second question, turn the left eye switch off and ask, “Do you see the stair steps?” Then turn the left eye switch on, turn the right eye switch off and ask, "Do you see the dotted line?"
- If the patient says "no" to any of the above questions, record an “X” above "LH" (left hyperphoria) and "RH" (right hyperphoria) in item 31, Standard Form (SF) 88 (fig. 1–20), Report of Medical Examination, and continue with the next test.

NAME | IDENTIFICATION NUMBER | NO. OF SHEETS ATTACHED

MEASUREMENTS AND OTHER FINDINGS

20. HEIGHT	21. WEIGHT	22. COLOR HAIR	23. COLOR EYES	24. BUILD	25. TEMPERATURE
				☐ SLENDER ☐ MEDIUM ☐ HEAVY ☐ OBESE	

26. BLOOD PRESSURE (Arm at heart level)						27. PULSE (Arm at heart level)				
A. SITTING	SYS. / DIAS.	B. RECUMBENT	SYS. / DIAS.	C. STANDING (5 mins.)	SYS. / DIAS.	A. SITTING	B. RECUMBENT	C. STANDING (3 mins)	D. AFTER EXERCISE	E. 2 MINS. AFTER

28. DISTANT VISION		29. REFRACTION			30. NEAR VISION		
RIGHT 20/ 30	CORR. TO 20/ 20	BY −0.25	S. −0.25	CX 180	20/40	CORR. TO 20/20	BY +1.00
LEFT 20/ 40	CORR. TO 20/ 20	BY −0.25	S. −0.50	CX 170	20/40	CORR. TO 20/20	BY +1.00

31. HETEROPHORIA (Specify distance)

ESO	EXO	R.H.	L.H.	PRISM DIV.	PRISM CONV. CT	PC	PD
−	2.0	−	1.0				
−	3.0	−	1.5				

32. ACCOMMODATION		33. COLOR VISION (Test used and result)	34. DEPTH PERCEPTION (Test used and score)	UNCORRECTED
RIGHT	LEFT	PIPS 10/14 PASSES	VTA-ND	CORRECTED PASSES "E"
35. FIELD OF VISION		36. NIGHT VISION (Test used and score)	37. RED LENS TEST	NCT 38. INTRAOCULAR TENSION @083
RIGHT	LEFT		PASSES	RIGHT 14 LEFT 15

39. HEARING			40. AUDIOMETER								41. PSYCHOLOGICAL AND PSYCHOMOTOR (Tests used and score)
				250 256	500 512	1000 1024	2000 2048	3000 2896	4000 4096	6000 6144	8000 8192	
RIGHT W/V	/15SV	/15	RIGHT									
LEFT W/V	/15SV	/15	LEFT									

42. NOTES (Continued) AND SIGNIFICANT OR INTERVAL HISTORY

Figure 1–20. SF 88.

- If the patient is able to answer the questions, determine the score and record it in item 42, SF 88. If the examinee needs assistance with answering, it may help to state, “The dotted line may seem to be moving a little, but it will seem to align with or will be closer to one of the numbered steps. What is the number of that step?” The answer should be a number between 1 and 9. All responses to stair steps 1, 2, 8, or 9 will be verified by asking the examinee, "Is

the dotted line as high as the top (or bottom) of the stair steps?" If the examinee reports the dotted line is above step 10 or below step 1, record an “X” under both LH and RH.

Administer distance binocular lateral phoria test (test 2)

This test evaluates esophoria and exophoria. It’s a measurement of the examinee’s horizontal eye alignment (one eye relative to the other).

Use the following steps to perform distance lateral phoria testing:

1. Set up the OVT and patient as described above.
2. Ensure the OVT is configured to illuminate internal lighting for both eyes (binocular).
3. Move the test dial to position 2.
4. Depress both “eye” selection buttons (green and orange).
5. Tell the patient that he or she will see a dotted line with numbers below and an arrow above it.
6. Ask the patient which number the arrow points to (fig. 1–21).
   - If patient does not see the arrow or numbers, use the procedure described in the last test.
   - If the arrow fluctuates, have the patient focus on the dots.
7. Record the score.

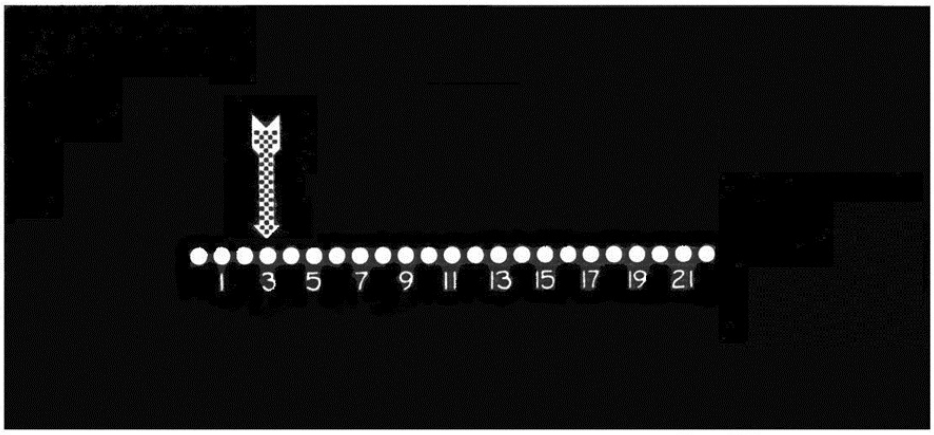


Figure 1–21. Test 2, distance lateral phoria.

If the patient gives a result of 0 to 22, then compare the result with the scoring key. A result of 0 yields a score of 11 esophoria, a result of 11 yields a score of orthophoria, and a result of 22 yields a score of 11 exophoria. Record the number above the "ESO" or "EXO" in item 31 of the SF 88. For example, if the patient is 2 exophoria, record a "2" above the "EXO" in item 31 of the SF 88 and a "0" above the "ESO." For orthophoria, record "0" above both the "ESO" and "EXO."

If the patient says it does not point to any number, or is between two numbers, ask the patient, "To which number is it closest?" If the patient gives a result of 0 to 22, then follow the above directions.

If the patient does not see the arrow, or does not see the numbers, occlude the right eye and ask, "Do you see the arrow with three dots?" Then occlude the left eye and ask, "Do you see the numbered line of dots?" Then remove the occluder and ask, "Now do you see both the numbered line of dots and the arrow?" Discontinue the test if the patient still cannot see both the arrow and the numbers at the same time. In this instance, record an “X” above the "ESO" and "EXO" in item 31 of the SF 88. Refer this patient to the optometrist to obtain valid results or to evaluate the cause.

If the patient sees the arrow and three dots to the left of the dot 0 or to the right of dot 22, discontinue test number 2 and place an “X” above the "ESO" and "EXO" in item 31 of the SF 88. Refer this patient to the optometrist to obtain valid results or to evaluate the etiology.

If the patient says the arrow moves over a wide range, ask the patient to "Look closely at the dots in the arrow and tell me where it is when you first see the numbered dots." If the arrow continues to move, cover and then uncover the right eye with the occluder, and then again ask the patient to which number the arrow is pointing. If the patient gives a result of 0 to 22, then record the results.

If the patient says the arrow points to the second one, verify the patient means the dot between number 1 and number 3.

Administer distance monocular VA test (test 3 or 4)

These tests simulate the evaluation of a patient's VA at 20 ft. (figs. 1–22 and 1–23). Test 3 is used for testing expected VA 20/50 or better, typically corrected VAs. Test 4 is used for measuring expected VA between 20/400 and 20/70, typically uncorrected VAs.

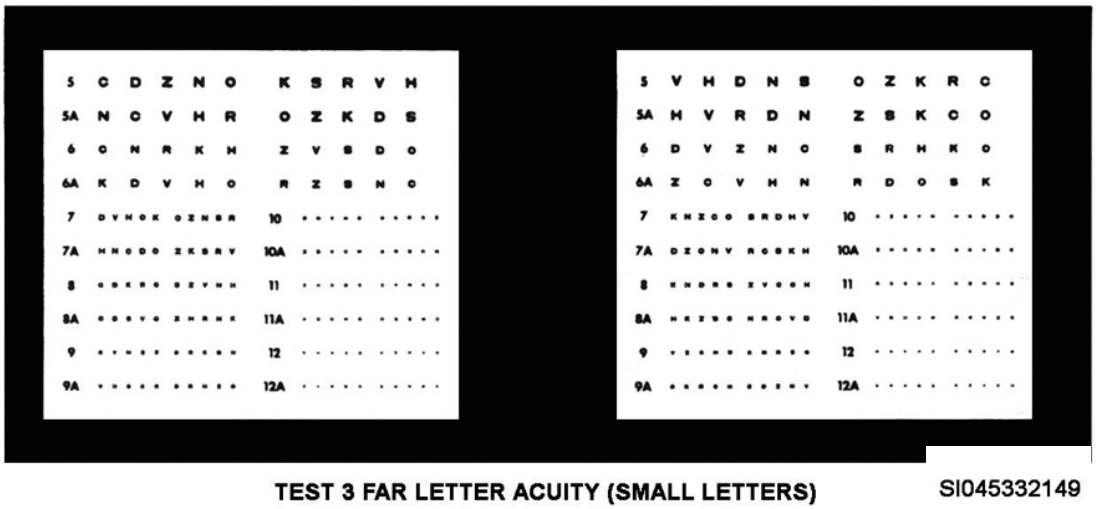


Figure 1–22. Test 3, distance monocular VA small letters.

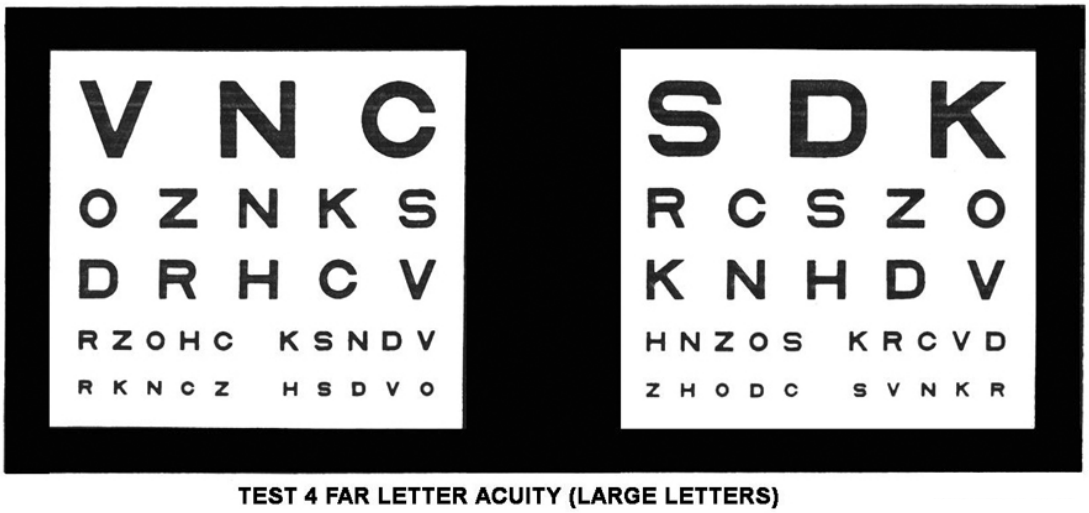


Figure 1–23. Test 4, distance monocular VA large letters.

This test must be performed with examinee wearing his or her vision correction, if the vision correction is intended or required for distance or full-time use. If the examinee is required to wear corrective lenses while performing military duties, test and record both uncorrected and corrected VA results.

A patient must correctly read seven or more letters of any line of letters containing 10 letters to pass that line, or, in other words, only three mistakes are allowed for each line of letters containing 10 letters. Applicants for flying duty must correctly read all the letters on a given line to receive credit for that degree of VA.

Use the following steps to perform distance monocular VA testing:

1. Set up the OVT and patient as described above.
2. Select the “distant” internal illumination (white button) (fig. 1–18).
3. Depress the button of the eye to be tested (monocularly)—the green button for the left eye or the orange button for the right eye.
4. Move the test dial to position 3 or 4.
5. Find line 5/5A for the right eye on the OVT scoring key (fig. 1–22).
6. Tell the patient “Do not squint.”
7. Tell the patient to read line 5/5A (20/50).
8. If the patient makes three or less errors on line 5/5A:
    - Have the patient try to read line 9/9A (20/20).
    - Have the patient read whichever line he or she can.
    - The patient needs to read at least 70 percent of a line correctly for credit.
9. Be sure to have the patient identify the number of the line he or she can read so you can verify responses with the OVT scoring key.
10. Record the score in item 59, SF 88.
11. If the patient makes four or more errors on line 5/5A, move the dial position to 4 or 11.
12. Starting on line 1 (fig. 1–23), have the patient read each line until he or she makes two or more errors.
13. The patient is allowed only one error on line 1. If the patient does not successfully complete line 1, then record 20/0 and refer to the optometrist.

Administer binocular fusion and depth perception test (test 5)

The binocular fusion and depth perception test is a measurement of the examinee’s ability to fuse different images and to perceive depth. The results indicate the level to which the examinee can use both eyes and how the brain pieces together the images it receives from each eye (neural integration). If examinee does not have full, simultaneous use of both eyes (amblyopia, trauma, strabismus, etc.) or there is a significant inequality in visual performance of each eye, depth perception is highly unlikely. If the examinee was unable to pass test 1 and/or test 2, it’s likely he or she will not be able to pass this test.

Accomplish test 5 in the following manner:

- This test must be performed with examinee wearing his or her vision correction, if the vision correction is intended for distance or full-time use. If the examinee is required to wear corrective lenses while performing military duties, test and record only corrected results.
- All test results will be recorded in the appropriate block of the SF Form 88. Place a dash ("–") in the "UNCORRECTED" box and record the results of the test in the "CORRECTED" box when lenses are worn. The dash ("–") indicates it was not required. When performing the test

as part of a preventive health assessment (PHA), you'll record the results on the SF 600, Chronological Record of Medical Care, as either Corrected or Uncorrected and the results (the letter of the last box passed). An example of this would be "Corrected Passes (F)" or "Uncorrected Passes (E)."

Use the following steps to perform depth perception testing:

1. Set up the OVT and patient as described above.
2. Select the "distant" internal illumination (white button).
3. Place the test dial at position 5 or 12 (5A).
4. Depress both "eye" selection buttons (green and orange).
5. Have the patient describe the arrow on the left of the slide.
   - Do not administer the depth perception test if the patient reports seeing two arrows, and/or two circles or one arrow with only a head or only a tail (fig. 1–24, image 2, 3, or 4).
   - If the patient reports diplopia or suppression as described above, the patient failed the test.
   - Record "X" in item 34, SF 88.
6. If the patient reports seeing an arrow with a circle in the center with a head and a tail (fig. 1–24, image 1), continue to step 7 below. Step 7 begins the depth perception portion of the test.

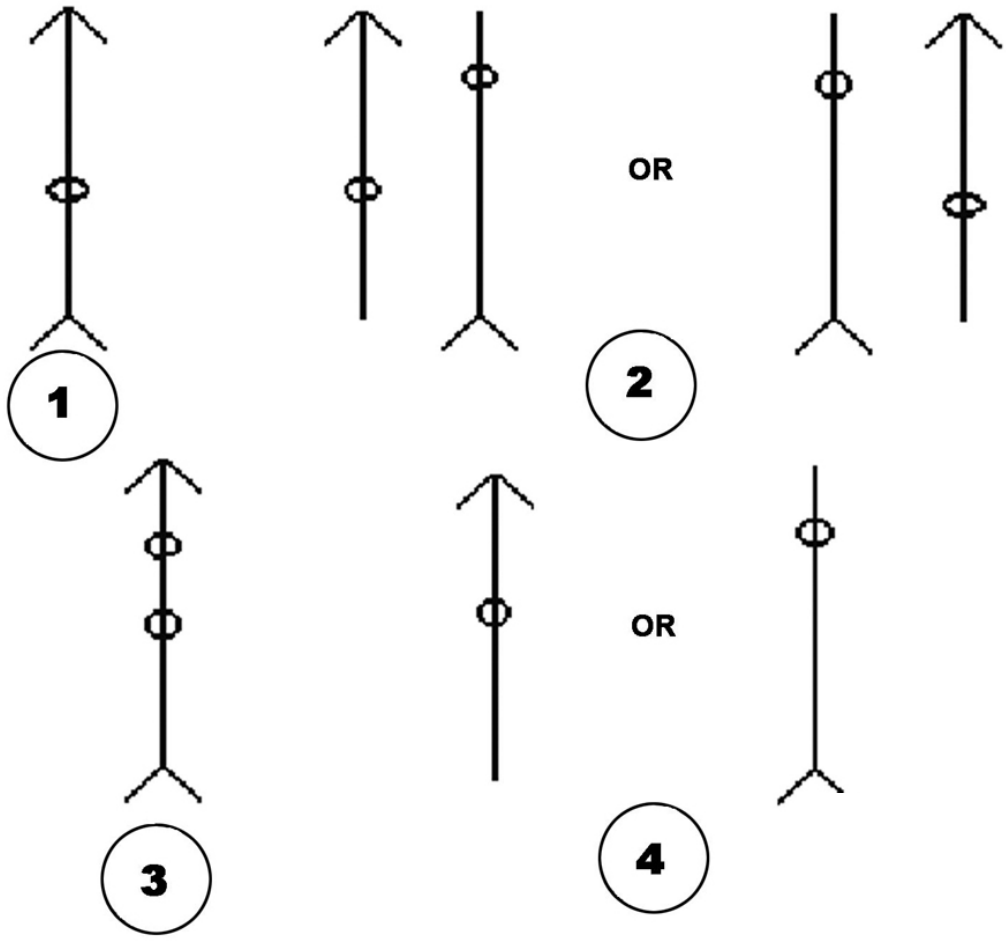


Figure 1–24. Arrows for fusion check.

Two reasons a patient may fail the fusion test are diplopia or suppression.

- Diplopia—The patient reports seeing two arrows side by side as in image (2) on figure 1–24, or two circles, one above the other as in image (3).
- Suppression—When both eyes are used, the patient sees only the head or only the tail of the arrow, as in image (4) on figure 1–24.

If the patient passes the fusion test, continue with the depth perception test. If the patient fails the fusion test or if, for some reason, the OVT is not working, record in item 34 of the SF 88 "OVT X" and dash the corrected and uncorrected boxes. An "X" states the test was required but not accomplished. An explanation is mandatory in item 42 of the SF 88 (i.e., 34. Failed the fusion test, patient has constant alternating exotropia).

Depth perception is the most difficult of all the OVT tests. Patients who have normal stereopsis may have to learn to see the apparent depth employed in this test. Good scores and normal depth perception go hand in hand; however, even complete failure on this test is not necessarily indicative of poor depth perception. Therefore, do not hurry through the demonstration and the practice period preceding the actual test. The depth perception slide used to test depth perception consists of a number of horizontal rows of circles, five circles in each row, one of which should appear slightly nearer to the patient than the other four (fig. 1–25).

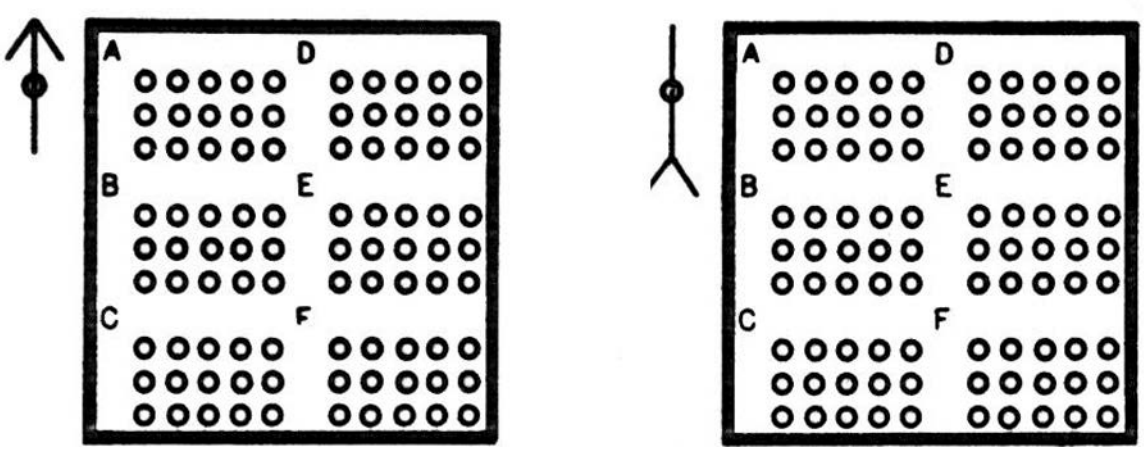


Figure 1–25. Test 5, depth perception test.

7. Have the patient sit back.
8. Explain the test as follows:
    - First, show the patient the demonstration device consisting of a transparent plastic plate with four black circles on the rear surface, one in the front. As in the depth perception test itself, one circle appears nearer than the other four. After showing the plastic demonstration model of the test, ask the patient to look into the instrument.
    - Instruct the patient not to move his or her head and to focus on Group A, the three rows of circles in the upper left corner of the square (fig. 1–25).
    - Use the first group to further explain the test and allow time for the perception of depth to develop. The top row of five circles in group A demonstrates a relatively large difference in depth, the middle row a moderate difference, and the bottom row a small difference. Some patients may not see any depth for the first minute or so; in such cases, do not hurry through the practice test.

- Provide the patient with the correct answers to the three rows of Group A and instruct the patient to look at each circle in turn until the patient can see that one of the five circles in each row is nearer than the others.
- You may use the occluder to demonstrate with monocular (one-eyed) vision all circles appear in the same plane, while with binocular (two-eyed) vision one may appear nearer than the other four.
- When you are satisfied the patient actually sees depth in at least the top row, proceed to the actual test. This will be given without any help or hints as done in the practice period.

9. Have the patient look into the OVT.
10. Direct the patient's attention to the circles in Group A (fig. 1–25).
11. Have the patient indicate, counting from left, which circle is nearer in the top, middle, and bottom row of Group B.
12. If the patient makes one or more errors in Group B, record as "X."
13. Also record in item 42 of the SF 88 the reason the patient failed, for example "Patient unable to complete Group B."
14. If no incorrect answers are given on B, have the patient continue with Groups C through F or until he or she makes an error.
15. If the patient makes an error in Group C through D, on the second attempt, record the score in the appropriate corrected or uncorrected box, SF 88 as "Fails" with the last group in which no errors were made (i.e., Fails C).
16. The patient must have the correct answers for groups A through D to pass (if the patient correctly answers all of D, continue through F). If a patient passes the test, record in the appropriate box the word "Passes" followed by the letter of the group in which no errors were made (i.e., Passes E).
17. Record the test used.

Administer near binocular vertical phoria test (test 6)

To administer the near binocular vertical phoria test, follow the procedures of test 1 (distance vertical phoria).

Near tests are performed in the same manner as far testing but with a minor variation in the machine settings. First, the OVT should be set to “near.” Second, use the “near” indicator when setting the dial to position number.

Use the following steps to perform near binocular vertical phoria testing:

1. Set up the OVT and patient as described above.
2. The OVT must be configured to illuminate internal lighting for both eyes (binocular).
3. Select the “near” internal illumination (white button).
4. Depress both “eye” selection buttons (green and orange).
5. Set the test dial to position 6.
6. Follow the same sequence as the distance binocular vertical phoria test.
7. Determine the score and record in item 31, SF 88.

Administer near binocular lateral phoria test (test 7)

To administer the near binocular lateral phoria test, follow the procedures of test 2 (distance lateral phoria).

Use the following steps to perform near binocular lateral phoria test:

1. Set up the OVT and patient as described above.
2. Ensure the OVT is configured to illuminate internal lighting for both eyes (binocular).
3. Select the “near” internal illumination (white button).
4. Depress both “eye” selection buttons (green and orange).
5. Set the test dial to position 7.
6. Follow the same sequence as the distance lateral phoria test.
7. Determine the score and record in item 31, SF 88.

Administer near monocular VA test (test 8 or 9)

To administer the near monocular VA test, follow the procedures for tests 3 and 4 (distance monocular VA). Tests 8 and 9 optically simulate a test distance of 13 inches. Test 8 is used for testing expected VA 20/50 or better. Have the patient wear his or her vision correction, if it is intended or required for near or full-time use.

Test 9 is used for measuring expected VA between 20/400 and 20/70 VAs. This test must be performed with examinee wearing his or her vision correction, if the vision correction is intended or required for near or full-time use.

If bifocals are worn, the examinee may not be able to maintain contact with the headrests while completing near tests with glasses. Allow the examinee to adjust his or her head position to ensure near test plates are viewed through the bifocal lenses. If extreme difficulty is experienced maintaining contact with the headrest because of bifocal lenses, depress and hold the override switch located on the side of the OVT. If the examinee is required to wear corrective lenses while performing military duties, test and record uncorrected and corrected results.

The examinee must correctly read all letters on a given row to be credited with that degree of VA. For example, an examinee who is scored as 20/20 VA must have read all 10 letters (10 of 10) on row 9 or 9A of test 3 (no mistakes are allowed.)

Use the following steps to perform near monocular VA testing:

1. Set up the OVT and patient as described above.
2. Ensure the OVT is configured to illuminate internal lighting for both eyes (binocular).
3. Select the “near” internal illumination (white button).
4. Depress the button of the eye to be tested (monocularly)—the green button for the left eye or the orange button for the right eye.
5. Move the test dial to position 8.
6. Follow the same sequence as the distance monocular VA test.
7. Record the score in item 30, SF 88.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

603. Taking a case history and performing a visual screening

1. What can give you insight on possible answers to the questions required for a good case history?

2. Once a patient has identified the *location* of a problem to you (i.e., “My right eye hurts”), what four additional things do you need to determine about the problem?

3. When a patient reports he or she is on medication, what two additional things do you need to know about the medication?

4. What is the SOAP format?

604. Measuring visual acuity

1. What is one of the basic functions of the eye clinic?

2. Why is it important to record VA as accurately as possible?

3. In simple terms, what is VA?

4. What are the most common test targets for a VA chart?

5. How many components is each Snellen letter composed of?

6. If a patient has 20/40 vision, what exactly does this mean?

7. What height should the 20/200 “E” be for a 20-ft. test distance? An 18-ft. test distance? A 15-ft. test distance?

8. What is an important safety item to remember when replacing a Project-O-Chart™ bulb that has burned out while in use?

9. Why should you always use a cloth or tissue to install a new bulb in the Project-O-Chart™?

10. What eye correction should the patient wear when performing VA testing?

11. Which testing charts are used for testing young children and illiterate patients?

12. If the patient is able to read over 50 percent of the letters on the 20/50 line and two letters on the 20/40 line, how is this recorded?

13. If a patient cannot read the 20/400 “E” of the VA chart from a distance of 3 ft., what would you do next?

14. How would you record the VA results for a patient’s eye that had no perception of light?

15. During the PH test, what does it indicate if a patient is able to see better looking through the PH?

16. What is the clinical definition of amblyopia?

17. Why would a patient reading 20/20 on a Snellen chart complain of poor vision?

18. Which contrast sensitivity chart is used for the Aviation CRS program?

19. What is the test distance that the contrast sensitivity test is designed for?

20. What are the VA ranges for the PV chart if the PV chart is set at 4 meters, 2 meters, and 1 meter?

21. What can cause vision to be degraded in bright light conditions?

605. How to use the optec vision tester

1. When using the OVT, what does each of the standard test plates check?

2. If a patient cannot see the white lines or numbered stairs during test 1 of the OVT, how is it recorded?

3. How would a patient’s response reflect diplopia during test 5 of the OVT?

Answers to Self-Test Questions

601

1. Prevention refers to the measures we take to keep patients and personnel from acquiring infections; control refers to the measures we take to keep infections from spreading.
2. (1) Universal precautions.
   (2) Body substance isolation precautions.
3. After touching blood, body fluids, secretions, excretions, and contaminated items, even if wearing gloves; after removing gloves; between all patient contacts; and whenever you may potentially transfer microbes to other patients or areas.
4. During patient care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions.
5. Mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation in areas where the need for resuscitation is predictable.

602

1. Handwashing.
2. Mechanically scrubbing them away as you rub your hands together, diluting the organisms by rinsing them away with water, and killing many organisms when an antibacterial soap is used.
3. Alcohol.
4. A solution of one part household bleach to 10 parts water (1:10)

603

1. The patient's health record.
2. (1) Severity.
   (2) Onset.
   (3) Cause.
   (4) Duration.
3. (1) The reason the patient is taking the medication.
   (2) How long the patient has been on it.
4. S = subjective—what the patient reports to you verbally. O = objective—things you can see or measure. A = assessment—doctor's assessment of the patient's condition. P = plan/prevention—what will be done based on the assessment made of the patient; counseling.

604

1. To measure the VA of patients.
2. For proper patient treatment and medical and legal reasons.
3. It's a measure of how well the eye "gathers" light, how well the nerves in the visual pathway transmit information to the brain, and what the brain does with that information.
4. Snellen letters.
5. Each letter has five components.
6. That the smallest discernible letter the patient can read at 20 ft. is the 40-ft. letter.
7. 20-ft. = 88 mm; 18-ft. = 79.2 mm; 15-ft. = 66 mm.
8. The bulb and housing will be extremely hot; use a towel or lots of tissue to remove it.
9. The oil from your hands will cause hot spots and lead to short bulb life.
10. The appropriate Rx for the given test distance.
11. Tumbling E, Landolt C, and the Object Chart.
12. $20/50^{+2}$.
13. The FC test.
14. NLP.
15. It indicates he or she could see better with spectacles.

16. VA that is 20/40 or worse in an eye even after the best correction possible is used to improve the vision and after ruling out all other causes.
17. Snellen acuity measures an individual's ability to see HC images in a controlled environment.
18. The PV® chart.
19. Charts are designed for 4-meter test distance (patient to chart). 4 meters = 13 ft.
20. If set at 4 meters, VA range = 20/10 to 20/125; if set at 2 meters, VA range = 20/20 to 20/250; if set at 1 meter, VA range = 20/40 to 20/500.
21. Opacities in the ocular media.

605

1. Test 1: Binocular vertical phoria; Test 2: Binocular lateral phoria; Test 3 and 4: Monocular VA; Test 5: Binocular fusion and depth perception; Test 6: Binocular vertical phoria; Test 7: Binocular lateral phoria; Test 8 and 9: Monocular VA; Test 11 and 12: DVA; Test 13 and 14: NVA.
2. Test 1 will be discontinued and an X will be recorded above the left and right hyperphoria in item 31 of the SF 88.
3. The patient reports seeing two arrows side by side or two circles, one above the other.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the AFCDA.

1. (601) In regards to infection control procedures, the *standard* precautions were combined from the formerly named universal precautions and
   a. infection control procedure precautions.
   b. body-substance isolation precautions.
   c. prevention of infection precautions.
   d. patient-care isolation precautions.

2. (602) This is the single most important means of preventing the spread of infection.
   a. Mask.
   b. Gown.
   c. Gloves.
   d. Hand washing.

3. (602) In addition to mechanically scrubbing away and diluting microorganisms to remove them, effective hand washing also
   a. eradicates many organisms when hot water is used.
   b. kills many organisms when an antibacterial soap is used.
   c. destroys many organisms when hot air is used for drying.
   d. eliminates many organisms when paper towels are used for drying.

4. (603) Which is *not* one of the suggested items to include in a case history checklist?
   a. Latest prescription.
   b. Last eye examination.
   c. Last dilated fundus exam (DFE).
   d. Mother’s cataract surgery.

5. (603) If a patient states “none” when asked about medication allergies, record it in the medical record as
   a. none.
   b. not applicable (N/A).
   c. no drug allergies (NDA).
   d. no known drug allergies (NKDA).

6. (604) “Visual efficiency” refers to
   a. seeing a 20-foot letter at 20 feet.
   b. seeing how well the eye gathers light.
   c. seeing comfortably without eyestrain.
   d. receiving, transmitting, and interpreting visual images.

7. (604) How many minutes of arc does each component of a letter in the 20/20 line on an “E” eye chart subtend?
   a. 10.0.
   b. 5.0.
   c. 2.5.
   d. 1.0.

8. (604) How *may* bright light affect a patient's visual acuity (VA)?
   a. No change.
   b. Increase.
   c. Decrease.
   d. Cause it to fluctuate.

9. (605) Use the backup tests on the Optec Vision Tester (OVT) when the patient is
   a. farsighted.
   b. amblyopic.
   c. nearsighted.
   d. malingering.

10. (605) This is the first test given when using the Optec Vision Tester (OVT).
    a. Far vertical phoria.
    b. Near vertical phoria.
    c. Far lateral phoria.
    d. Near lateral phoria.

11. (605) When testing visual acuity (VA) with the Optec Vision Tester (OVT), how many letters minimum out of 10 must a patient get correct to receive credit for that line?
    a. 5.
    b. 6.
    c. 7.
    d. 8.

Student Notes

Unit 2. Preliminary and Ancillary Tests

A THOROUGH WORK-UP OF A PATIENT by a competent ophthalmic technician can save the doctor valuable time during his or her examination. Your ability to perform reliable preliminary testing before the doctor sees the patient is a valuable skill that will increase the efficiency of your clinic. During this initial assessment, not only is it important to accurately document the results of your testing, but also to train yourself to notice any abnormalities to pass along to the doctor. When abnormalities are noted, it is beneficial for you to also be trained to perform the appropriate ancillary tests that would further gather information for the doctor. In this unit, we'll discuss some of these important preliminary and ancillary tests.

2–1. Preliminary Tests

The preliminary test results from a patient's initial work-up gives the doctor a starting point from which to begin his or her examination. The more information you provide, the more the doctor is able to customize the examination to that specific patient. The lesson below discusses some of the preliminary tests you may perform to gather this important information.

606. Administering the pupillary reflex test

Pupil reflex testing is easy to do and only takes a minute or two. The equipment necessary is minimal (a transilluminator) and the information gained is of tremendous medical value. So knowing how to test pupils and interpret the results are very important to today's ophthalmic technician.

Purpose of pupillary reflex testing

Pupillary reflex testing checks the visual afferent (sensory) pathway and the brain's efferent (motor) response to visual and light stimulus. Pupillary reflex tests are a simple but effective way to detect and diagnose the presence of cranial lesions in or near the visual pathway. Pupil testing can also help in detecting nerve palsy, nerve damage, systemic disease, visual abnormality, and more. You can detect and narrow down the cause of these conditions by performing four simple pupillary tests:

1. The *direct* pupillary response.
2. The *consensual* pupillary response.
3. The *accommodative* pupil test.
4. The *swinging flashlight* test.

Performing pupillary reflex testing

Perform pupillary reflex testing in a dimly illuminated exam room, with light distributed evenly throughout. The patient *always* looks at a distant target during pupil testing, with the sole exception being when you ask the patient to look at a near target to accomplish the accommodative test. Do not occlude the patient's eyes while testing.

When performing the pupil reflex tests, the rate and symmetry of pupil constriction should be the same in each eye. A difference in the rate and/or symmetry of pupil constriction between the two eyes indicates a problem.

A simple way to remember what you're looking for during pupil testing is to think of the acronym **P E R R L A**:

- **P E R** stands for "**p**upils **e**qual and **r**ound." This assessment begins even before you shine the penlight into the patient's eyes. Have the patient look at a distant target and evaluate whether the pupils are equal and round. Look to determine if one pupil is larger than the other, distorted, or misshapen (i.e., oval).

  NOTE: When the pupils are different in size by 1 mm or more, the term used to describe the condition is *anisocoria*. Roughly, 10 percent of the adult population has anisocoria and is normal. This means it is not caused by any systemic disease or ocular condition. Anisocoria could be caused by corneal abrasions, headaches, or something as serious as massive brain tumors. The point is, if you evaluate a patient and find the pupils are not equal, test and observe the patient very carefully. There may be a more complex reason for the unequal pupils.
- **R L** stands for "**r**eacts to **l**ight." Confirm this with the direct and consensual pupil tests.
- **A** stands for "**a**ccommodation," meaning the pupils respond when the eyes accommodate on a near target.

The final test is the swinging flashlight test. This test checks for an afferent pupillary defect (APD). The Marcus Gunn (MG) test is another name for the swinging flashlight test. The results are annotated using one of the following:

- If the patient's pupils respond normally, he or she has a "(–)**APD"** or a "(–)**MG**.
- If the patient's pupil responses are not normal, then the abnormal eye is labeled as having a "**(+)APD**" or a "**(+)MG**."

Direct pupillary reflex testing

In this test, shine the transilluminator into an eye and observe the eye's reaction. Test the right eye first, and then the left eye. The patient should be looking at a distant target while you do this test (fig. 2–1).

Position the transilluminator about 3–4 inches away from the eye to be tested. The light needs to be close enough so that a good concentration of the light enters the eye being tested and does not inadvertently shine into the opposite eye. Make sure you keep the light contained or restricted to just the eye being tested. When you shine the light into the eye being tested, note the rate and symmetry of constriction of that pupil. Now turn off the light and note the rate and symmetry of re-dilation.

If you shine the light in an eye and the pupil gets smaller and then re-dilates when the light is turned off or removed, the patient has a normal direct response. Be sure to test both eyes before moving on to the next test. If you do notice a difference in the rate and symmetry of pupil reaction between the two eyes, note which eye reacted slower or to a lesser degree and pass this information to the doctor.

Note whether the pupil constricts and how brisk the reaction is. Rate the briskness on a scale of 0–4.

- **0** = nonreactive.
- **1+** = very sluggish.
- **2+** = sluggish.
- **3+** = brisk.
- **4+** = very brisk.

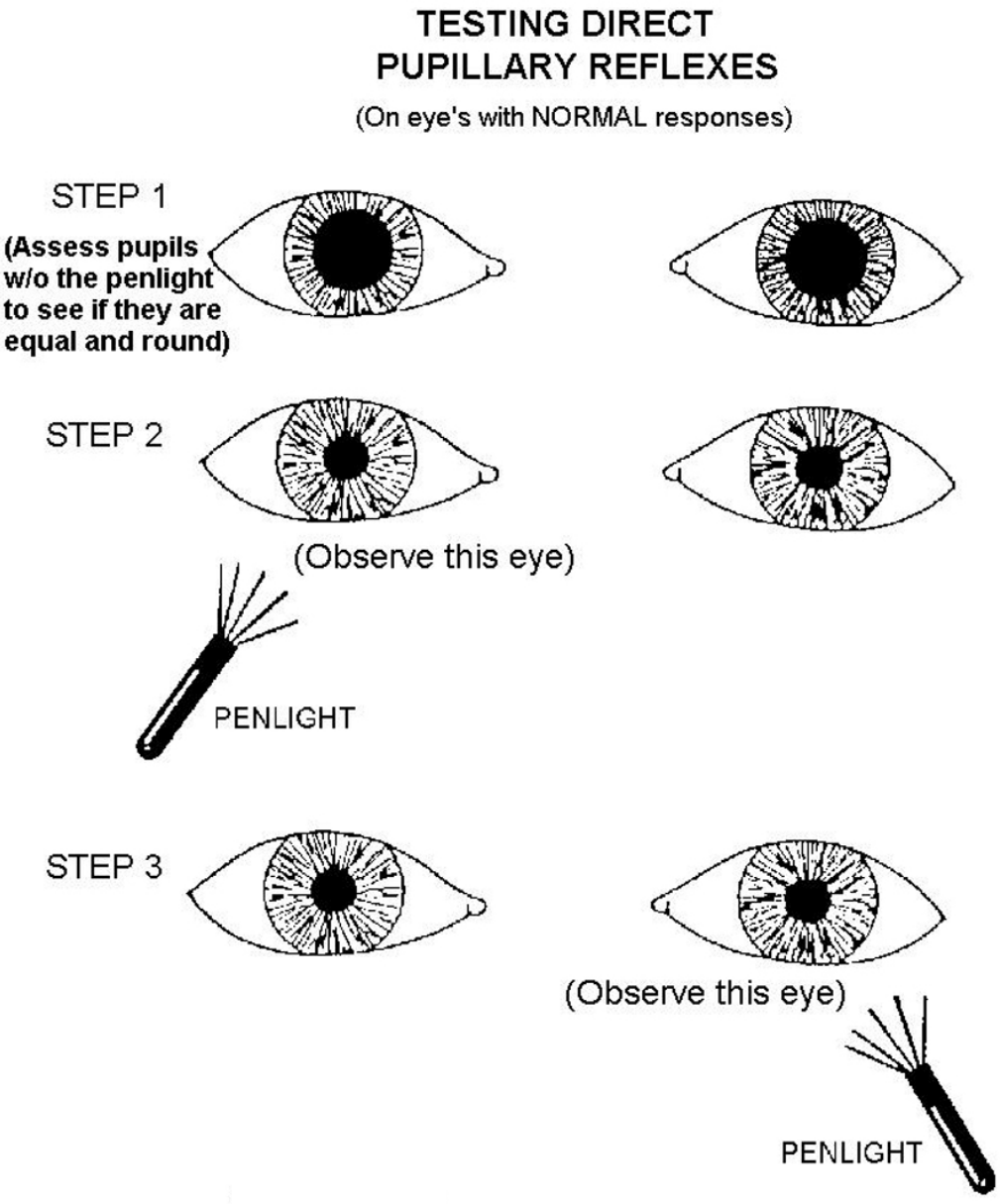


Figure 2–1. Direct pupillary reflex test.

If the pupil is nonresponsive, it's indicative of damage along the pupillary pathway. The most likely culprits causing a problem when the direct pupillary response is absent include the optic nerve of that eye, the pretectal area, cranial nerve (CN) III on that side, or the iris constrictor muscle.

Consensual pupillary reflex testing

For consensual pupillary response testing, shine the light into one eye, but actually observe the *opposite* eye for a reaction. For example, shine the light into the right eye, but watch the left eye for a consensual response, and vice versa (fig. 2–2).

Again, note the rate and symmetry of constriction and re-dilation. If both eyes responded consensually, then they are normal. If one eye fails to respond consensually to the light, note which eye did not have a consensual response. If the rate and symmetry of the reactions of both eyes were not the same, note which eye responded slower or to a lesser degree. For the consensual reflex test, there is no need to grade the briskness.

Absence of a consensual response may be due to damage to the optic nerve of the opposite eye, damage to the pretectal area, CN III damage, or damage to the iris constrictor muscle.

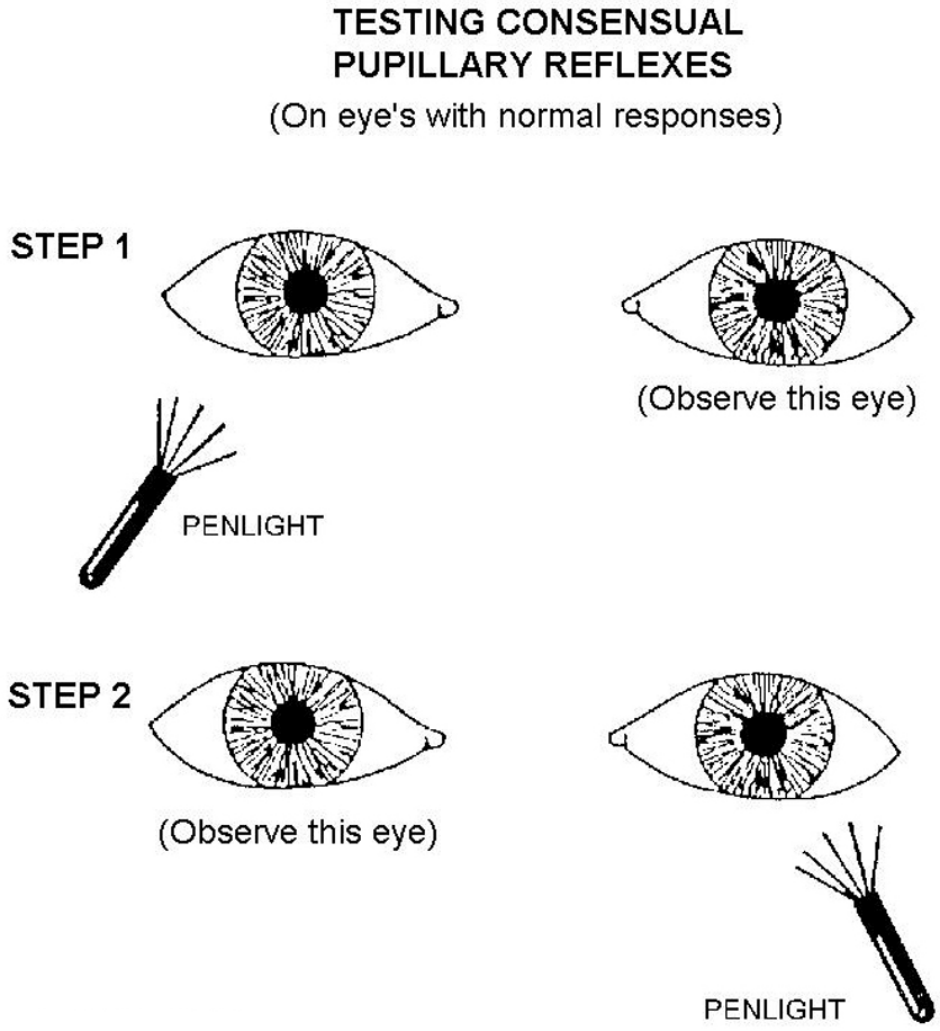


Figure 2–2. Consensual pupillary reflex test.

Accommodative pupillary reflex testing

Do not use the transilluminator for this test. You'll need a fine-tipped object or other small target for the patient to look at instead. Once again, begin the test with the patient looking at a distant target. Hold the near target about 6 inches in front of the patient's face, level with the eyes, and ask him or her to look at it. Observe both eyes to see if they constrict when looking at the near object (fig. 2–3). Then have the patient look back at the distant target again, and watch to see both if eyes re-dilate. Perform this test two or three times to give you plenty of opportunity to observe both eyes to see if they constrict or re-dilate and whether their rate and symmetry of constriction and re-dilation is equal.

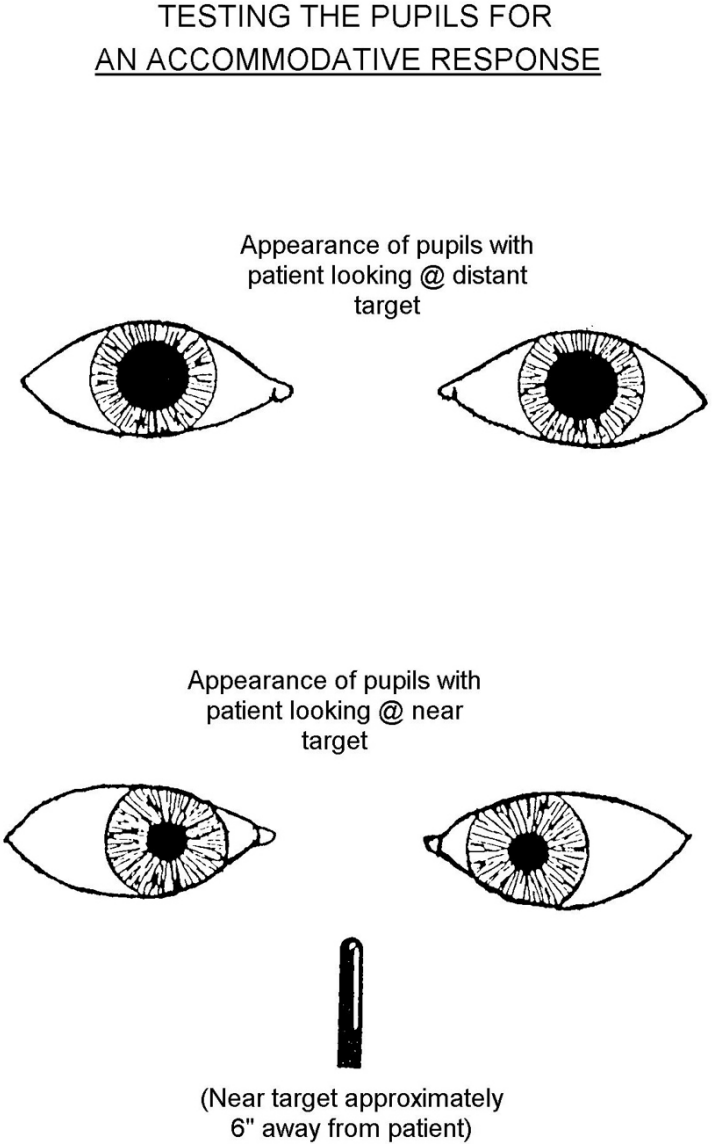


Figure 2–3. Accommodative pupillary reflex test.

If one or both eyes failed to constrict, note which eye had problems. If the rate and symmetry of the constriction and re-dilation are not equal, again note which eye was slower or responded to a lesser degree.

Swinging flashlight test

The swinging flashlight, also known as the MG test, is performed to compare the afferent pathways of one eye against the other. It helps identify any apparent APD.

Some people may tell you this test is not required if the patient's pupils are equal and round. This is simply not true. Whether the patient's pupils were equal and round or had anisocoria when initially assessed does not indicate presence or absence of an APD. To be sure, test every patient.

To administer the swinging flashlight test, have the patient look at a distant target. Shine the transilluminator into the right eye. Leave the light on and mentally note the constricted size of the pupil. Hold the light in front of the right eye for three to five seconds. Next, without turning the light off, move the light directly and quickly straight across to the left eye, and observe the first movement

of that pupil. At this point, you have just tested the left eye. If the left pupil stayed the same size or constricted initially, the left eye is normal (fig. 2–4).

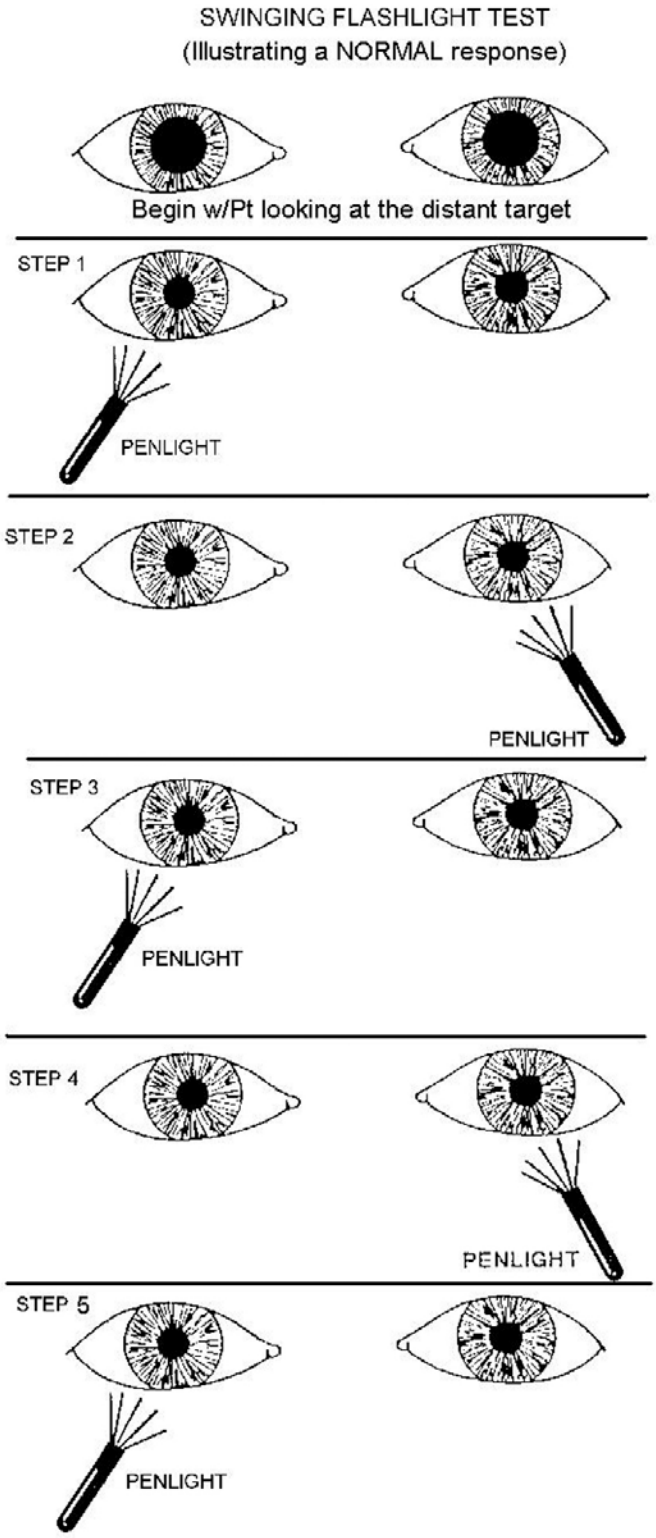


Figure 2–4. Swinging flashlight test on a patient with normal pupillary responses.

If, however, the first movement was of the pupil dilating, even if only a mm or two, there is a possible APD in the left eye (similar to step 2, fig. 2–5). Keep in mind, a 1+ APD may have a very weak initial constriction, but then the pupil dilates and remains dilated.

NOTE: Despite the fact that the test is called the "swinging flashlight test," do not swing the flashlight from one eye to the next. Move the light straight across the nose, quickly and smoothly.

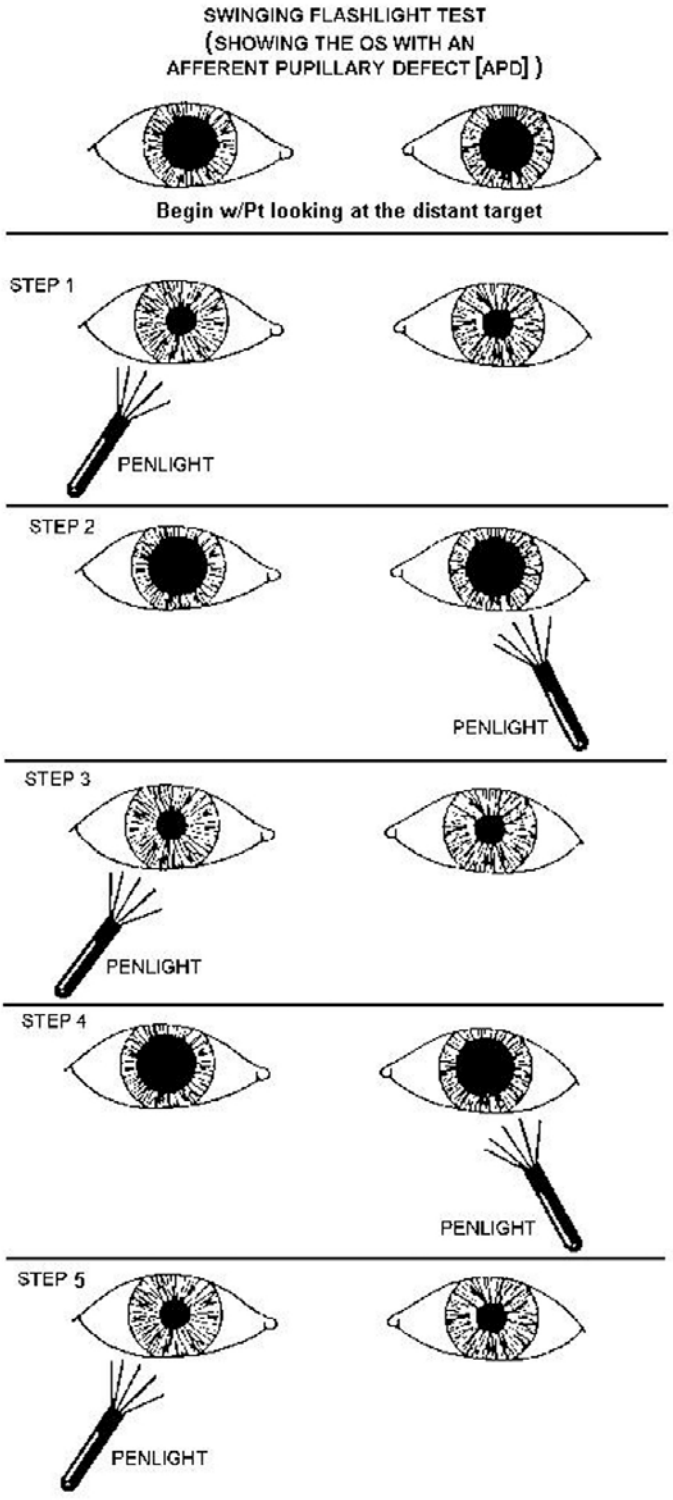


Figure 2–5. Swinging flashlight test on a patient showing the OS with an APD.

Having moved the light to the left eye and observed the first movement of the pupil, now, hold the light on in front of the left eye for three to five seconds, observing its size. Once again, *without turning off the light*, quickly move the light to the right eye and watch the pupil's first reaction.

Having tested each eye once, perform the test three more times on each eye. If you're still not sure about what you're seeing, perform it a few more times. This is an important test so make sure you perform an accurate assessment.

If a patient does have an APD (or an MG pupil) (fig. 2–5), it means there is something wrong with the afferent pathway of the affected eye. Usually problems *anterior to the optic chiasm* cause an afferent pupillary defect, meaning the problem is with the optic nerve or the retina. An afferent pupillary defect is commonly a sign of optic neuritis or retrobulbar neuritis, both of which are often signs of multiple sclerosis. If the patient has a (+) APD or (+) MG, you may have noticed one pupil was larger than the other was during your assessment to see if the pupils were equal and round. Not always, but it's an indicator.

Another possible indicator you may have observed was that the eye with the (+) APD or (+) MG was more sluggish in its response to the direct pupil test. Finally, an eye with a (+) APD usually has some decreased VA. The following tips may help you in your evaluation of a patient.

- **(–) APD** = no afferent pupillary defect. Both pupils constrict equally without evidence of pupillary re-dilation with the "swinging flashlight test," except possibly for "*hippus*". Hippus refers to nonrhythmic fluctuations in pupillary size when there is a steady illumination.

  NOTE: Hippus is a fluctuation of the pupil size. It's perfectly normal. Some people get confused while administering the test when they move the flashlight from the right eye to the left eye because they initially see the left pupil constrict slightly (which is good), but then the pupil starts to get slightly bigger (dilate). The pupil then starts to get smaller (constrict) again, then larger, etc. This is normal. Do not let this back and forth between constriction and dilation confuse you. Remember, you are looking for the *first movement*. Do not record the secondary movement of the pupil (to slightly dilate) as a (+) APD! It is not. The first movement was of constriction. This initial movement is the one that matters. If the pupil stays the same size or constricts slightly, it's normal. Remember, a 1+ APD may have a very weak initial constriction; the pupil then dilates and remains dilated. In contrast, hippus causes the pupil to continually fluctuate.
- **1+ APD =** mild afferent pupillary defect**.** One pupil shows a weak initial constriction, followed by dilation to a greater size.
- **2–3+ APD** = moderate afferent pupillary defect. One pupil shows no constriction, followed by dilation to a greater size.
- **4+ APD** = severe afferent pupillary defect. One pupil shows an immediate dilation to a greater size.

Recording the results

After testing the pupils, record your results. Assuming the patient's pupils responded normally to all tests (the **p**upils were **e**qual and **r**ound, **r**eacted to **l**ight directly and consensually, and showed an **a**ccommodative response with no evidence of an afferent pupillary defect), simply record the pupils as being **PERRLA (–)APD**.

If there are any abnormalities, leave off the corresponding letter of PERRLA that does not apply and explain the observed abnormality. For example, if the patient's pupils are normal except for the accommodative response, record "PERRL (–) APD, pupils did not react to accommodation."

Let's complete a few more examples just to be sure you have it. Say the patient's pupils are not equal in size (i.e., he or she has anisocoria where the right pupil was larger than the left), but everything else is normal. Record as "PRRLA (–) APD, OD>OS."

What if the patient's pupils are normal, except the right pupil reacts sluggishly to direct light, and the right eye has an afferent pupillary defect? You would record "PERRLA (+) APD OD, OD sluggish to direct light."

Let's assume in this example that the pupils are not equal or round. The left pupil is larger and the right pupil is oval shaped. In addition, the eyes do not respond to direct or consensual light, but there is an accommodative response. The swinging flashlight test cannot be accomplished since there is no pupil reaction to light. How do you record all this? "PA, OS>OD. OD is oval shaped. Neither eye responds to direct or consensual testing. APD testing cannot be accomplished." (By the way, this would be what the pupil test results will look like for a person with Argyll-Robertson pupils.)

Do not make recording pupil testing harder than it is. Just record what you did or did not see happen. It really is that easy.

Using the pupillary reflex tests to determine cause and type of defect

Once the pupils have been tested, you can make some educated decisions as to what your pupillary testing results mean. The following chart shows what certain findings on pupillary testing may mean in terms of what condition may be causing problems.

Pupillary Testing Cause and Effect				
Cause of Defect	**Pupil Size and Shape**	**Direct Reaction**	**Consensual Reaction**	**Accommodative Reaction**
Adie's pupil	Unequal pupils (affected pupil larger).	Sluggish constriction and sluggish re-dilation.	Delayed and slow.	Normal to sluggish.
Argyll-Robertson	Small, unequal, and irregularly shaped.	No reaction.	No reaction.	Present.
Horner's syndrome	Unequal pupils (affected pupil smaller). Noticed more in dim light.	Normal.	Normal.	Normal.
CN III palsy	Unequal (affected pupil larger).	No constriction in dilated eye.	No consensual response from dilated eye; normal eye has a normal response.	Normal in the good eye.
Acute narrow angle glaucoma attack	Affected pupil dilated and oval in shape.	No reaction in affected eye.	No reaction in affected eye.	No reaction in affected eye.

Adie's pupil

Adie's pupil is often called tonic pupil and should be apparent upon pupillary testing. The pupils are unequal in size (affected pupil is larger in early stages and then smaller later on). The direct and consensual tests all reveal sluggish constriction and re-dilation. While there is usually an accommodative test response, it's usually quite sluggish.

Adie's pupil is often caused by a viral infection damaging the ciliary ganglion or the posterior ciliary nerves leading to the pupillary sphincter muscle of the iris. This condition primarily affects young women. Tests consist of using a very weak percentage (0.12 percent) drop of Pilocarpine®. If the patient has an Adie's pupil, even the very weak concentration of Pilocarpine® causes an intense constriction of the pupil.

Argyll-Robertson pupils

Argyll-Robertson pupils are normally small, unequal, and irregularly shaped. They do not react to light (direct or consensual), but they do accommodate for a near target. This abnormality is usually

due to a lesion in the midbrain light-reflex path caused by diabetes and other diseases; however, it's most often brought on by neurosyphilis (syphilis of the brain). This is the same kind of syphilis spread as a sexually transmitted disease. If left untreated it eventually affects the brain and kills the person afflicted. If Argyll-Robertson is found, the patient needs to be tested for syphilis as soon as possible to confirm or deny its presence.

Horner's syndrome

Notice in the chart that for *Horner's syndrome*, other than unequal pupils, all the other test results are normal. So, what would ever make a doctor decide there might be something else going on besides normal anisocoria? Horner's syndrome is usually given away by one eye having a ptosis (droopy lid), accompanied by a small pupil (miosis), and the fact the patient does not seem to sweat on that side of the face (anhydrosis). Therefore, suspecting someone has Horner's syndrome depends on several indicators beyond just the pupils.

Horner's syndrome is caused by an interruption of the sympathetic nervous systems innervation to the dilator muscle of the affected eye. Common causes are Hodgkin's disease, tumors, trauma to the neck, or a migraine. If the patient was born with Horner's syndrome, his or her *irides* (irises) are often different shades or even different colors (a condition called heterochromia).

Horner's syndrome can only be verified clinically through cocaine testing. A drop of 5- to 10-percent cocaine is put into the eye with the smaller pupil. Then another drop is added about a minute later. If the pupil fails to dilate, then the Horner's syndrome is confirmed since cocaine is a powerful mydriatic. The reason other mydriatics cannot be used for the test is because of the specific *way* cocaine causes mydriasis. However, this is beyond the scope of this text.

607. Performing tonometry

The most commonly performed type of tonometry in the AF and civilian world is NCT. Performing NCT is a quick and painless way to screen patients for elevated intraocular pressure (IOP). An NCT has one major advantage over other types of tonometry. There is no contact with the eye, therefore, no need for a topical anesthetic. This significantly decreases testing time and reduces the possibility of an eye injury or infection as compared to conventional applanation tonometry.

Noncontact tonometry

NCT instruments emit, for lack of a better term, a "puff" of air that "applanates" the patient's eye. The instrument then display a read-out of the patient's IOP in mm of mercury (Hg).

During the past several years, malpractice has become an increasing reality. To prevent any possible legal action against you, the doctor, or the medical facility to which you are assigned, it's prudent to perform tonometry on every patient who is physically able to be tested. Be sure to document the results on the patient's exam form.

Video monitor display

Most modern NCTs have a video monitor (fig. 2–6) instead of an objective eyepiece. They generally have several buttons on the control panel, which may include those listed in the following table with their function.

Common NCT Video Monitor Display Features	
Button	**Function**
Clear	Clears all prior readings (some models require this button to be held for a second to clear the data).
Demo	Used to demonstrate the air "puff" to the patient.
Print	Generates printouts of the results.
Average/single	Allows the operator to choose single readings or an average of several readings.
Average/manual	Allows the operator to choose whether he or she will press a button to manually release the air "puff" or allow the machine to automatically take the measurement when aligned properly.

Common NCT Video Monitor Display Features	
Button	**Function**
Help	Offers assistance. Also used to change the date and time settings.
Mode	Selects the measurement mode. This is found on all-in-one autorefraction/keratometry/NCT machines.

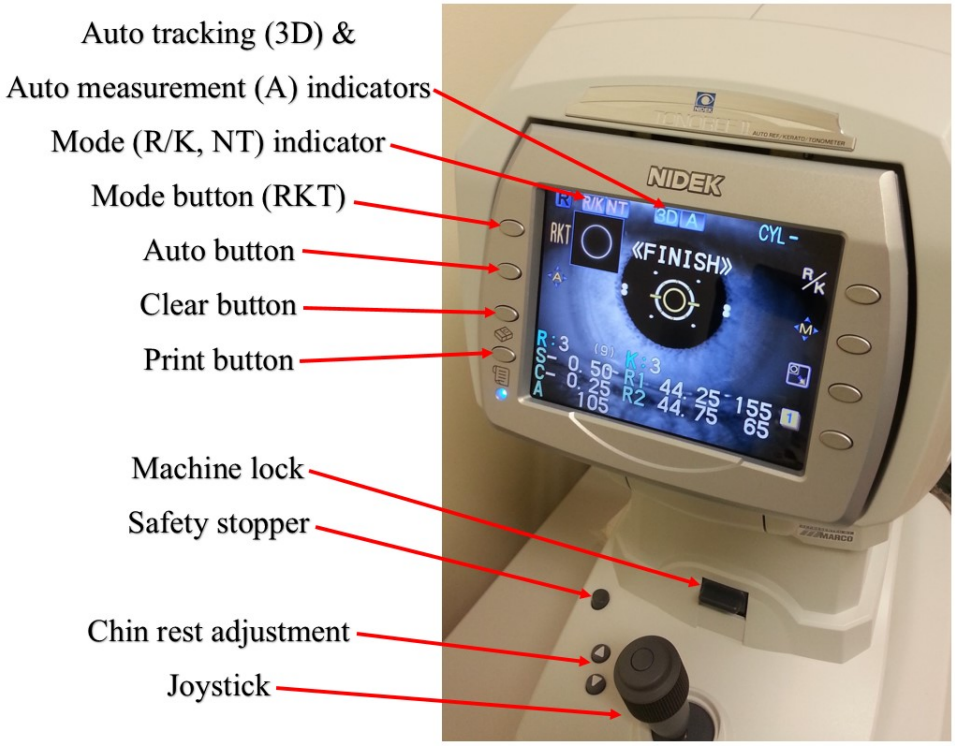


Figure 2–6. Nidek TONOREF II™ video monitor display.

NCT operation

There are several makes and models of equipment that perform NCT, but the following information and procedures are similar on all devices.

NOTE: In some cases, SCLs can be worn during the test. Check with your doctor. The following information covers the proper setup and use of the Nidek TONOREF II™ NCT. If your clinic uses a different type of equipment, refer to the operator's manual for its operating procedures.

Steps to Operate the Nidek TONOREF II™ NCT	
Setup:	
1.	Ensure the test is NOT performed under bright lights or in direct sunlight.
2.	Use an alcohol pad to clean the chin and forehead rests (fig. 2–7).
3.	Ensure the travel lock is disengaged.
4.	Turn the instrument on.
5.	Seat the patient comfortably in front of the instrument. Adjust the table height to an appropriate level for the patient.
6.	Explain the procedure and purpose of the test to the patient.
7.	Demonstrate the test by having the patient place his or her finger about ½-inch from the air outlet. Press the demo button to initiate a puff.

Steps to Operate the Nidek TONOREF II™ NCT	
Procedure:	
1.	For safety purposes, always keep one hand on the instrument.
2.	Set the instrument to NCT mode by pressing the mode button (RKT) at the top left until the box (R/K) disappears and the box (NT) remains. If both boxes are shown (R/K)(NT), the machine will take refraction and keratometry readings first, then switch to tonometry mode.
3.	Ensure the tracking and measurement is set to automatic (3D)(A). If it is not, press the auto button (an A surrounded by arrows) until the boxes for 3D/A are shown at top.
4.	Pull the stage back as far as possible and have the patient place his/her chin in the chinrest and forehead against the forehead rest.
5.	Raise or lower the chin cup so the patient's outer canthus is aligned with the canthus marker using the up/down chinrest arrows.
6.	Have the patient close his or her eyes. Press down on the safety stopper button and move the tonometer forward until you are 5 mm from the patient's right eyelid. Release the safety stopper and move the machine back again. This sets the forward limit of the machine.
7.	Instruct the patient to open his or her eyes and fixate on the blinking green light when it comes into view.
8.	Carefully move the stage forward until the image of the patient's right eye appears on the monitor.
9.	In the monitor you will see five white dots on the patient's eye.
10.	Center the target in the circle using the joystick (fig. 2–8).
11.	Adjust the machine so the middle light is in the center of the alignment circle. a. Rotate the joystick to adjust the vertical position. b. Move the joystick to the left or right to adjust the horizontal position. c. Move the joystick forward or back to adjust the focus.
12.	When moving the machine forward or backward, alignment hash marks may appear. a. Green hash marks below the target indicate you need to move forward. b. Purple hash marks above the target indicate you are too close and must move backward. c. The warning message "TOO CLOSE" will appear if you go too far forward. d. You may also have large red arrows directing you to move the machine up, down, left or right.
13.	If you engaged the automatic tracking and measurement feature in step 3 above, once the center light is properly aligned in the center of the target circle, the machine will automatically take a reading. You will still need to move the machine forward and/or backward to get the initial focus. On manual mode, press the button on the joystick to take a reading.
14.	Repeat the procedure for the other eye.
15.	If the pressure reading is 21 mm Hg and below, proceed to the next step. If the pressure is more than 21 mm Hg, or there is a difference of 4 mm Hg or more between the two eyes, take two more readings in each eye and inform the doctor.
16.	Engage the travel lock in the back left position.
17.	Print the results. To record the results, staple the printout to the exam form or transcribe the data to appropriate locations on the exam form.

Figure 2–7. Nidek TONOREF™ II chin and forehead rests.

Figure 2–8. Nidek TONOREF II™ manual measurement (no "A" box at top of the screen).

NOTE: Many operator manuals state that you should take *at least three readings per eye* regardless of the initial reading. Your doctor's policy will always be the final authority on what you actually do in your clinic.

Here are a couple of examples of recorded results:

Example #1:
NCT
OD 19, 17, 18 mm Hg @ 0930 hours (hr.)
OS 20, 18, 19 mm Hg

Example #2:
NCT
OD 11 mm Hg @1500 hrs.
OS 14 mm Hg

The doctor may *suspect* glaucoma if the patient's IOPs reveal the following:

- Two or more readings of 22 mm Hg (or higher) in one eye.
- One or more reading of 25 mm Hg (or higher) in one eye.
- An average difference in readings of 4 mm Hg (or more) between the right and left eye, after three readings in each eye.

It's important to note the criteria for repeat NCT testing are different from the criteria for *suspected* presence of glaucoma.

The tono-pen®

The tono-pen® (fig. 2–9) is a handheld instrument used to measure IOP. Its chief advantage over other tonometers is its portability. The tono-pen® can be used on wheelchair or bedridden patients. It's compact, lightweight, and battery operated, making it useful in field conditions or on humanitarian missions.

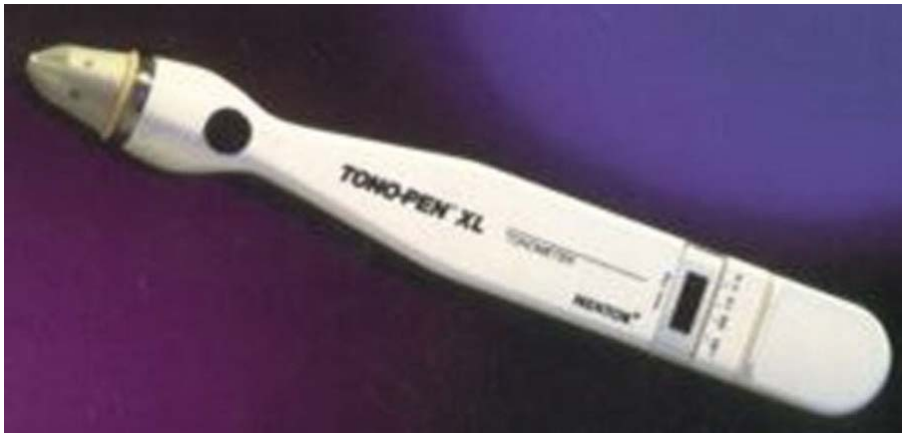


Figure 2–9. Tono-pen®.

The tono-pen® measures the amount of pressure required for the plunger-like tip to be pushed back into the instrument's sleeve. The IOP is converted into an electrical signal and is displayed as mm Hg. The tono-pen® is more accurate in the normal range of pressures. Recheck elevated readings with a Goldman applanation tonometer.

Components of the tono-pen® kit

The following items are included in a tono-pen® kit (fig. 2–10):

- Desiccant.
- Stylus blade.
- Ocu-cell batteries.
- Ocu-film tip covers.
- Tono-pen® tonometer.

Figure 2–10. Tono-pen® with case and supplies.

Safety

To get a measurement, the tono-pen® is gently touched to the patient's cornea. Too much force causes injury. Do not use the tono-pen® if the patient is allergic to latex. The tono-pen® tip is a solid-state strain gauge easily damaged by striking it against a hard surface. The tono-tip cover must be used for measurement and storage. Never wipe the tip with alcohol or immerse it in fluids.

Replacing batteries

When the batteries need replacement, the liquid crystal display (LCD) reads "Lob." Use the stylus to remove the battery cover (fig. 2–11) and remove the batteries. Once new batteries are inserted, the instrument must be calibrated.

Figure 2–11. Tono-pen®, remove battery cover with stylus.

Calibrating the tono-pen®

Perform calibration daily prior to use, after battery replacement, or whenever indicated by the LCD. Perform the following steps to calibrate the tono-pen®:

1. Point the tip of the tono-pen® straight down.
2. Depress the operator button **TWO** times (within 1.5 seconds).
3. The tono-pen® **BEEPs** and displays **CAL.**
4. The tono-pen® **BEEPs** again and displays **UP** (within 15 seconds).
5. Immediately point the tono-pen® tip straight up—within 1 second.
6. The LCD displays **Good** or **bAd** followed by a **BEEP.**

If **Good** is displayed, depress the operator's button **ONCE** and the tono-pen® displays [8.8.8.8], followed by a single row of dashes [------], followed by a double row of dashes [= = = =]; the instrument is now ready to take a measurement.

If **bAd** is displayed, repeat calibration procedures (1) through (6)

If calibration is unsuccessful, loosen or replace tono-tip cover, spray tip with compressed gas, or replace batteries. If none of these steps fixes the problem, request to have a biomedical equipment technician look at the tono-pen® for possible repair.

Performing measurements

As with any test, first explain the procedure to the patients. Tell them you are taking a measurement of their eye pressure. They will not feel a thing, but they will hear the instrument beep. They are to keep both eyes open and look at the fixation target you identify for them. Apply one drop of topical

anesthetic to both eyes and be sure to use a fresh tono-tip cover. The following steps are necessary to successfully measure a patient's IOP.

1. Hold the tono-pen® as you would a pencil (fig. 2–12).

Figure 2–12. Tono-pen® held as a pencil.

2. Position yourself to the side of the patient to facilitate viewing of the probe tip and the patient's cornea where contact is made.
3. Brace the heel of your hand on the patient's cheek for stability while holding the tono-pen® perpendicular and within 1/2 inch of the patient's central cornea.
4. Depress the operator's button ONCE**.**
5. If it displays CAL, followed by a single row of dashes **[----]**, it indicates the instrument requires calibration.
6. If a double row of dashes **[= = = =]** is displayed, it indicates the tono-pen® is activated and ready to measure IOP.
7. Once activated, touch the tip to the cornea LIGHTLY and BRIEFLY.
8. A reading displays on the LCD and a CHIRP sounds.
9. After four readings, a final beep sounds and the averaged measurement appears along with a statistical bar denoting statistical reliability.

Interpreting the LCD

The number display is the IOP reading in mm Hg. A number with a single horizontal bar displayed is the average of the measurements. A number without a single horizontal bar is the reading from a single measurement. The display of one of the four horizontal bars indicates statistical reliability.

If 5 percent is displayed, the standard deviation of the valid measurement is 5 percent or less of the number shown and the measurement is valid. If 20 percent is shown, the measurement should be repeated. The tono-pen® readings are as follows:

- *A single row of dashes* indicates the instrument is activated.
- *A double row of dashes* indicates the instrument is ready to take measurements.
- *CAL* indicates the instrument needs to be calibrated or is undergoing calibration.
- *Lob* indicates the need to replace the batteries.
- *UP* indicates the instrument is being calibrated and the tip should be pointing up.
- *Good* indicates the calibration check was successful.
- *bAd* indicates the calibration check was unsuccessful and must be repeated.

608. Ocular motility testing

In an earlier volume of the career development course (CDC), you were given an in-depth look at the anatomy and physiology of the extraocular muscles (EOM). To understand your observations when testing a patient's ocular motility, you need to understand the primary actions of the muscles. That way, when something abnormal happens, you can make an intelligent analysis and judgment of the problem. The following tables give you a quick review of muscle innervation and the primary action of the six EOMs.

Cranial nerves

The following table shows how the cranial nerves play a role in ocular motility:

Cranial Nerves and Ocular Motility	
Cranial Nerve	**EOM Innervated**
III CN (Oculomotor)	Superior rectus (SR) Inferior rectus (IR) Medial rectus (MR) Inferior oblique (IO)
IV CN (Trochlear)	Superior oblique (SO)
VI CN (Abducens)	Lateral rectus (LR)

EOMs primary actions

The primary actions of the EOMs are listed in the following table:

EOM Primary Actions	
Muscle	**Primary Action**
LR	Abduction
MR	Adduction
SR	Elevation
IR	Depression
SO	Intorsion
IO	Extorsion

Anomalies of ocular motility

The alignment of the eyes are placed into one of three general categories:

1. Orthophoria.

2. Heterophoria.
3. Heterotropia.

Orthophoria

Orthophoria is the condition in which the two eyes are always pointing in the same direction. Under conditions of disassociation, there is no deviation of the lines of sight of one eye from the other. In other words, both eyes remain directed toward the object of regard, even if one eye is occluded. For the person with orthophoria, both eyes are aligned correctly all the time, even if an occluder is placed in front of one eye.

Heterophoria

Heterophoria is the condition where the two eyes do not point in the same direction when one eye is occluded; if unoccluded, the eyes do point in the same direction. Heterophoria is a latent (or hidden) condition. Heterophoria is detected when the eyes are disassociated (i.e., one eye is occluded). If the covered eye assumes a position of deviation (i.e., it turns in, up, down, or out), in relation to the eye not covered, the patient has a latent muscle deviation (heterophoria).

Upon removal of the cover (and a return to normal binocular vision), the eye that was deviated almost immediately returns to normal alignment with the other eye. The muscle deviation occurring in heterophoric patients only happens because of dissociation (the covering of one eye). When the eyes are left alone, they remain correctly aligned.

Heterotropia

Heterotropia is the condition in which the two eyes are not pointing in the same direction, whether or not an eye is occluded. Heterotropia is a *manifest* condition (a condition that is obviously seen). It's often called strabismus, squint, wandering eye, or tropia. Heterotropia exists when the lines-of-sight of the two eyes fail to align correctly, at the same time, on the object of fixation.

If one eye fixates on (looks at) an object, and the other eye is looking off to the left, right, above, or below the object, the patient is said to have a heterotropia. In heterotropia, the misalignment of the two eyes is always present, whether or not the eyes are disassociated.

Diagnostic (muscle) "H" test

The diagnostic (muscle) "H" test is designed to evaluate the EOMs of the eyes for weaknesses or paralysis (paresis). Remember, the muscles of the two eyes are yoked together. Based on this fact, certain muscles are isolated in certain directions of gaze (fig. 2–13). If done properly, the muscle "H" test isolates the individual muscles of each eye.

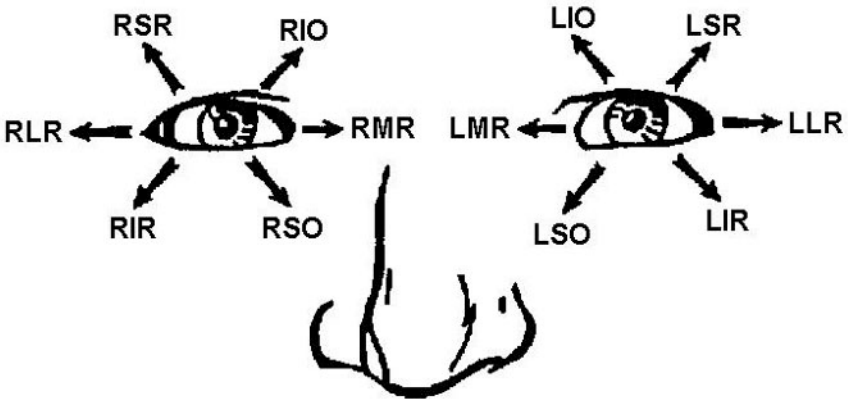


Figure 2–13. Muscle actions.

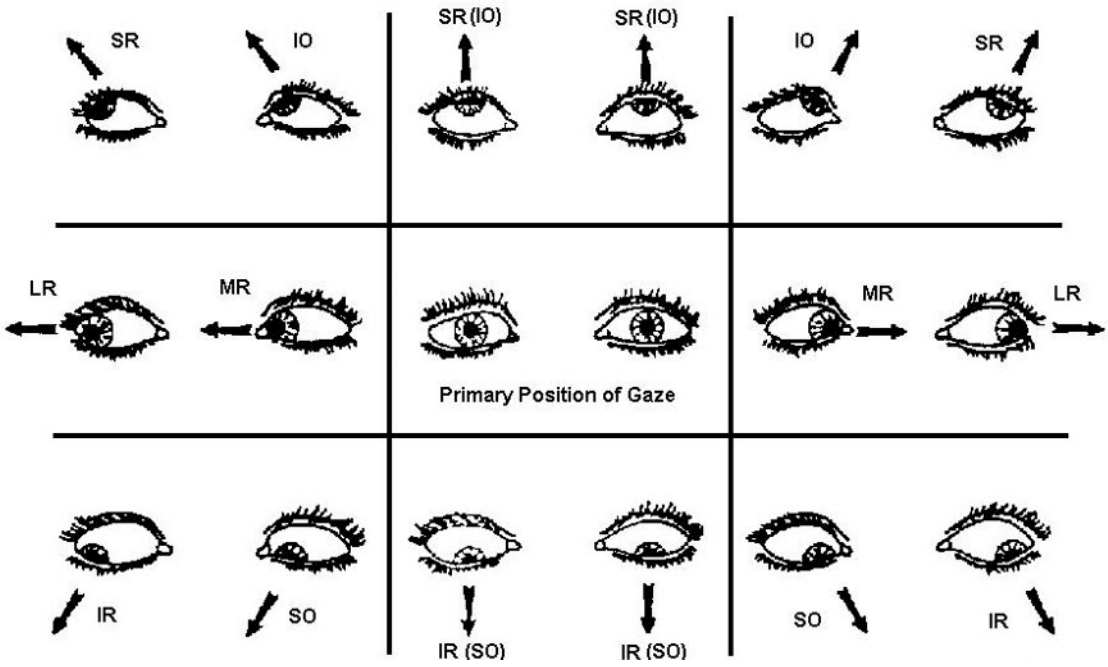


Figure 2–13. Muscle actions.

While administering this test, observe the position of both eyes. Do the eyes appear to be pointing forward, or is one eye pointing in a different direction from the other eye? Both eyes should be in relatively the same position as they look at a target in various positions of the VF. If you watch the eyes, you can tell if a weakness or paralysis (paresis) of an EOM is present. The eyes should also follow the target smoothly.

Nystagmus

Before we go through the steps of testing, let's look at a condition that can cause involuntary eye movement. You may encounter someone with nystagmus, a condition where the eyes jerk back and forth uncontrollably. This condition is sometimes found during the diagnostic (muscle) "H" test.

You do not routinely test for this condition. However, if nystagmus occurs before you get the light 30 degrees (°) from the patient's primary position of gaze, this could be a sign of alcohol intoxication or a tumor. Make sure you annotate the findings when recording the results.

End-point nystagmus

A condition known as end-point nystagmus can be found at the extreme end-point of gaze (between 60 and 90° out from the primary position of gaze). End-point nystagmus is a normal finding.

Administering the diagnostic (muscle) "H" test

Administer the diagnostic (muscle) "H" test in a well-lit room. Seat the patient facing you, remove spectacles (if worn), and have him or her fixate on an illuminated penlight held at eye level, 16 inches in front of him or her. Instruct the patient to fixate on the penlight at all times, without moving his or her head.

Now move the light to the patient's right about 50 to 60° or until the corneal reflex from the patient's left eye disappears. If the patient's eyes follow the light, the right lateral rectus (RLR) and left medial rectus (LMR) are intact. If both eyes do not follow the light, then either the RLR or the LMR is restricted. As the patient follows the light, evaluate the eyes' ability to follow the light. Are the movements smooth or jerky? Patients should be able to track a target smoothly.

Now elevate the light about 30° above the midpoint, while the patient is still looking to the right. Do both eyes follow the light? Do they move smoothly, or is the movement jerky? Is there a restriction of

one of the muscles? If the eyes follow the elevating light, then the left inferior oblique (LIO) and the right superior rectus (RSR) are intact. If the eyes do not track up and to the right, or the patient reports seeing double, then the LIO and RSR must be suspected.

Now, move the light down about 30° below the midpoint, with the patient still looking to the right. This checks the left superior oblique (LSO) and right inferior rectus (RIR). You may have to elevate the eyelids to observe if the eyes moved down together. Now bring the light back up to the midpoint; then move the light across to the patients left side, going out about 50 to 60° (i.e., until the light reflex is lost in the patient's right eye). Did the patient's eyes smoothly follow the light across? Are both eyes still observing the light? If the patient maintains binocular fixation, then the left lateral rectus (LLR) and right medial rectus (RMR) are fine.

With the patient still looking to the left, elevate the light to a position about 30° above the midpoint. This checks the left superior rectus (LSR) and right inferior oblique (RIO).

Now lower the light until it is about 30° below the midpoint. This checks the left inferior rectus (LIR) and right superior oblique (RSO). Again, you may have to raise the eyelids to observe the eyes. Move the light back to the midpoint and bring it back to where the patient's eyes are back to the primary position of gaze (i.e., looking straight ahead). If the eyes do not track down and to the left, or the patient reports seeing double, then the LIR and RSO are suspect.

If both of the patient's eyes followed the light to all of the positions of gaze tested, and the movements were smooth, record the results as "EOM–F/S/U," which stands for "**e**xtra**o**cular **m**uscles **f**ull, **s**mooth, and **u**nrestricted." If the patient's eye movements were jerky during testing, then record as "EOM–F/U, Jerky." If the patient could not move the eyes to one or more of the positions tested, record this as, "Possible paresis of the (list muscle or muscles of concern)." Bring any abnormalities found to the doctor's attention.

Figure 2–14 illustrates some of the abnormal findings during a diagnostic (muscle) "H" test.

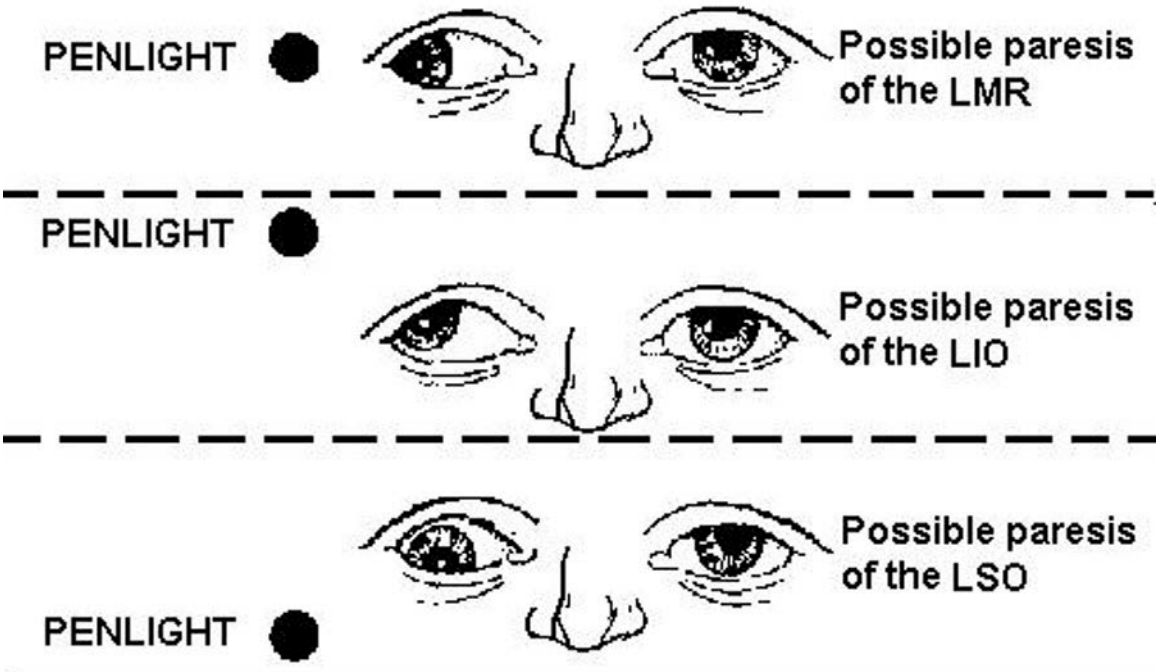


Figure 2–14. Abnormal diagnostic (muscle) "H" findings.

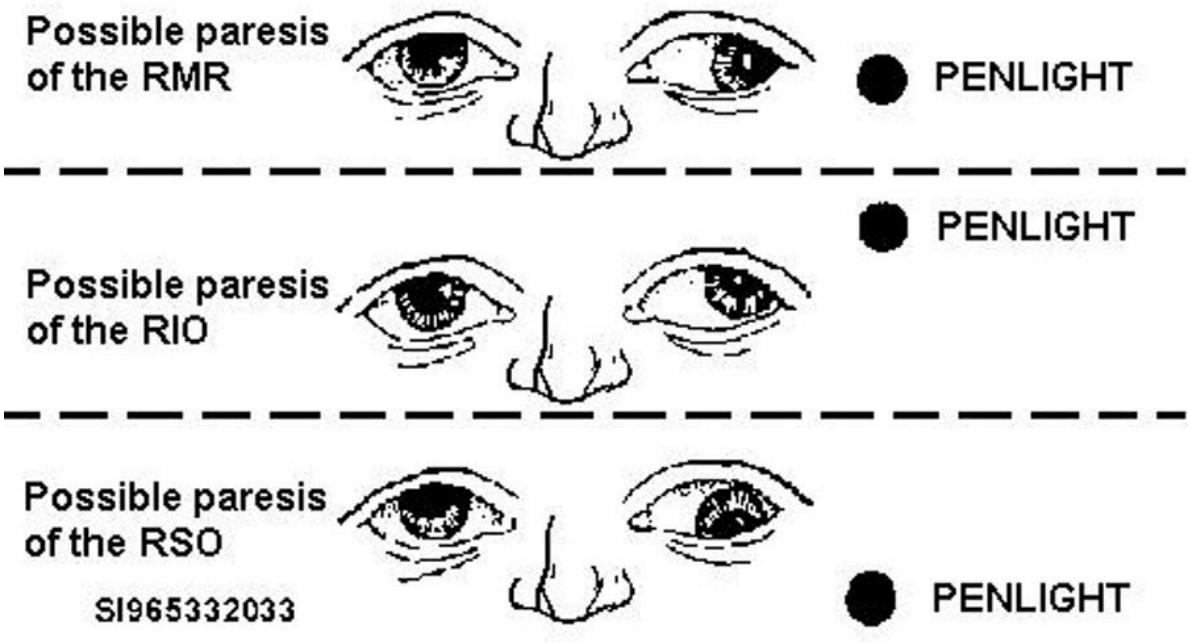


Figure 2–14. Abnormal diagnostic (muscle) "H" findings.

Cover test

The cover test reveals a patient's true, binocular alignment. The patient wears his or her habitual Rx for the distance being tested. First, administer the test with the patient looking at a target 20 ft. away; it's then repeated with the patient looking at a target 16 inches away. The cover test is actually two tests: the unilateral cover test and the alternating cover test.

Understanding eye alignment problems as seen during cover testing

An orthophoric (ortho) patient has perfect eye alignment and his or her eyes do not move during the test. This individual has perfect eye alignment without the brain having to do any fine-tuning to maintain it, even if one eye is covered. As already explained earlier, during testing a patient may show to be heterophoric (phoria) or heterotropic (tropia). But, as a quick review, they are covered again in the following paragraphs.

A heterophoric (phoria) patient shows eye movement during the test when one of the eyes is covered. This individual's eye alignment is not perfect. The brain has to do some fine-tuning to maintain alignment.

A heterotropic (tropia) patient shows eye movement during the test. In fact, before you start testing you can see the misalignment. It's obvious. Nevertheless, you still need to complete the test to determine the type of condition and direction of the misalignment. (Small angle tropias are NOT obvious.)

Performing the cover test

Now that you understand what the eyes do when a person has a phoria or a tropia, it's time to discuss the actual testing procedures. Performing the tests properly makes figuring out which condition a person has very easy.

In this course, we always perform the unilateral cover test first. It's taught that way in civilian optometry schools as well as our military optometry course. You may encounter, or very well be, one of those technicians who perform the alternating cover test first. This is not incorrect, just another approach to doing cover testing.

Test your patients at distance (20 ft.) and then again at near (16 inches). The patient wears his or her habitual Rx during cover testing.

Always begin testing at 20 ft. first. Project a letter or spot on the eye chart using a chart projector. Instruct the patient to fixate on the target. You must remain out of the way so the patient can see the target with both eyes.

Although we discuss the unilateral test at distance and near before discussing the alternating test, your actual testing sequence is:

1. Unilateral at distance.
2. Alternating at distance (if no movement on unilateral).
3. Unilateral at near.
4. Alternating at near (if no movement on unilateral).

Preparing the patient

To prepare the patient, complete the following:

1. Seat the patient comfortably. (If the patient wears spectacles, they are worn for this test.)
2. Present an appropriate target. When testing at distance, use a single letter in a row one line above the patient's corrected VA. When testing at near, use a small picture or letter target or a transilluminator as a target. The near target is held 16 inches from the patient's eyes.
3. Explain what you're going to do during each step. Use a simple statement like "I'm going to check the alignment of your eyes."

Performing the unilateral cover test

The purpose of the unilateral cover test is to detect the presence of a tropia. The test is performed both at distance and near in the same manner.

1. Ask the patient to fixate on the selected target.
2. Use the occluder to cover the left eye while observing the right eye for movement.
3. After 1 to 2 seconds, uncover the left eye while observing the right eye for movement.
4. Cover and uncover the left eye at least four times.
5. Repeat steps 1–4, covering and uncovering the right eye and observing the left eye for movement.

Interpreting results of the unilateral cover test

To interpret the results of the unilateral cover test, answer the following questions:

1. Are the eyes **phoric** or **tropic?**

If you see no movement, the eyes are phoric and you must proceed to the alternating cover test (still at distance). In the case of heterotropia, only one eye fixates on the target. If you cover the fixating eye, the nonfixating eye must make a compensatory movement to take up fixation. Therefore, if you do see movement, the patient has a tropia and you must answer the following questions for an accurate assessment.

2. Is the eye exhibiting an **eso**, **exo**, **hyper**, or **hypo** tropia?

The terms *eso*, *exo*, *hyper* and *hypo* are used to describe the direction the eye is deviating. Remember you are evaluating the movement of the eye NOT being covered. Where did the uncovered eye come from when it was forced to fixate? This is what you need to evaluate.

The following table shows the eye movement and the resulting deviation.

Eye Movement and Deviation	
Movement	**Deviation**
Out	Esotropia
In	Exotropia
Down	Hypertropia
Up	Hypotropia

3. Is the tropia **right**, **left**, or **alternating**?

A patient who has an alternating tropia alternates fixation between his or her eyes. Consider a patient with an alternating tropia. When the right eye is covered, the patient is forced to take up fixation with the left eye, therefore we see a movement. When the right eye is uncovered, the patient continues to fixate with the left eye (no movement as the patient has alternated fixation).

If you covered the left eye, the right eye would move once, to take up fixation and would remain the fixating eye when the left eye is uncovered. We see only one movement, during the cover portion of the test, regardless which eye is covered and uncovered. The brain can fixate with the right or left eye equally well. It does not favor either eye.

A patient who has a right tropia uses his or her left eye to fixate unless forced to use the right eye. When the left eye is covered, the patient is forced to take up fixation with the right eye (one movement). When the left eye is uncovered, the patient takes up fixation once again with the left eye and the right eye moves back to its misaligned position (second movement). We see two movements, one during the cover portion and one during the uncover portion of the test.

A patient who has a left tropia uses his or her right eye to fixate unless forced to use the left eye. When the right eye is covered, the patient is forced to take up fixation with the left eye. When the right eye is uncovered, the patient takes up fixation once again with the right eye and the left eye moves back to its misaligned position. We again see two movements, one during the cover portion and one during the uncover portion of the test.

The table below will help you determine if a tropia is right, left, or alternating by observing the number of eye movements and which eye is moving.

How to Determine Right, Left, or Alternating Tropia		
Movements	**Eye that Moves**	**Right, left, or alternating**
1	Both right and left	Alternating
2	Right	Right
2	Left	Left

4. Is the tropia **constant** or **intermittent**?

If the tropic eye exhibits movement each time the opposite eye is covered, the tropia is constant. If the tropic eye exhibits movement only some of the times the opposite eye is covered, the tropia is intermittent.

Recording results of the unilateral cover test

If movement was noted on the unilateral cover test, ask four questions to determine what type of tropia the patient has. **If there was no movement, wait until you have performed the alternating cover test to record findings. The patient may have a phoria.**

The standardized abbreviations to record the findings are listed in the table below.

Cover Test Abbreviations			
CT = distance cover test	**R** or **OD** = right eye	**E** = eso	**Ø** = orthophoric
CT' = near cover test	**L** or **OS** = left eye	**X** = exo	**P** = phoria
	A = alternating	**Hyper**	**T** = constant tropia
		Hypo	**(T)** = intermittent tropia

Let's consider an example.

It's much easier to consider the distance and near results separately. So, let's concentrate on the distance findings first.

Patient A exhibits outward movement of the left eye during the DISTANCE unilateral cover test. The movement is observed each time the right eye is covered. Remember, ask the following questions:

1. Are the eyes **phoric** or **tropic**? There is *movement on the unilateral cover test*, so patient A has some type of tropia.
2. Is the movement **eso**, **exo**, **hyper**, and **hypo**? The movement is *outward*, indicating an ESO deviation.
3. Is the tropia **right**, **left**, or **alternating**? Only the *left eye* exhibits movement, so Patient A has a left tropia.
4. Is the tropia **constant** or **intermittent**? The eye *moves every time* the other eye is covered; this is a constant tropia.

Conclusion: Patient A has a constant left esotropia (LET) at distance. To record the results, first document the appropriate abbreviation for the test distance (**CT**). Then indicate the tropic eye(s) (**L**). Next, record the appropriate abbreviation for the direction of the tropia (**E**). Finally, indicate whether the tropia is constant or intermittent (**T**).

Therefore, your cover test findings would indicate: **CT: LET**

Now let's consider the findings at near.

Patient A exhibits outward movement of the left eye during the NEAR unilateral cover test. The movement is observed only some of the times the right eye is covered. Again, ask the following questions:

1. Are the eyes **phoric** or **tropic**? There is movement on the unilateral cover test, so patient A has some type of tropia.
2. Is the movement **eso**, **exo**, **hyper**, and **hypo**? The movement is outward, indicating an **ESO** deviation.
3. Is the tropia **right**, **left**, or **alternating**? Only the left eye exhibits movement, so Patient A has a left tropia.
4. Is the tropia **constant** or **intermittent**? The eye moves only some of the time the other eye is covered; this is an intermittent tropia.

Conclusion: Patient A has an intermittent LET at near. If we included the above results from our distance test, we would record the cover test findings as: **CT: LET CT': LE(T)**

Performing the alternating cover test

The purpose of the alternating cover test is to detect the presence of a latent deviation (phoria) in the alignment of the eyes. *Only perform this test if there is no movement noted on the unilateral cover test.* The test is performed both at distance and near in the same manner. Perform the following steps to complete the test:

1. Ask the patient to fixate on the target selected.
2. Use the occluder to cover the left eye.
3. After 1 to 2 seconds, uncover the left eye and move the occluder to cover the right eye.
4. Always observe the eye for movement as it's being uncovered.
5. Alternate covering the eyes 7 to 10 times.

Interpreting results

To interpret the results of the alternating cover test, answer the following questions:

1. Are the eyes **orthophoric** or **heterophoric**?

If you see no movement, the eyes are orthophoric and no additional testing is needed at distance. Test at near.

If you do see movement, the patient has some type of phoria, and you must observe the movement to determine the direction of the phoria. The table below will help you determine if a phoria is orthophoric or heterophoric by observing eye movement.

How to Determine Orthophoria or Heterophoria		
Movement	**Orthophoria or Heterophoria**	**Action**
No	Orthophoria	Stop and record orthophoria.
Yes	Heterophoria	Determine the direction of the phoria.

2. Is the eye exhibiting an **eso, exo, hyper**, or **hypo** phoria?

The terms **eso**, **exo**, **hyper**, and **hypo** are used to describe the direction of phorias as well as tropias. Remember you are evaluating the movement of the eye as it's being uncovered.

The table below will help you determine the direction of the phoria.

How to Determine the Direction of Phorias		
Movement	**Deviation**	**Action**
Out	Esophoria	None
In	Exophoria	None
Down	Hyperphoria	Identify hyper eye
Up	Hypophoria	Identify hyper eye

That's it! The designators **right**, **left**, **alternating, constant**, and **intermittent** do **not** apply to phorias with one exception. With a vertical phoria, the hyper eye is always the referenced eye.

Recording results of the alternating cover test

To record the results, first document the appropriate abbreviation for the test distance. Next, record the appropriate abbreviation for the direction of the phoria. Finally, document it as a phoria.

Let's consider an example.

Patient B exhibits no movement on the DISTANCE unilateral cover test and no movement on the DISTANCE alternating cover test. Patient B exhibits no movement on the NEAR unilateral cover test and inward movement of both eyes during the NEAR alternating cover test.

Again, consider the distance and near results separately. So concentrate on the distance findings first and ask the four questions discussed earlier:

Patient B exhibits no movement on the DISTANCE unilateral cover test and no movement on the DISTANCE alternating cover test.

1. Are the eyes **phoric** or **tropic**? There is no movement on the unilateral cover test, so patient B is phoric. Record the results of the alternating cover test.
2. Are the eyes **orthophoric** or **heterophoric**? There is no movement on the alternating cover test, so patient B is orthophoric.

Conclusion: Patient B is orthophoric at distance and is recorded as: **CT: Ø**

Now let's consider the findings at near.

Patient B exhibits no movement on the NEAR unilateral cover test and inward movement of both eyes during the NEAR alternating cover test.

1. Are the eyes **phoric** or **tropic**? There is no movement on the unilateral cover test, so patient B is phoric. Record the results of the alternating cover test.
2. Are the eyes **orthophoric** or **heterophoric**? There is movement on the alternating cover test, so patient B is heterophoric.
3. Is the movement **eso**, **exo**, **hyper**, and **hypo**? The movement is inward, indicating an **EXO** deviation (the eyes were out while covered).

Conclusion: Patient B has exophoria at near. This would be recorded as: **CT: Ø CT': XP**

NOTE 1: The only time **hypo** is used as a descriptor is when a patient has a right or left hypotropia. For phorias, always reference the hyper eye.

NOTE 2: A patient may have a tropia at distance and a phoria at near and vice versa.

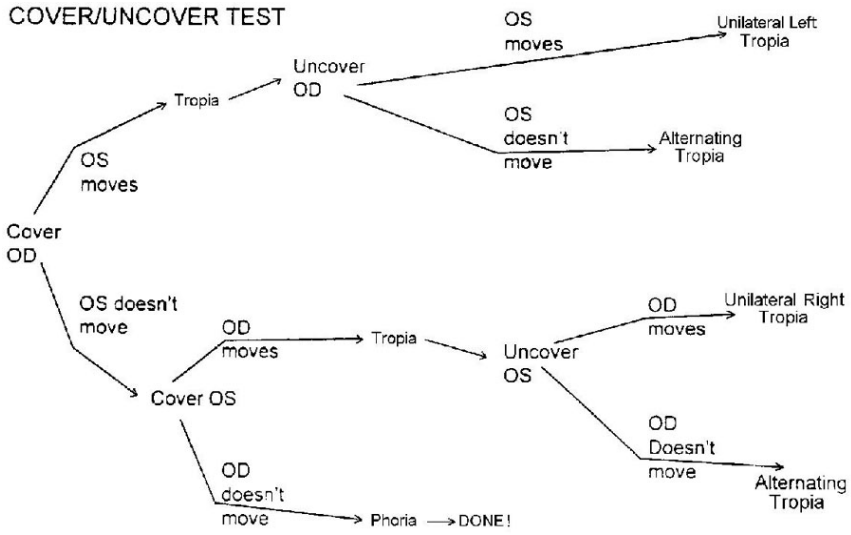


Figure 2–15. Cover test flow chart.

To view a flow diagram for the cover and uncover test, see figure 2–15.

So far you've learned how to perform the cover test and assess the alignment of a patient's eyes. Eye alignment plays an important role in visual performance and visual comfort. It's also crucial to depth perception. Mastery of cover testing takes practice; the more you practice, the better you become at interpreting results.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

606. Administering the pupillary reflex test

1. Pupillary reflex tests are a simple and effective way to detect and diagnosis what medical condition?

2. List the four pupillary tests.

3. Under what type of lighting is pupillary testing performed?

4. What is the significance if there is a difference in the rate and symmetry of pupil constriction between the patient's eyes?

5. What term is used to describe unequal pupil size? What percentage of adults normally has unequal pupil size that is not caused by a pathological condition?

6. What is another name for the swinging flashlight test?

7. What is the distance away from the eye that the transilluminator is held for the direct pupillary reflex test? Why?

8. Which test does not use a penlight to stimulate the pupillary response? What is used to stimulate the pupillary response in this test?

9. While performing the swinging flashlight test, you move the penlight to the left eye and the pupil's first movement is dilation. What does this indicate?

10. How should you move the penlight from eye to eye when performing the swinging flashlight test?

11. What is hippus?

12. Using the PERRLA method for recording, how would you record the test results of a patient whose pupils did not react to accommodation, but all else was normal?

13. What findings would you expect when a patient has III CN palsy?

14. What causes *Adie's* pupil (tonic pupil)? Whom does it primarily affect?

15. What sexually transmitted disease can cause Argyll-Robertson pupils?

16. A 5- to 10-percent solution of cocaine is used to absolutely confirm which pupil defect?

607. Performing tonometry

1. What is a significant advantage the NCT has over conventional applanation tonometry?

2. Why is it important to perform tonometry on every patient who can physically be tested?

3. When performing NCT, can SCLs be worn?

4. What is the *chief advantage* of the tono-pen® over other tonometers?

5. Where should you brace your hand for stability when using the tono-pen®?

608. Ocular motility testing

1. The III CN (oculomotor) innervates four of the six EOMs. Which nerves innervate the other two muscles?

2. What are the primary actions of the two oblique muscles?

3. The alignment of the eyes can be classified into three general categories. What are they?

4. Of the three eye alignment categories, which is a latent (hidden) alignment problem?

5. Which test is designed to evaluate the EOMs for possible muscle paresis?

6. During the diagnostic (muscle) “H” test, how many degrees above the midpoint, do you move the penlight to test the patient’s upward gaze?

7. When performing the diagnostic (muscle) “H” test, what would be the proper-recorded response if it appeared the patient’s left superior oblique is paralyzed?

8. When you have a patient look to his or her extreme left during the diagnostic (muscle) “H” test, you notice the patient’s right eye is not “tracking” the penlight to the midpoint. How would you record this?

9. At what two distances is a cover test performed?

10. What two tests make up the cover test?

11. What is the term used for a patient with perfect eye alignment, without the brain having to do any fine-tuning to maintain it?

12. Which part of the cover test is performed first?

13. List the testing sequence of the cover test.

14. What is the purpose of the unilateral cover test?

15. You are performing the cover test on a patient. During the unilateral cover test, you cover the right eye, the left eye moves in. You then uncover the right eye, and the left eye moves out. You repeated the unilateral cover test three more times, getting the same results every time. What condition is this?

16. You are performing the cover test on a patient. During the unilateral cover test, you cover the right eye, and the left eye moves up. When you uncover the right eye, the left eye *does not move.* You repeat the unilateral cover test three more times. One time, you get the same results. The other two times, you saw no movement of either eye during the unilateral cover test portion of testing. What condition is this?

17. You are performing the cover test on a patient. During the unilateral cover test, you cover the right eye, and the left eye does not move. When you cover the left eye, the right eye does not move. You repeat the unilateral cover test three more times and get the same results each time. During the alternating test, the eyes move out. What condition is this?

2–2. Ancillary Tests

You'll perform various tests on patients in your clinic but not necessarily on every patient. These are called ancillary tests. They include tests such as administering the Amsler grid, performing confrontation fields, giving laser eye exams, testing suppression and depth perception, testing color vision, taking BP, and measuring accommodation and near point of convergence (NPC). In this section we'll discuss each of these tasks and learn how they are performed and, in some cases, how to interpret the results. Let's start with the Amsler grid test.

609. Amsler grid and confrontation field testing

The Amsler grid test is primarily a test of the macular and foveal area of the retina. It's used when a patient is suspected of having some type of central VF problem, such as ARMD, cystoid macular edema (CME), or damage caused by a solar eclipse. Any condition that could cause a change to the macular function would likely be tested using the Amsler grid test, since the grid "blankets" the macular area during testing (fig. 2–16).

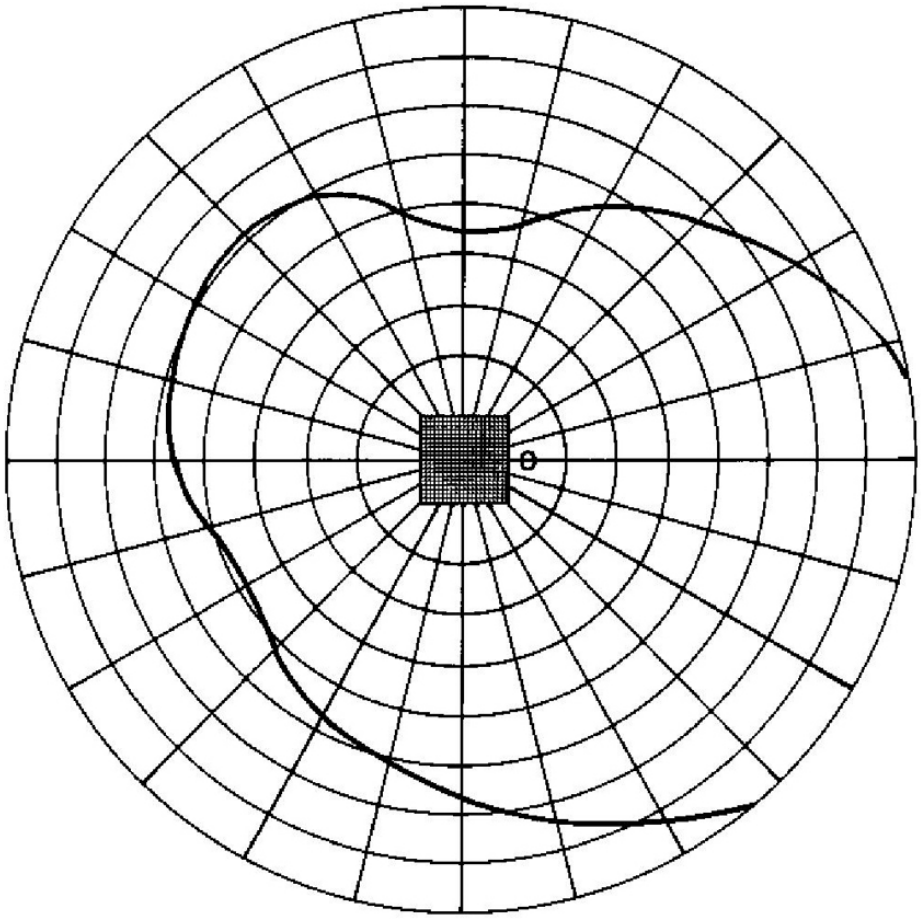


Figure 2–16. Macular area tested by the Amsler grid.

The Amsler grid

The Amsler grid is a central VF test used to detect abnormalities in the central 20° of the field of vision (fig. 2–17).

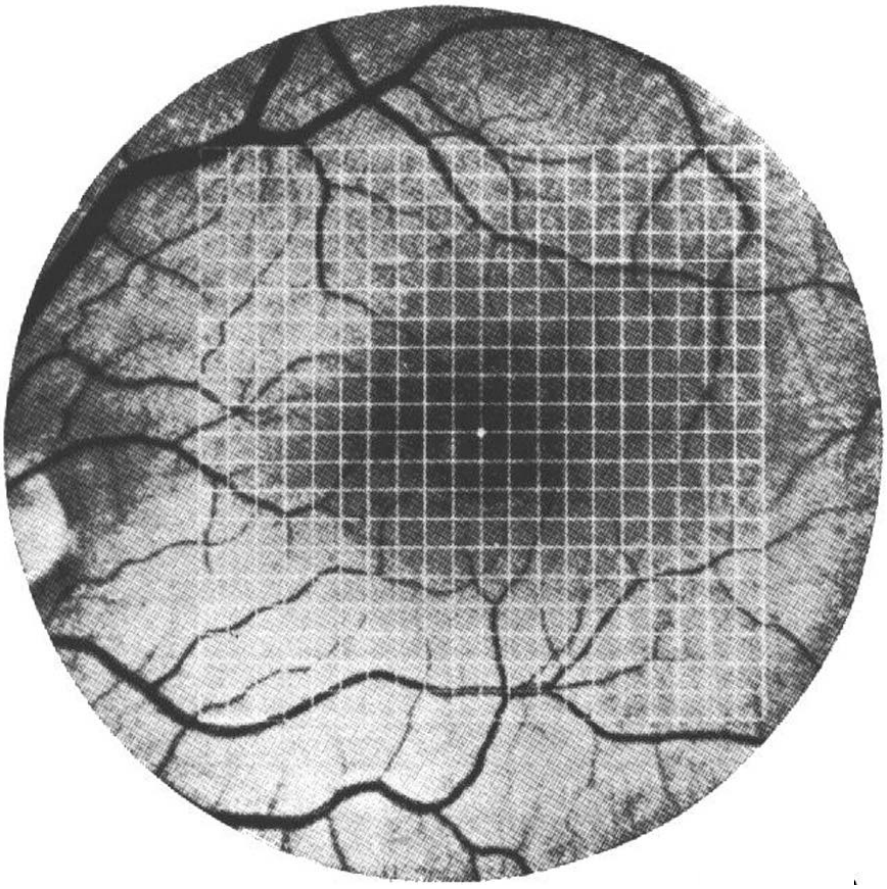


Figure 2–17. Depiction of how much area an Amsler grid tests in relation to a Goldmann VF chart.

The primary test chart (chart #1) for the Amsler grid test consists of a grid of white lines on a dull black background (fig. 2–18).

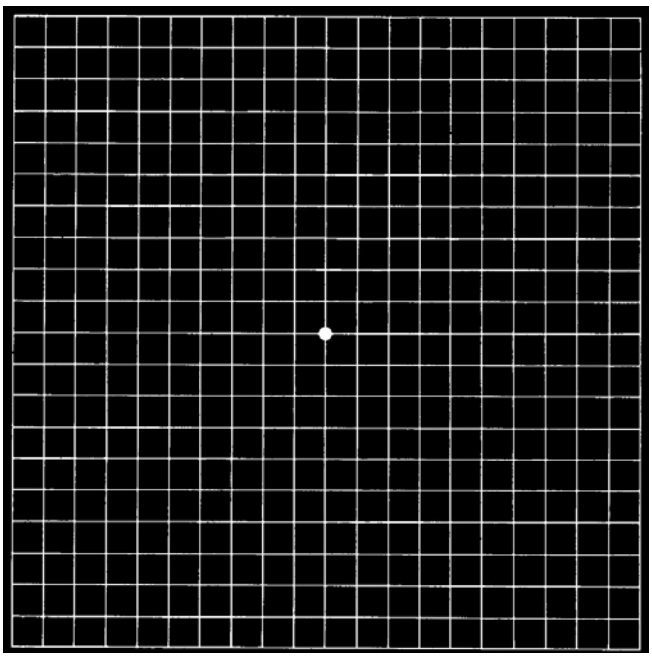


Figure 2–18. Primary test chart (chart #1) for the Amsler grid test.

The squares on the chart are 5 mm × 5 mm in size, and they are designed to subtend an angle of 1° when the chart is held at the proper test distance of 12 inches (30 centimeters [cm]) from the eye. In the center of the chart is a white dot serving as a fixation point. Altogether, there are 400 squares on the primary testing chart.

There are six more Amsler grid test charts, which are variations of the primary test chart (chart #1), and then there is the Amsler grid recording chart, which is like the primary test chart, except it has black lines on a white background (fig. 2–19). Though many people use the recording chart for actual testing, this is definitely not recommended. The actual test chart provides much more accurate results.

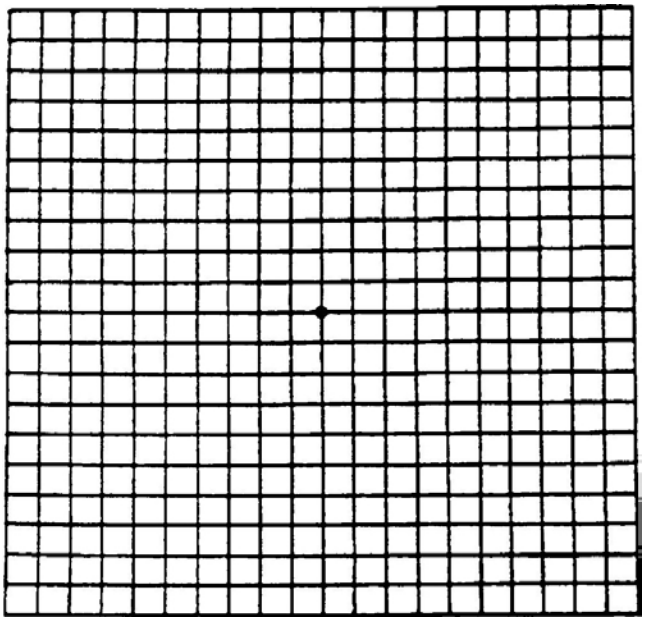


Figure 2–19. Recording chart for the Amsler grid test.

Administering the Amsler grid test

Perform the Amsler grid test in a well-lit room. The patient is tested monocularly (one eye occluded) while wearing near vision correction (if required). The test chart is held 12 inches (30 cm) from the patient.

NOTE: If the test chart is held closer than 12 inches (30 cm), the amount of VF tested will be greater than the intended 10° from center. This could cause the physiological blind spot, which is 15° from central fixation, to show up in the test results. This could lead the doctor to the false conclusion that there is a macular scotoma present, when in fact, there is not. Make sure the test chart is held 12 inches away.

Test procedures are as follows:

1. Explain the test to the patient.
2. Ensure the eye being occluded is completely covered.
3. Have the patient hold the Amsler grid (chart #1) 12 inches (30 cm) from his or her eye. You may need to help a patient who is wearing bifocals or trifocals by lifting the spectacles slightly so the patient is looking through the center of the near segment. This prevents distortions caused by the segment line getting in the way.
4. Ask the patient the following questions about what he or she sees on the chart:
   - Do you see the white spot in the center of the grid?

     If so, explain he or she is to focus on the center dot throughout the testing.

If not, the patient may have a central scotoma. In this case, switch to Amsler grid test chart #2 (fig. 2–20).

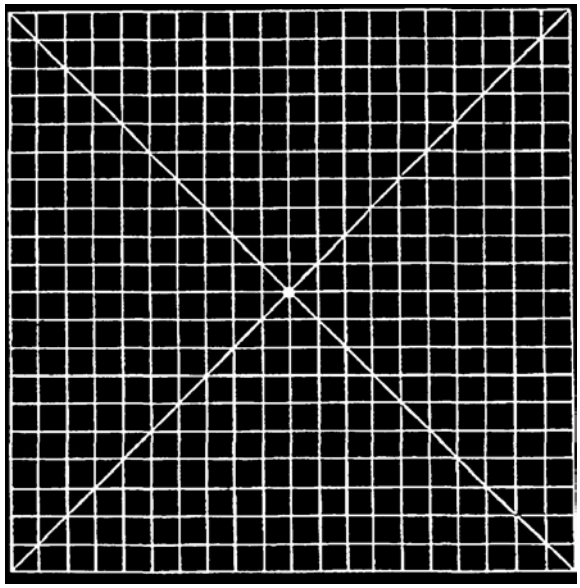


Figure 2–20. Amsler grid test chart #2.

The diagonal lines on chart #2 pass through the central fixation point and help the patient fixate by allowing the patient to imagine the location of the center of the chart. At this point, though, get the recording chart out and have the patient trace the missing area.

- While looking at the center dot, can you see the four corners and four sides of the square?

  If the patient answers “yes,” move on to the third question; if the answer is “no,” get the recording chart out and have the patient trace the missing area. If you are performing the test because the doctor suspects toxic amblyopia, go to testing chart #3 at this time.

  Testing chart #3 looks just like the primary test chart (chart #1) except the lines of the grid are red instead of white (fig. 2–21).

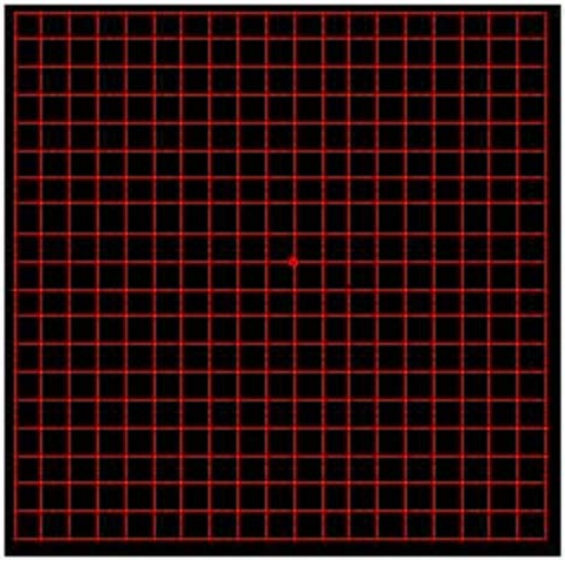


Figure 2–21. Amsler grid test chart #3.

Toxic amblyopia usually shows itself as reduced VA accompanied by a VF defect, usually in both eyes. It's caused by excessive consumption of tobacco, alcohol, or some poisonous substance. It's also sometimes called caecocentral scotoma amblyopia. The reason the red chart helps reveal this condition more readily than the white chart is simple: the toxic effects of smoking, alcohol, and some poisons can lead to a dramatic reduction in a person's ability to see color, especially red.

- While looking at the center dot, do you see the entire grid intact, or are some of the lines missing or blurry?

  If the patient replies the entire grid is visible and intact, go to the next question. If the patient reports a blurred or missing area, have the patient trace the area affected on the recording chart. Indicate if the area reported was missing or just blurry. If the patient is having difficulty visualizing the area missing, chart #4, (fig. 2–22) may help him or her perceive the scotoma more easily.

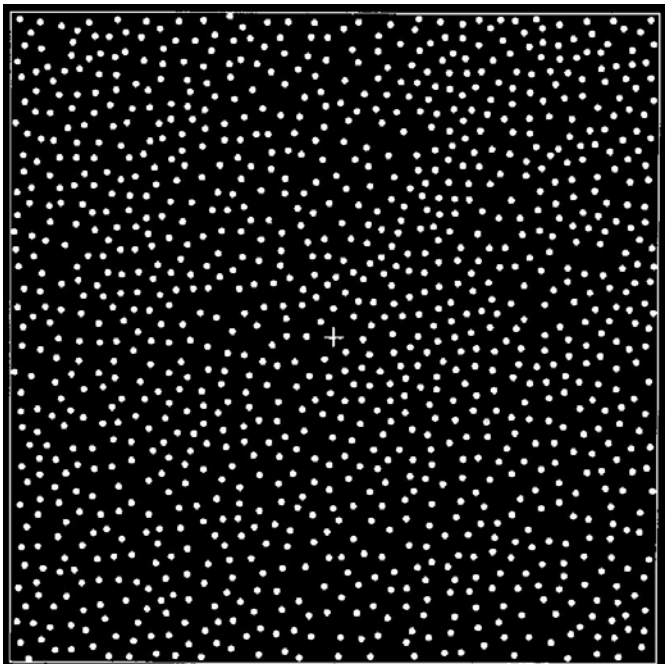


Figure 2–22. Amsler grid test chart #4.

- While looking at the center dot, are the horizontal and vertical lines of the grid straight and parallel, or are they wavy or distorted?

  This question explores the possibility of *metamorphopsia* (distortion of vision). If the patient states the lines are straight and parallel, you're done with the test. If the patient states he or she sees some waviness or distortion of the lines, have him or her trace the areas affected on the recording chart.

  In some cases, using chart #5 (fig. 2–23) or chart #6 (fig. 2–24) can be helpful in pinpointing the area and number of lines affected.

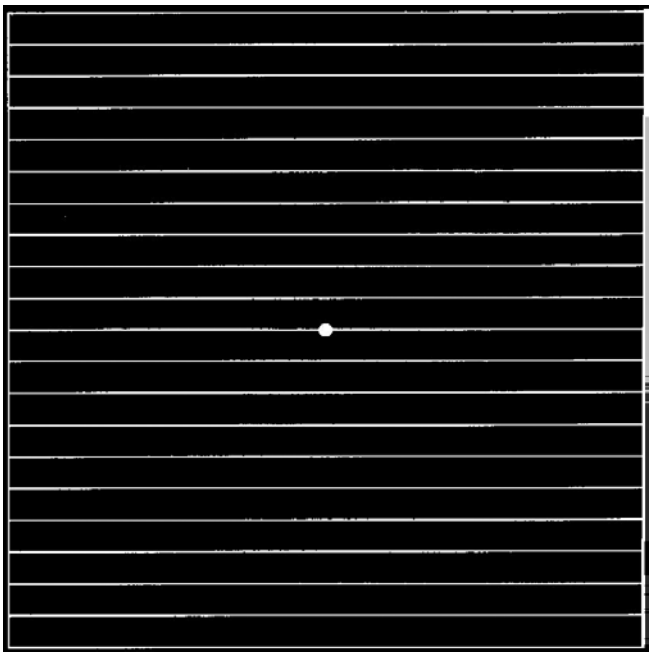


Figure 2–23. Amsler grid test chart #5.

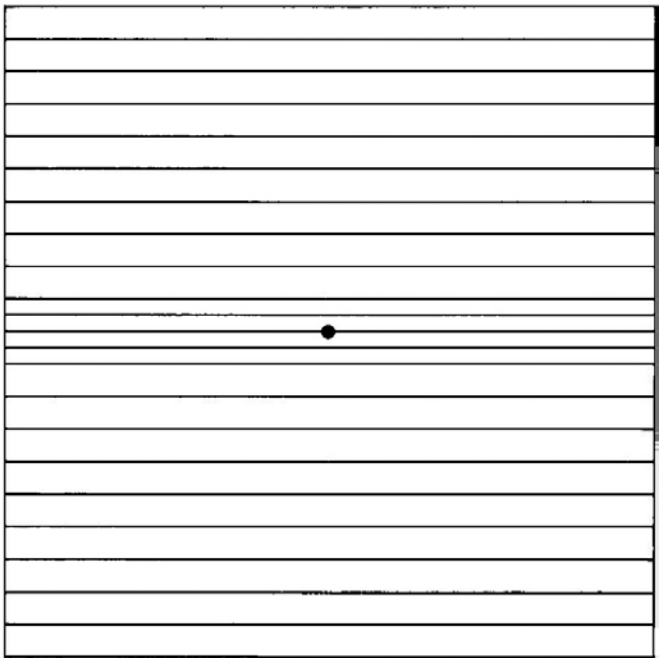


Figure 2–24. Amsler grid test chart #6.

The patient should be shown the chart(s) with the lines running vertically first and then again with the chart held so the lines are going horizontally. This is to see if the waviness and distortion is more prominent in one direction or another.

You may be asking yourself, “What about test chart #7?” Test chart #7 (fig. 2–25) provides a more thorough examination of the juxta-central area. Chart #7 is also very useful in cases of high myopia.

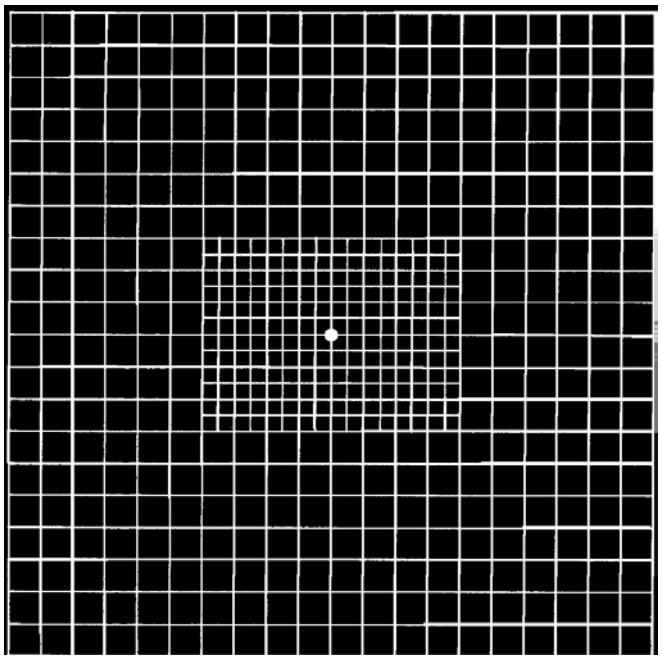


Figure 2–25. Amsler grid test chart #7.

Once the testing is complete and the patient has drawn the defects on the recording chart, document and describe the defect on the recording chart. Label the areas indicated by the patient (if any) as to whether they were missing, dim, distorted, wavy, and so forth. For a patient with macular degeneration, you could end up with an Amsler grid chart looking like figure 2–26.

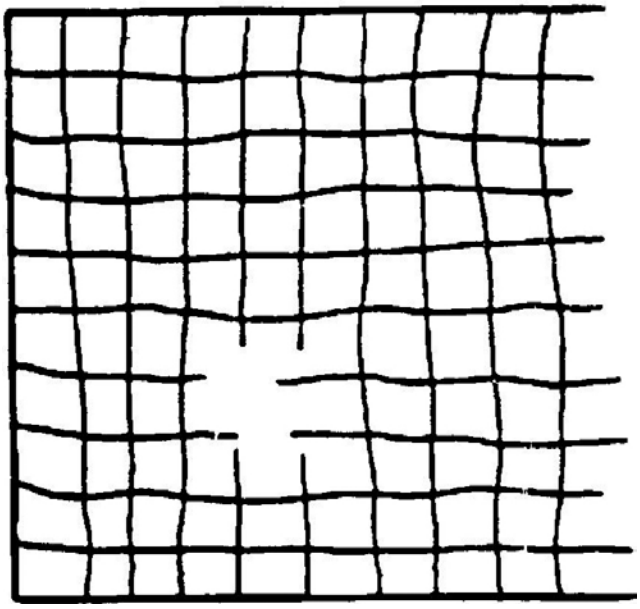


Figure 2–26. Example of how the Amsler grid chart could look to a patient with macular degeneration.

Try to use the same terms the patient used to describe the problem. On the recording chart itself, record the patient's name, the last four numbers of the sponsor's Social Security number, the eye tested, and the date accomplished. This goes into the patient's medical record. Now switch to the other eye and test it.

Confrontation VF test

Confrontation VF testing is a quick, general, peripheral screening. It can reveal only very large defects in the peripheral field, such as quadrantanopsias, hemianopsias, and very large scotomas. These types of defects are usually caused by vascular trauma (such as a stroke), tumors in the visual pathway, a large retinal detachment, neurological disorders, end stages of glaucoma, and advanced retinitis pigmentosa.

Confrontation VF testing is easy to perform. It can be done relatively quickly, without fancy test equipment, and can be performed most anywhere. Most often, the test results are normal, but when they are abnormal, a serious ocular or systemic condition is usually the cause. This is why it's such a great test for a technician to know how to do.

Performing the confrontation VF test

Perform the confrontation VF in a well-lit room, with the patient's spectacles removed (if applicable). The test is normally performed monocularly, so the patient needs to cover one eye or put an eye patch on one of his or her eyes. Patch or cover your opposite eye. For example, if the patient is covering his or her left eye, cover your right eye when testing.

Follow these procedures to complete the confrontation visual test:

1. With the patient seated in the exam chair, sit at arm's length (about 2 ft.) directly in front of the patient at eye level. Under ideal conditions, the patient should have his or her back to the light and the background behind the examiner should be uniform and dark.
2. Tell the patient to remove his or her spectacles (if wearing them) and have the patient cover the left eye with the left hand. Make sure the patient does not push on the left eye or look between his or her fingers.
3. Close or cover your right eye and tell the patient to look at your open eye (your left eye). You are comparing the patient's field of vision to yours.
4. Make it clear to the patient not to look anywhere else but at your open eye.
5. Start the test with your left hand out of sight, between you and the patient, at about 8 o'clock.
6. Slowly move your hand (with one, two, or four fingers extended) toward your line of sight. You can also have the patient identify the number of fingers held out. With small children, a small toy can be used.
7. Tell the patient to tell you as soon as he or she sees your fingers. You should see your fingers as soon as the patient sees them. You are actually comparing your peripheral vision with the patient's.
8. Repeat this procedure in all remaining quadrants (10, 2, and 4 o'clock). For the 2 and 4 o'clock quadrants, use your right hand. Each quadrant is tested twice.
9. Now test the patient's left eye in the same manner.

If there are no defects or limitations, record "FTFC" to indicate the patient's visual field was "full to finger counting." If there were defects or limitations, use a simple diagram to record them. Draw a circle and divide it into four quadrants. Then simply scribble in the areas not seen by the patient and notify the doctor.

With a little practice, the test should not take more than a minute or two to administer, but finding a defect could mean the difference between sight and blindness, or *life and death*, for your patient.

610. Depth perception

When a patient is suffering from diplopia (double vision), the brain is receiving two conflicting images from the visual system. The brain can labor to either bring the two images together (fusion), or turn off one of the images (suppression). As you may remember from previous material, prolonged suppression can lead to amblyopia.

Suppression may be caused by several factors—diplopia, aniseikonia (unequal retinal image sizes), anisometropia (unequal refractive error), blowout fractures with muscle entrapment, and so forth. Testing for suppression and depth perception can determine if, and to what degree, a patient has a problem.

The first depth perception test we cover is the Titmus stereo fly test. Over the next few years, you'll become very familiar with this test. The Titmus stereo fly is a quick and very precise tool.

Titmus stereo fly test

This is probably the most recognized and the most commonly used depth perception test. It gives the examiner an insightful and accurate assessment of the patient's binocular status. Without binocular vision, the patient cannot pass the test.

Testing procedures

The standard Titmus stereo fly test set consists of three items: the test booklet, a pair of polarized spectacles, and the directions for use (fig. 2–27).

NOTE: Although the Titmus stereo fly test is found in most eye clinics, the OVT depth perception test (test #5) is used for official AF testing, such as routine physicals.

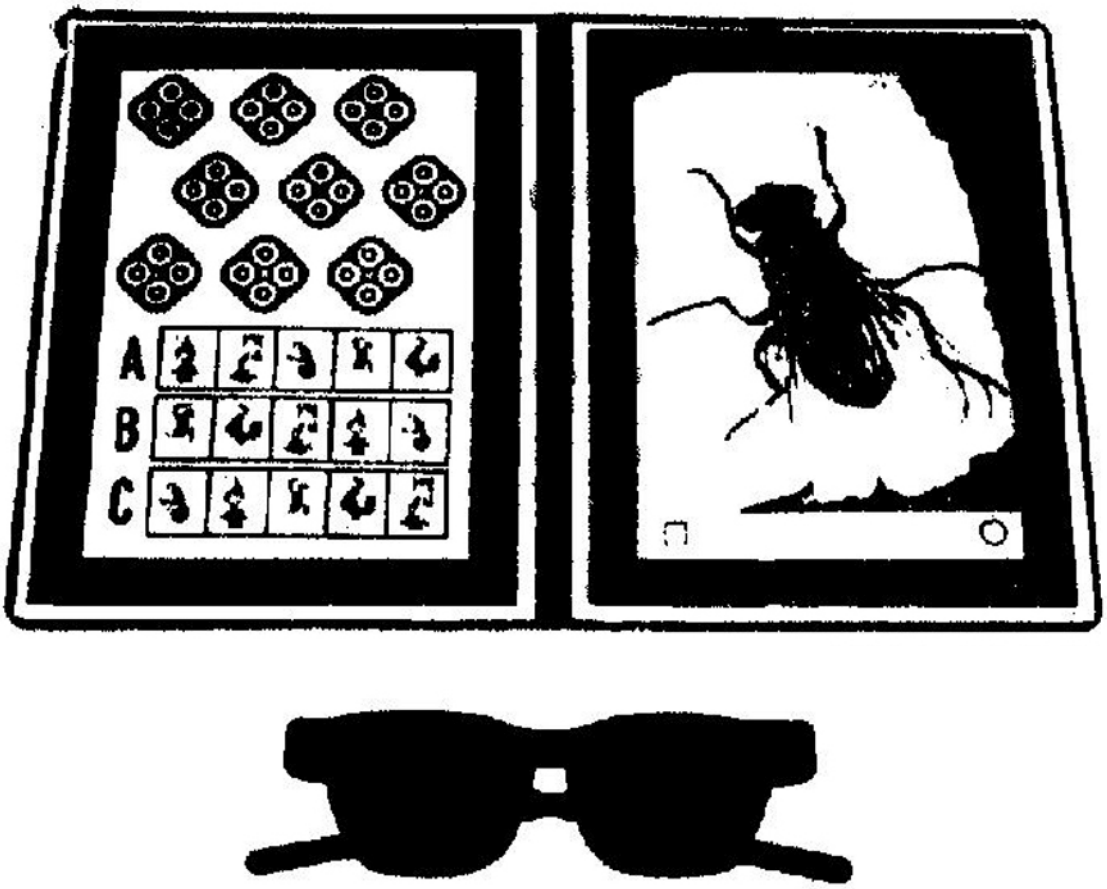


Figure 2–27. The Titmus stereo fly test set.

The testing procedures are rather simple. Seat the patient comfortably. Have the patient wear the polarized spectacles. If prescription spectacles are worn, the polarized spectacles are placed on top of the patient's habitual near Rx. The test booklet is held 16 inches away from his or her eyes and parallel to the patient's face (line of sight). Room lighting should be normal, but do not allow glare

from lighting to strike the booklet. To pass the test, the patient must have binocular vision and sufficient VA.

Testing adults

For adults, begin the test by checking for suppression. At the bottom of the right-hand page, there is a circle with an R in it and a square with an L in it. If the patient cannot see one of these letters, suppression is present and you can stop the test. Record “suppression OD” or “suppression OS” on the form.

If no suppression is evident, have the patient try to grasp the wings of the fly on the same page. When there is stereopsis, the patient pinches the fly’s wing an inch or so above the booklet. If the patient cannot grab the fly’s wing, then try wiggling or moving the picture back and forth slightly. This may assist some patients whose stereoscopic vision is sluggish. If the patient still cannot grab the fly’s wing, or grabs the wing at the level of the test plate, continue with the next step of the test. When recording the results, write “Patient unable to grab the fly’s wing.”

After the patient attempts to grasp the fly’s wing, have the patient look at the left-hand page. Ask which ring (up, down, left, or right) appears closer to him or her or stands off the page. Continue until the patient either makes two errors in a row or completes all nine diamonds. Scoring is measured in seconds of arc. Find the scoring data on the stereo fly test instruction card.

Testing children

Skip the suppression test for children. Children should start the Titmus stereo fly test by trying to pinch the fly’s wing (some children may be hesitant to grab the fly’s wing because of its appearance). If the child cannot grab the fly’s wing, try wiggling or moving the picture back and forth. This may assist some of them. If the child still cannot grab the fly’s wing, or grabs the wing at the level of the test plate, continue with the next step of the test. When recording the results, write “Child unable to grab the fly’s wing.”

Regardless of whether the child could pinch the fly’s wings or not, the next step is to have the child try the animal test. Ask the child which animal is trying to get out of the cage. Ask him or her to push it back in. If the child can push the animals with ease, have him or her try the circle test.

Recording test results

If an adult has suppression on the test, record which eye was suppressing and discontinue any further depth perception testing. If either an adult or a child is unable to grab the fly’s wing, record that he or she was unable to grasp the fly’s wing, but continue with your testing. Some individuals are unable to perceive the wings floating in air; however, they are able to correctly answer the other portions of the test.

Record the circle test in seconds of arc (i.e., 40 seconds of arc). Have the patient tell you which circle stands out starting with #1 and working through #9. Continue until the patient makes two errors in a row. Once the patient makes two consecutive mistakes, discontinue the test and record the last correct answer.

You can find the complete score list in the booklet that came with the set. Additionally, record the last correct diamond and the total number of diamonds. For example, if the patient gets #1 through #7 correct, but misses #8 and #9, record it as “60 seconds of arc, 7 of 9.” If the patient cannot discriminate the #1 diamond or any of the circles, then record “0 of 9.” In this case, you would not record the seconds of arc.

For the animal test, again you would record in seconds of arc. The answer key is on the instruction card. Additionally, record the last correct animal and the total number of animals. If a child gets the first and second animal, but misses the third animal, record it as “200 seconds of arc, 2 of 3.” If the child misses all three animals, then record “200 seconds of arc, 0 of 3.”

Red lens test

The red lens test is used to detect diplopia or suppression in all nine cardinal positions of gaze. The test is required for Flying Class I and IA physicals. With optometry's alignment under aerospace medicine, more and more visual screenings for flying personnel are making their way back to the eye clinic and the red lens test is one screening tools we use.

Equipment

The equipment needed is simple. You only need a red lens occluder and a light source, such as a transilluminator.

Testing

Seat the patient and explain the test to the patient, "I am going to test how well your eyes work together". Instruct the patient *not* to move his or her head, but follow the light with his or her eyes only. Have the patient place the red lens occluder in front of one eye. For consistency purposes, cover the right eye.

Hold the transilluminator in the primary position of gaze (directly in front of the patient) at a distance of 16 inches from the patient's eyes.

Ask the patient to focus on the transilluminator and occlude the eye without the red lens over it. Ask the patient what color of light he or she sees—the patient should report seeing a red light only. If the patient doesn't see any light, he or she is suppressing the unoccluded eye. Now have the patient occlude the eye with the red lens over it and ask the patient what color of light he or she sees—the patient should report seeing a white light only. Again, if he or she does not see any light, he or she is suppressing the unoccluded eye.

Now ask the patient to open both eyes and report which color of light he or she sees with both eyes open (remember one eye still has the red lens in front of it)—the patient should see a single pink light. A patient seeing one pink light indicates the patient has stereopsis. However, if the patient reports seeing only a red light or white light, one of his or her eyes is suppressing.

Once you have established each eye is functioning correctly and the patient understands which colors can be seen, you're ready to begin testing.

Move the transilluminator from the position of gaze or fixation out toward the periphery of each remaining (eight) cardinal positions of gaze, stopping at each position of gaze and asking the patient how many lights he or she sees and what color—the patient should report one pink light. However, if the patient reports seeing a white light and a red light at any time, he or she experiencing diplopia in that position of gaze.

As previously mentioned, if the patient reports seeing only a red light or white light at any time, he or she has an eye that is suppressing. To determine which eye it is, look at where the red lens is. If the red lens is in front of the right eye, and the patient reported seeing only a white light, then the right eye is suppressing. If the patient reported seeing only a red light with the red lens in front of the right eye, then the patient is suppressing the left eye.

Recording

If the patient does not report diplopia or suppression, he or she PASSES.

Any diplopia or suppression during the red lens test is considered a FAIL.

You can record the red lens test in a Tic-Tack-Toe format. When doing so, you must indicate whether the recorded results are from the patient's or tester's point of view (fig. 2–28).

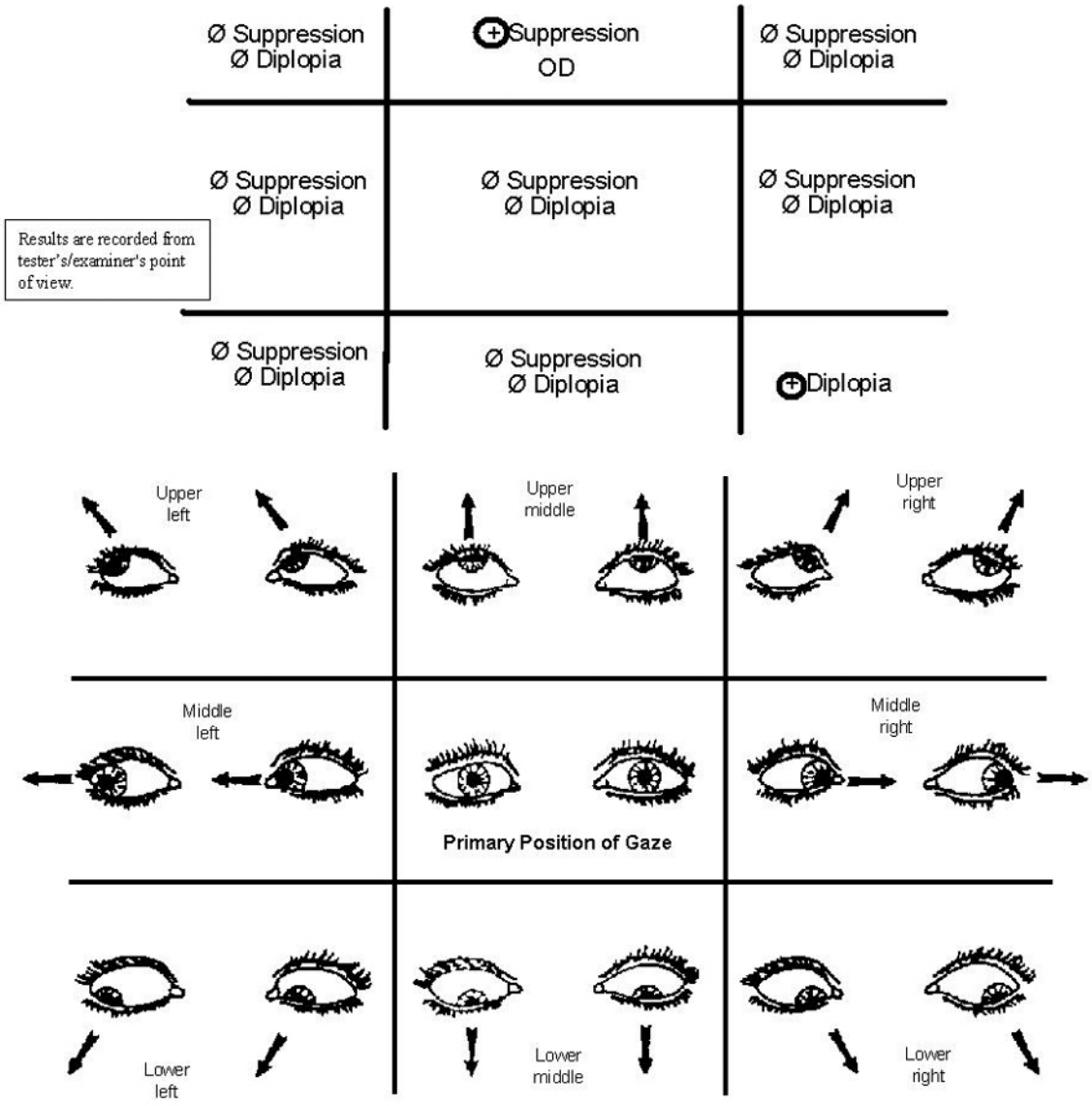


Figure 2–28. Recording the red lens test.

Refer to the results recorded in figure 2–28. The patient reported suppression when looking straight up, and diplopia when looking down and to his or her left (examiner's right).

If diplopia or suppression is found, finish the test and record the results. The patient may have more than one problem area. If there are any abnormalities, refer the patient to your doctor for further evaluation.

Vectographic stereopsis test

This is a measurement of the patient's ability to fuse different images and to perceive depth. The results indicate the level to which the patient can use both eyes and neural integration to perceive spatial depth perception. If patient does not have full, simultaneous use of both eyes (amblyopia, trauma, strabismus, etc.) or there is a significant inequality in visual performance of each eye, depth perception is highly unlikely.

Therefore, the Vectographic projection slide is a distant stereopsis test used to determine the waiver potential of substandard stereopsis with aircrew members. The American Optical (AO) Vectograph is

used as an alternate test to monitor stability of stereopsis performance. It can also test for visual central suppression and is performed at 6 meters (20 ft.).

Test administration

This test must be performed with the patient wearing his or her vision correction, if the vision correction is intended for distance or full-time use. If the patient is required to wear corrective lenses while performing military duties, test and record only corrected results. Record the results as either Corrected or Uncorrected and the results (minutes of arc). An example of this would be “Corrected (1 min of arc)” or “Uncorrected (2 min of arc).”

The adult Vectographic depth perception demand (in arc-minutes) is listed in the following table. The table is used to determine the level and minutes-of-arc achieved by the examinee, as explained in the following text.

Adult Vectograph Slide	
Level	**Minutes of Arc**
Level 1	4 minutes of arc
Level 2	3 minutes of arc
Level 3	2 minutes of arc
Level 4	1 minute of arc

Vectographic slide setup

Place the Vectographic slide in the projector. Position slide to “present” Stereopsis test (located at bottom of slide. All illumination that reflects on the projection screen should be off (i.e., overhead lights). A dim, indirect light source (chair lamp) may be used.

NOTE: Polarized glasses or phorotor polarized lens must be used during examination.

Depth perception test

The "simulated" depth used for this test may be difficult to recognize initially, even for those with normal depth perception ability. The Vectographic depth perception test consists of four rows of five circles. Each eye sees separate and almost identical boxes laid out in the same pattern. Row for row each eye sees five circles of identical size and equal separation in its respective target box. However, in each row, one of the five circles is shifted horizontally. That slight displacement gives rise to the perception of depth.

Allow the patient a few seconds to look at the test block before starting the test. Most patients with normal depth perception will observe the perceived depth is more apparent if allowed a brief time to adapt.

Explain the test by stating, "You will see four rows of circles. Each row has five circles. One circle in each row will appear to be closer to you or slightly elevated. Starting with the top row of circles, tell me which circle is elevated above the other four circles; the first, second, third, fourth, or fifth.”

If the patient can not perceive elevation of any circles, confirm setup (Vectographic slide setup above). If still unable to identify any circle elevation, display a single row (usually the top row). Tell the patient the correct answer to the presented row. Instruct him or her to look at the row knowing which circle is supposed to appear elevated. If the patient reports the ability to recognize the elevation, then present all four rows as a single display in a random order. The remainder of the test will be given without any further help or hints. If the patient reports inability to discern the elevated circle in the first row, discontinue the test.

Use the scoring key or the table above to determine the minutes of arc achieved. Record level and corresponding minutes of arc successfully completed.

611. Color vision

Genetically speaking, a person's color vision does not change. This means a person who is born with normal color vision always has normal color vision and a person who is born with a color vision problem always has a color vision problem. Some reasons you perform color vision testing would be to determine if a person has *acquired* a color vision defect, for a job qualification, and to counsel patients. An acquired color vision problem is usually due to a systemic or ocular disease, but a patient who receives too high a dosage of certain medications (such as Plaquenil sulfate) could also develop a color vision problem.

Color vision basics

When a person is born with a color vision defect, it's usually a defect of the red or green variety. Another clue a color vision defect is congenital is that the problem shows up in both eyes equally. Remember, approximately 0.5 percent of females and 8 percent of males are born with color vision problems.

When a person acquires a color vision defect, it's usually a defect of the blue variety. Acquired color vision defects also tend to show up in only one eye, or if the defect does show up in both eyes, one eye is always worse than the other.

A lot of experimentation with color and lighting has proven any perceived color can be produced by a mixture of just three specific lighting hues (colors)—red, green, and blue—and these three hues are called the primary colors of light.

Experimentation with instruments called spectrometers has shown most people with normal color vision can differentiate about 500,000 different color sensations if both hue and saturation are varied. Another instrument called an anomaloscope has proven 99.5 percent of women see colors essentially the same way and only 92 percent of the men do. The remainder of people could not differentiate certain colors from each other.

Scientists have seen some people name colors differently from other people, but most thought this was an educational problem rather than a perceptual one. However, early experiments with the anomaloscope provided the first proof of differences in color perception among individuals.

Color vision tests

There have been many different color vision tests developed over the years. The AF uses the cone contrast test (CCT) and the Vision Test Set–Color Vision (VTS–CV), also called the pseudoisochromatic plates (PIP), for official physical exam testing. The AF also uses the Farnsworth D–15 hue test but only to aid in further defining a possible color deficiency. It's not a pass-or-fail type test.

If a patient cannot pass the color vision test, he or she is restricted from many jobs where identification of color is required. Imagine an explosive ordnance technician who failed the color vision test having to cut the red wire to disarm a bomb. Unfortunately, red and green looks the same to this person. Of course, we would not want someone with a color vision defect in this particular line of work.

Therefore, while it's unfortunate for patients to be restricted from certain career fields due to color vision defects, the standards requiring normal color vision are there for a reason. As an eye technician, you may have to screen patients for color vision defects. Do not allow yourself to be coerced into "fudging" the test results for a person who cannot pass. In the end, you only end up doing him or her and the AF a disservice.

The only tests covered in this lesson are the CCT, PIP, and Farnsworth D–15 hue tests. Technicians in the ophthalmic clinic are primarily concerned with these tests since the AF has deemed them more discriminating than other color vision tests.

While the AF physical exam program is looking for patients with congenital color vision defects to screen people from certain jobs, we in the ophthalmic clinic are more interested in acquired color vision problems, although congenital defects are also checked for on some occasions. In the ophthalmic clinic, use color vision testing to determine the degree and the types of color vision defects that may be present. Since the CCT, PIP, and D–15 give us more diagnostic information, you'll read about those in the following paragraphs.

One final note about the color vision testing performed in your clinic: you perform all the testing monocularly, meaning the patient is always tested one eye at a time. As stated earlier, this is because acquired defects usually show up in only one eye, or one eye is usually worse than the other. If you allowed the patient to use both eyes when testing, he or she may "pass" the tests and you would miss the indicator that there's an acquired problem. Keep this in mind. It's important.

Cone contrast test

The CCT is the primary color vision screening for AF aviators and aviation applicants.

The CCT is similar to anomaloscope testing and exceeds PIP sensitivity. It's a rapid, computer-based evaluation using color and contrast. It selectively stimulates each of the three cone types (red, green, and blue) in the retina. The test presents a randomized series of colored letters on a grey background visible only to specific cones, with the letters decreasing in contrast until a threshold is reached (fig. 2–29). The test is performed monocularly, with a passing score of 75 or above.

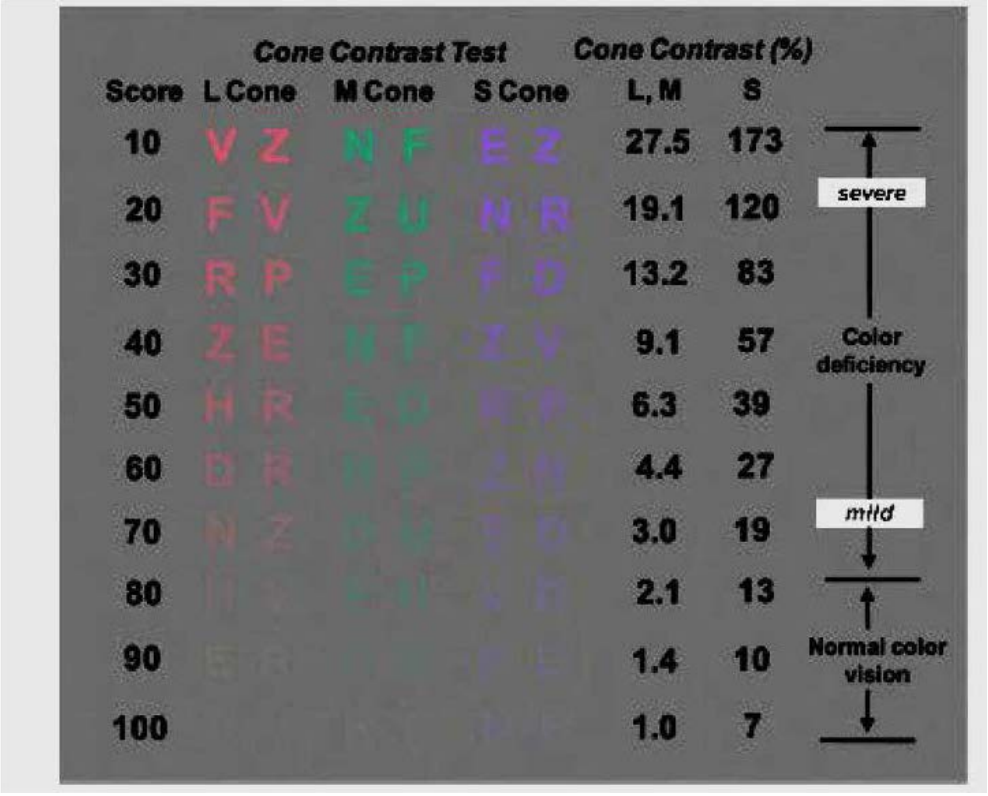


Figure 2–29. CCT score range.

The test aids in diagnosing the type and severity of any hereditary deficiency. It also aids in the detection of acquired deficiency due to ocular, neurologic, and/or systemic disease, as well as injury and physiological stressors, such as altitude and fatigue.

The CCT uses custom software but is a consumer, off-the-shelf Netbook-type system (fig. 2–30).

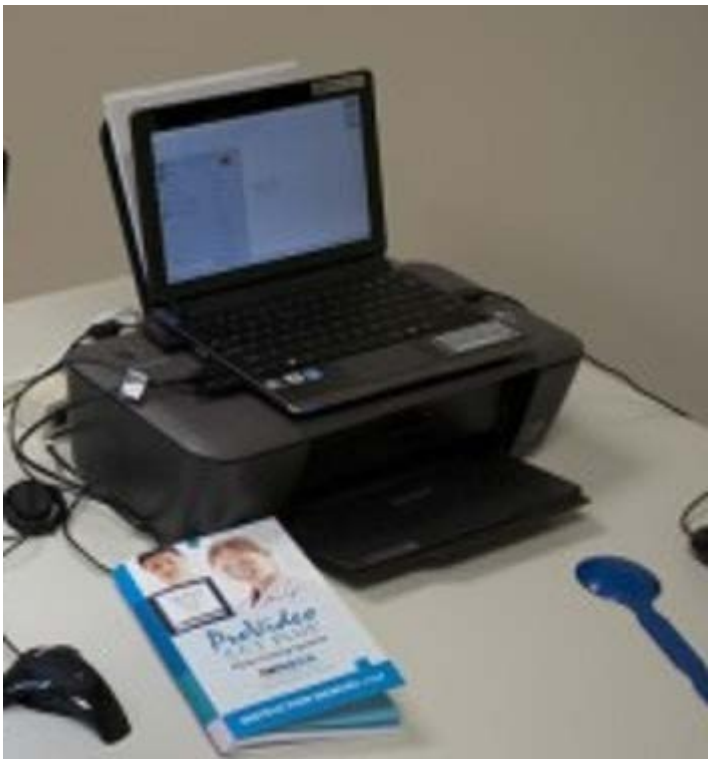


Figure 2–30. CCT.

Because it's "off the shelf," it's critically important to ensure that the patient is seeing accurate screen colors. Monitor properties can change over time and even between monitors from the same manufacturers. Therefore, the CCT includes a colorimeter (the Spyder3™) that can test the system to see if it's calibrated properly. If it's not, the Spyder3™ colorimeter and custom software can be used to calibrate the system for proper function.

A calibration test must be run weekly. When prompted, you'll plug the Spyder3™ into your netbook USB port. Then place the Spyder3™ on the measuring area of the screen (fig. 2–31). Select start. It usually takes 3–5 minutes for the system to check for proper calibration, and then it will recalibrate if needed.

Figure 2–31. Proper colorimeter (Spyder3™) placement for calibration.

Do not randomly adjust the color or brightness settings on the CCT Netbook. The keyboard-controlled brightness setting comes preset from the factory at maximum. It should remain at this setting. You can verify this by pressing and holding the red function “fn” key on the keyboard lower left and adjusting the red brightness key (lower right) to maximum display brightness.

As a computer-based program, the CCT test is easily administered. Conduct the test in dim lighting, but should you need to leave a door open or provide some background lighting so that the keyboard and mouse are visible, just make sure no light is directed at the CCT display.

Seat the patient approximately 36 inches from the CCT display. He or she should wear glasses or contacts, if applicable. To improve clarity, a +0.75 diopter lens can be added to aid older patients or those lacking focusing ability.

To ensure the patient is parallel to the display, place the monitor end of the monitor alignment tube on the display and have the patient look into the tube. Ask the patient if he or she sees one or two dots. If one, the patient is parallel. If two, adjust the display angle until the patient verifies that he or she only sees one dot.

Start the test by clicking on the ProVideo icon, followed by clicking on the CCT-Stair on the upper right corner of the screen. A Subject Identification (ID) Window then appears, in which you enter an ID number (usually the last 4 numbers of the patient’s Social Security number) and the patient’s name. Once you have completed all fields, press “Enter.”

An “orientation” screen will appear, allowing the patient to briefly practice the test. Instruct the patient to use the mouse to click on the letter in the Response Grid on the lower right, which matches the letter in the center of the display (fig. 2–32).

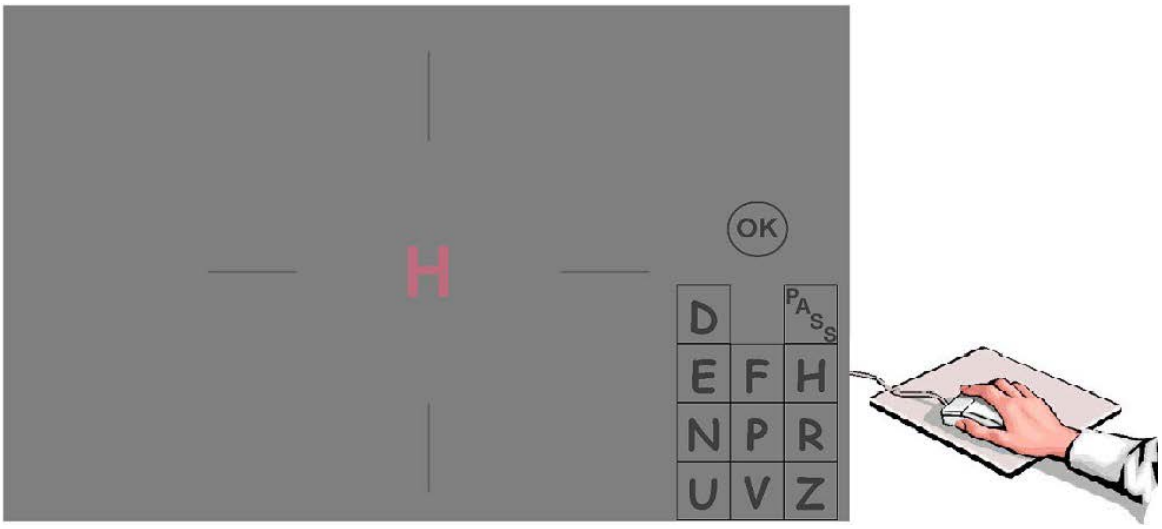


Figure 2–32. Example CCT screen.

A voice will report the patient’s response. If the patient responds correctly, the program will automatically decrease the letter contrast; if incorrect, the letter contrast increases. The patient can practice red, green, and violet letters similar to those on the test.

After the patient practices and is ready for the actual test, cover the patient’s left eye so you can test the right. Instruct the patient that he or she will see a colored letter on a grey background. Direct the patient to use the mouse to select from the lower right-hand side of the screen the letter he or she sees.

Click “OK” and follow the prompts on the CCT. The test records the patient’s responses to calculate the CCT scores. When the right eye is complete, a prompt appears notifying you to cover the right eye and begin testing the left eye. When both eyes are complete, a prompt appears notifying you to

print the results stored on the Netbook in the CCT Data folder. Pass these results along to the doctor for further review (fig. 2–33).

Figure 2–33. Example CCT results.

Pseudoisochromatic plates

The PIP (fig. 2–34) consists of a test lamp and a booklet with one demonstration plate and 14-test plates.

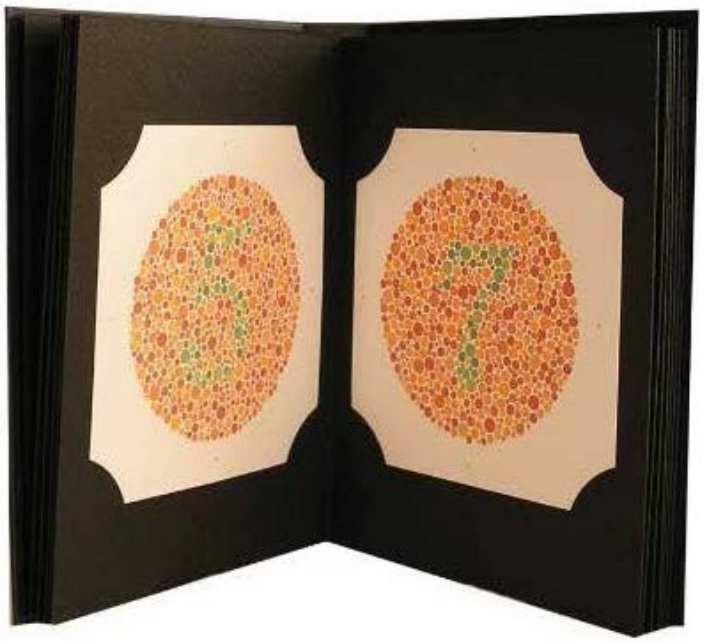


Figure 2–34. PIP test.

The test lamp is an important part of the test. It ensures standardized illumination so the test is as accurate as it can be. Remember the type of illumination can influence the colors people see. The test light used with the PIP plates must be either the Macbeth easel lamp or the Richmond Products True Daylight® lamp (fig. 2–35). Using only one or the other of these two lighting sources helps ensure the accuracy and reliability of the test.

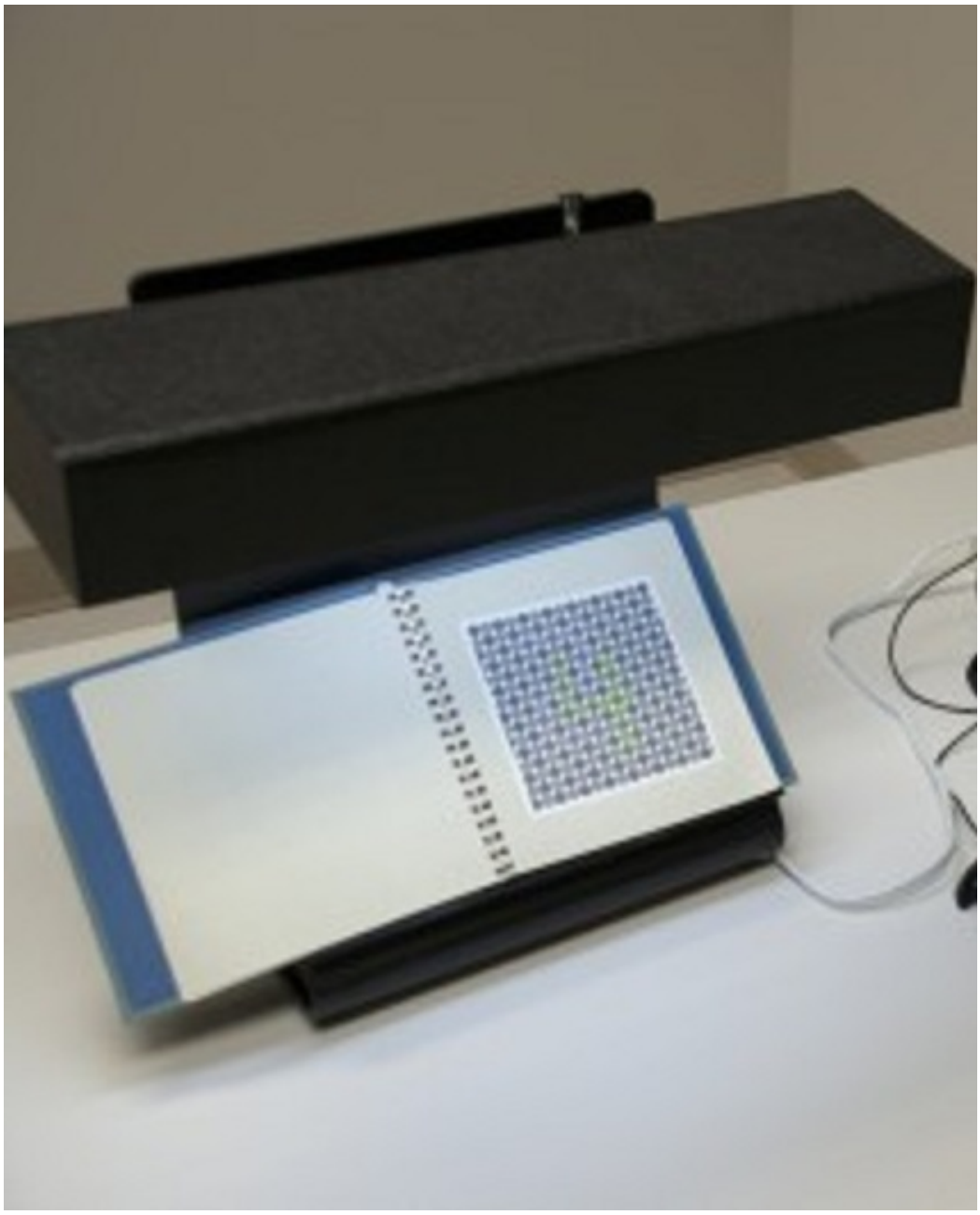


Figure 2–35. Color vision testing under correct illumination.

Testing procedure

Follow these procedures when testing:

1. Position the patient approximately 30 inches from the test booklet (which is positioned under the test lamp). If the patient wears spectacles, determine if he or she sees better with them on

or off at the 30-inch test distance. Have the patient wear spectacles if he or she sees better with them. Remember it's a color vision test, not a VA test.

2. Explain the test to the patient. He or she is to tell you what numbers he or she sees on the test plates within five seconds of you showing the plate. If he or she does not respond within five seconds, you automatically move on to the next test plate. Let the patient know there is no penalty for guessing. Tell the patient not to touch the plates with his or her fingers, as the oil from the hands affects the colors over time.

   NOTE: Children and illiterate patients are the only ones who can touch the plates using a cotton swab or small paintbrush to trace the numbers for you. This avoids finger oil on the plates.
3. Occlude the patient's left eye. Test the right eye first, unless the vision is very poor in that eye. Otherwise, test the eye with the better acuity first. Use your best judgment.
4. Show the demonstration plate first. Every person, regardless of whether he or she has normal or abnormal color vision, can read the demonstration plate. If the patient claims to be unable to see the demonstration plate, you know he or she is malingering. Discontinue the test and notify the doctor. Do not confront the patient and do not let on anything is amiss. Just let the doctor handle it.
5. Once the patient has been given instructions and correctly identifies the number on the demonstration plate, begin testing. Turn off all the room lights and only use the illumination from one of the two approved test lamps mentioned earlier.
6. Begin showing the 14 test plates one at a time. Allow the patient a maximum of five seconds to respond to each plate. If there is no response after five seconds, just flip to the next plate. Regardless of whether he or she answers right or wrong, or says nothing, do not comment during the test.
7. Keep track of how many of the test plates the patient is getting wrong (or right) as you go. If test plates have a two-digit number, give the patient credit for the plate only if they identify both numbers correctly. There is no "half-plate" credit given. To keep track of how the patient is doing, have the answer sheet located where it's visible to you but not the patient. If you have trouble seeing the numbers, you could premark the back of each plate in the book with the correct answer so you can see if the patient responded right or wrong as you turn to the next plate. Be sure to keep track of how the patient is doing, without giving away the answers.

When the test is complete, annotate how many plates out of the 14 the patient answered correctly. Ten or more plates correct is considered passing, while nine or fewer is failing. If the patient got 12 right, document "PIP OD: 12/14–Patient Passes." If the patient got eight correct, write "PIP OD: 8/14–Patient Fails." Close the test book and have the patient switch the occluder to his or her other eye, and begin the test again starting with the first test plate. Do not show the demonstration plate again.

Recording

If the patient is tested due to an eye problem or medical suspicions of the doctor, record the results electronically on whatever form you're using for eye exams in your clinic. Just indicate the test performed and the outcome. Something along these lines: "PIP OD: 12/14–Patient Passes; OS: 08/14–Patient Fails." Remember the first number is the number of test plates the patient answered correctly. The second number is the number of test plates used. Do not count the demonstration plate.

If the test is performed for an official AF physical exam, the results are often recorded on the SF 88. Once again, 10 or more correct responses to the 14 test plates is considered normal color vision. Make the entry, "Passes: PIP," in item 64 of the SF 88. If the patient got nine or fewer correct, enter "Fails: PIP" in item 64 of the SF 88.

With the exception of the demonstration plate, which is always first, periodically change the order of the test plates to prevent patients from memorizing and cheating on the test. If you suspect a patient may have somehow memorized the plate numbers, shuffle the test plates and retest the patient. If he or she has normal color vision, he or she can still pass. If the patient were trying to beat the system and has defective color vision, he or she will fail.

Farnsworth D–15 hue test

The D–15 test is a very informative color vision exam for clinical use. Just keep in mind it's *not* to be used for official AF physical exams. The eye doctor often requests this test if a patient scores poorly on the PIP. The D–15 test gives a more specific measurement of a patient's color vision.

The purpose of the D–15 test is to reveal the *type* and *degree* of color vision defect a person has. Below are the possible results of a D–15 test.

- An abnormal trichromat—a person who is protanomalous (red-weak), deuteranomalous (green-weak), or tritanomalous (blue-weak)—can complete the D–15 test with few or no errors.
- A dichromat—a person who has protanopia (red blindness), deuteranopia (green blindness), or tritanopia (blue blindness)—makes several specific errors. The patterns of the mistakes dichromats make on the D–15 test conclusively show the type and degree of color defect they have.
- A true monochromat—a person who sees everything in one color (like you or I would see colors on a black and white television set)—cannot place the testing caps of the D–15 test in any kind of order and or any specific pattern. True color-blind people (monochromats), fortunately, are very rare. Only about one person in 10 million is legitimately and truly color-blind. Most people who claim "color blindness" really just have a color vision defect and they can still see most colors to one degree or another.

The test consists of 16 slightly different colored caps, a wooden case, and score sheets used to interpret the results of the test (fig. 2–36).

Figure 2–36. D–15 test.

The colored caps are situated in the lid of the case. They are colored on top and numbered on the bottom. One of the colored caps is permanently attached to the left end of the case and is used as a reference. It's called the "pilot color cap," and the letter "P" on the score sheet represents it.

The D–15 test can be done under the lighting of the sun (if you have a window in your clinic), the Macbeth easel lamp, or the Richmond Products True Daylight® lamp. The test is not as accurate, or as valid, when done under fluorescent or incandescent lighting.

There is no specified test distance. Patients can position the test at a distance comfortable for them, and the test can be completed with or without spectacles. Again, whichever way the patients feel most comfortable.

NOTE: Spectacles with any type of colored tint can affect the results of the test. Patients with rose- or amber-tinted lenses, for example, will not see the cap colors as they truly are because of the "filtering" effects of their tinted lenses. Test these patients without their spectacles on, or they should switch to a perfectly clear pair of spectacles for testing purposes.

Now for some considerations on handling and storage of the D–15 test set. Do not leave the colored caps exposed to light needlessly. Always close the case when it's not in use. Additionally, you and the patients should avoid touching the colored portion of the test caps with your fingers, because the natural oils from your skin discolors the caps over time. Replace dirty, damaged, or missing caps.

To administer the D–15 test, follow these steps:

1. Arrange the 15 loose colored caps into a random order next to the case.
2. Have the patients begin putting the caps in order of color, using the fixed cap as the starting point. They should find the next closest color to the fixed cap (the "pilot" cap), then the next closest colored cap to the one they just picked, etc. They continue doing this until they have put all the caps in order. To prevent the patients from wasting a lot of time, give them a time limit. Two minutes is usually plenty of time for patients to get 15 caps in order.

   NOTE: Monitor the patients during the test to ensure they are not looking at the numbers on the bottom of the caps or touching the colored portion of the caps with their fingers. Do not give verbal or nonverbal clues to patients while they are performing the test. Keep your "poker" face to avoid influencing their choices.
3. Close the lid on the caps, turn the case upside down, and open it. The numbers of the caps then appear.
4. Record the order of the results on the score sheet. Start with the reference cap "P" and record the numbers on the bottom of the caps, in the order of their arrangement. Next, go down to the circular dotted portion of the score sheet and simply "connect the dots" in the order the patients had the caps arranged.
5. The diagram created after connecting the dots reveals the type of color defect, if any, the patient has. A perfect circle or only one or two minor errors in essentially the correct pattern would indicate trichromatic color vision. However, the patient may be protanomalous, deuteranomalous, or tritanomalous. Errors following the patterns shown on the score sheet would indicate the type of color vision problem present (protanopia, deuteranopia, or tritanopia). Errors following no particular pattern, but not following the order of the circle, are usually an indicator the patients are abnormal trichromats (pro-, deu-, or trit-anomalous). Look at figure 2–37 for examples of the different scoring patterns possible.

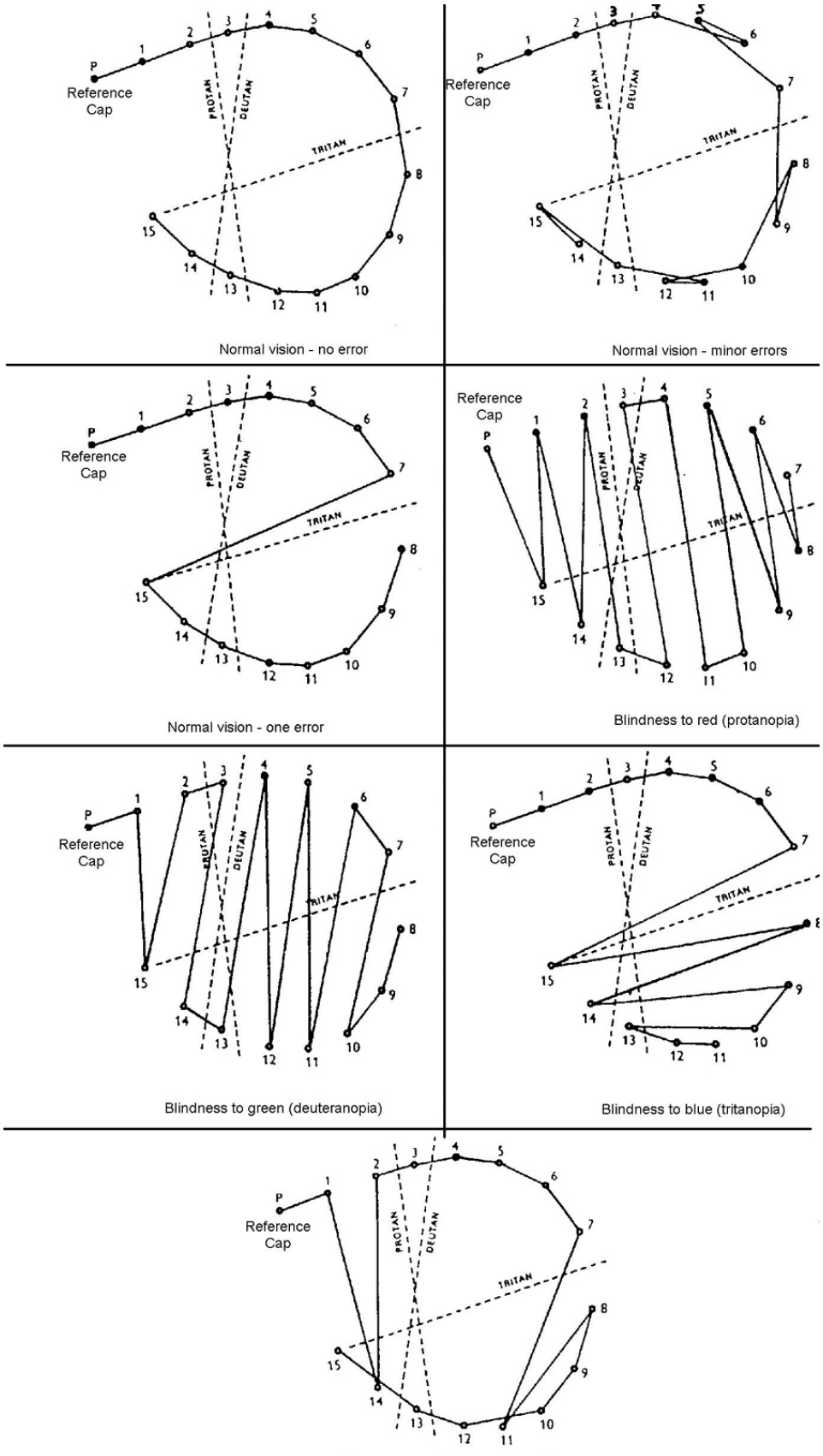


Figure 2–37. Analysis of D–50 score sheets.

612. Measuring blood pressure

The average adult circulatory system contains about eight pints of blood. BP is the force of the blood pushing against the walls of the arteries. Many factors affect a person's BP. BP is normally lower in children. It's slightly higher in men as compared to women of the same age. Those who are obese tend to have an elevated BP. BP levels will generally rise during periods of emotional distress, moments of excitement, or during physical exertion. Too much pressure over time can cause problems throughout the body.

Disease conditions affecting the circulatory and renal systems may increase BP, as can pain. Arteriosclerosis is a common cause of higher BP. Some diseases weakening the heart may lower BP. Hemorrhage (bleeding) and shock lowers BP. Drugs have various effects and may raise or lower BP.

Reasons for measuring BP

BP increases and decreases throughout the day, depending on a person's activity. This is normal and to be expected. In some people, however, BP may tend to remain chronically high or chronically low. Either situation could cause problems, although high BP is really the killer in most cases.

People who have chronic HBP are often referred to as having hypertension (HTN). This is usually a sign of a systemic problem possibly resulting from poor physical condition, arteriolosclerosis, and/or heart disease.

The most serious consequence of HBP is death. Less severe complications can cause visual problems. Branch retinal vein occlusions and hypertensive retinopathy (which is bleeding in the retina and choroid) are two examples. These problems could lead to scotomas (blind spots in the eye) or even total blindness in one or both eyes.

Having chronically low BP is a condition called hypotension. This could cause physical problems, such as transient vision loss, fatigue, and fainting (syncope). Hypotension is not usually fatal, and effects on vision are usually transient.

As an eye technician, be sure to accurately measure a patient's BP. Knowing a patient has a BP problem could aid the doctor immeasurably in detecting potential visual problems before they occur. If abnormal BP is detected early on, the patient can be treated to prolong his or her life and vision.

Measuring and recording BP

Automated BP machines require little skill or knowledge. Therefore, our lesson will cover measuring BP using a stethoscope and a sphygmomanometer (BP cuff) (fig. 2–38).

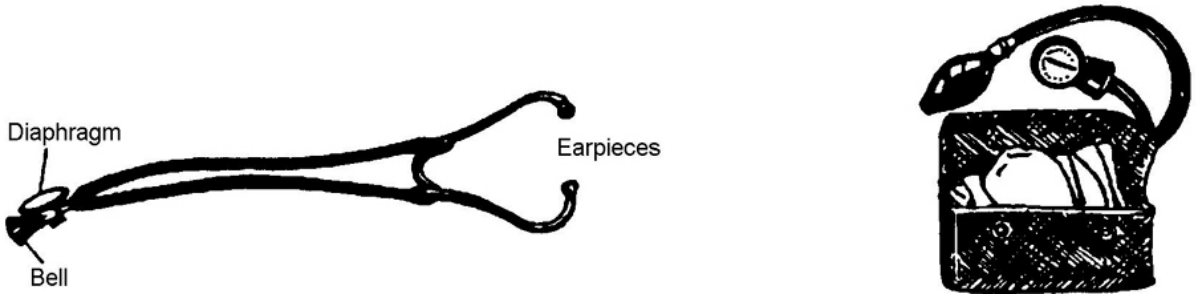


Figure 2–38. Stethoscope and sphygmomanometer (BP cuff).

The steps for measuring BP with a stethoscope and BP cuff are as follows:

1. Wash your hands.
2. Explain the procedure to the patient.
3. Wipe earpieces and diaphragm of the stethoscope with an alcohol pad. You do not want to give yourself an ear infection or touch the patient with "dirty" equipment.

4. Position the patient in a comfortable sitting or lying position.
5. Position the patient's arm so it's resting on a table, chair armrest, or bed. The arm needs to be turned so you can access the antecubital space (inside crook where the arm bends). You can measure the BP in either arm.
6. Expose the upper arm so the BP cuff can be applied without having clothing under it.
7. Open the valve near the bulb of the BP cuff and squeeze the cuff to expel any remaining air. Then gently close the valve.
8. Locate the brachial artery at the inner aspect of the elbow (antecubital space).
9. Place the arrow marking on the cuff over the brachial artery. Wrap the cuff around the patient's upper arm at least 1 inch above the antecubital space. The cuff should be unwrinkled and snug.
10. Place the earpieces of the stethoscope in your ears.
11. Find the brachial artery again and position the diaphragm of the stethoscope over it. Check the stethoscope valve ensuring it's in the correct position for you to hear through the diaphragm side of the stethoscope "head."
12. Inflate the cuff to 200 mm Hg. Do not go higher than this without your doctor's permission.
13. Open the valve slightly on the BP cuff so the pressure bleeds off at a rate of approximately 2–4 mm Hg per second.

    Listen carefully as you watch the BP gauge needle. Note the point on the scale where you hear the first sound of the heartbeat. This is the systolic reading. The systolic pressure represents the pressure in the artery when the ventricles of the heart have contracted (squeezing blood out and circulating it through the body).

    NOTE: If you hear the heartbeat the moment you begin releasing air from the BP cuff, the patient's systolic pressure is *at least* 200 mm Hg. Consult with your doctor before trying again. Do not pump the cuff to over 200 mm Hg without the doctor's permission.
14. Continue to deflate the cuff and monitor the gauge. Note the point where the sound of the heartbeat disappears or "dies." This is the dia<u></u>stolic reading. (You can memorize this by remembering dia<u></u>stolic is when the sound "dies".) On some people, the sound never seems to disappear, but it does change and get distinctly fainter. The point when the sound changes is the diastolic reading. Diastolic pressure represents the pressure in the arteries when the ventricles of the heart relax.
15. Deflate the cuff completely. Remove the stethoscope from your ears. Remove the cuff from the patient's arm.
16. Record the BP with the systolic pressure reading first, then the diastolic pressure reading. Here is an example of a correctly written BP, 120/80 mm Hg. The 120 represents the systolic pressure and 80 corresponds to the diastolic pressure.
    - BP normal ranges:
      - Systolic – < 120 mm Hg
      - Diastolic – < 80 mm Hg

People with readings within the ranges less than 120/80 are considered to have normal BP. Patients with a systolic reading of 120–139 mm Hg or diastolic reading of 80–89 mm Hg are classified as prehypertensive. Stage 1 HTN are patients with a systolic reading of 140–159 mm Hg or diastolic reading of 90–99 mm Hg. Stage 2 HTN patients have systolic readings of 160 mm Hg and greater or diastolic readings of 100 mm Hg and greater.

If a patient's BP is considered "high" (for example, 150/92), it will be up to your doctor to refer the member to family practice or internal medicine to further evaluation. Your job is to accurately take

and record the BP. Beyond that, leave it to the doctor to make decisions based on all the clinical findings and make the appropriate referrals as needed.

Some common mistakes people make when taking BP:

- Deflating the cuff too rapidly or too slowly.
- Not locating the brachial artery before positioning the stethoscope.
- Working in a noisy clinic or rubbing the stethoscope tubing against things.
- Failing to ensure the valve on the stethoscope is in the correct listening position before pumping up the BP cuff.

Never check the pressure in one arm more than twice. If you have not gotten the pressure after the second try, switch to the patient's other arm. If you still cannot get it after two tries in that arm, seek assistance from a more experienced technician. Do not keep repeatedly trying. Do not make up a reading either. It's better to get help than to falsify a record. Falsifying a medical record is not only illegal and immoral, it could lead to incorrect medical decisions and have a long-term effect on the welfare of the patient. Do the right thing by seeking help when things are not working out.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

609. Amsler grid and confrontation field testing

1. What type of abnormalities is the Amsler grid designed to detect?

2. Describe the Amsler grid-recording chart.

3. Under what lighting conditions is the Amsler grid test performed?

4. What could happen if the test distance is less than 12 inches when you perform the Amsler grid test?

5. What could be wrong with the patient if he or she does not see the white dot in the middle of the test on chart #1?

6. What are Amsler grid test charts #5 and #6 used for?

7. What is the Amsler grid test #7 used for?

8. Is confrontation field-testing difficult to perform? Explain your answer.

9. When you are performing the confrontation field test, what do you compare the patient's field of vision against to determine the presence or absence?

610. Depth perception

1. What are two ways the brain deals with diplopia?

2. What three items make up the Titmus stereo fly test?

3. What depth perception test can be used by flight medicine technicians for physical exam testing?

4. What should patients do with their prescription spectacles when taking the Titmus stereo fly test?

5. Is the suppression test performed when testing children?

6. When you are using the Titmus stereo fly test on children and they successfully “grasp” the fly’s wings, what part of the test do you go to next?

7. How is scoring for the Titmus stereo fly test recorded?

8. What is the red lens test used for?

9. The red lens test is used for what type of physical exam?

10. If stereopsis is present, the patient will report seeing what color light?

611. Color vision

1. Any color a person perceives can be produced by a mixture of what three colors of light?

2. What color vision tests are used for official AF physical exams?

3. In the eye clinic, should all color vision testing be performed monocularly or binocularly?

4. What color vision test is the primary screening for AF aviators and aviator applicants?

5. What score is required to pass the CCT?

6. What will the patient see during the CCT test?

7. How many test plates does the PIP test have?

8. List the two acceptable lighting sources for performing the PIP test.

9. How far should the patient be from the PIP test booklet during testing?

10. When doing the PIP test on a person who has prescription spectacles, should the patient wear them or not?

11. Who is allowed to trace the colored portion of the PIP test plates?

12. How many seconds do you show a PIP test plate before moving on?

13. The PIP test plate has the number “29” on it. The patient reads the plate as saying “2.” How would you score this plate?

14. To pass the PIP test, how many plates must the patient get correct?

15. You perform the PIP test on a patient whom the doctor thinks is receiving too high a dosage of Plaquenil sulfate. The patient answers 9 test plates correctly with the right eye and 11 test plates correctly with the left eye. How would you record the results?

16. What form is often used to record the results of the PIP test for an official AF physical exam?

17. Although the D–15 color vision test is not a “pass” or “fail” test, what will the results from this test reveal?

18. How many colored caps come with the D–15 test? How many are loose and moveable?

19. What lighting can be used for D–15 testing?

20. What are the two considerations you should keep in mind when handling and storing the D–15 test?

21. How should the loose caps of the D–15 be arranged just prior to testing?

22. When the patient is done arranging the caps of the D–15 test in the order he or she thinks is correct, how do you score the test?

612. Measuring blood pressure

1. What is BP?

2. Does BP stay the same throughout the day?

3. What is the term used to refer to people who have chronic HBP?

4. Inflate the BP cuff no higher than what measurement without a doctor’s permission?

5. What are the normal ranges for systolic and diastolic measurements?

Answers to Self-Test Questions

606

1. Cranial lesions in or near the visual pathway.
2. Direct, consensual, accommodative, swinging flashlight.
3. In a dimly illuminated exam room, with light distributed evenly throughout.
4. It's an indicator of a problem.
5. Anisocoria. Roughly 10 percent.
6. The MG test.
7. Three to four inches. You need the light to be close enough so that a good concentration of the light enters the eye being tested eye but does not inadvertently shine into the opposite eye.
8. The accommodative pupillary reflex test. A fine-tipped object or small target for the patient to look at.
9. A positive (+) APD.
10. Move the transilluminator straight across the nose, quickly and smoothly.
11. A normal fluctuation of the pupil size.
12. PERRL (–) APD.
13. Unequal pupil size (affected pupil larger); no constriction in dilated eye; no consensual response from the dilated eye; and normal accommodative function in the good eye.
14. A viral infection damaging the ciliary ganglion or posterior ciliary nerves. Young women.
15. Syphilis.
16. Horner's syndrome.

607

1. There is no contact with eye.
2. To prevent any possible legal action against you, your doctor, or the medical facility.
3. In some cases; check with your doctor first.
4. Its portability.
5. On the patient's cheek.

608

1. The IV CN (trochlear) innervates the SO, and the VI CN (abducens) innervates the LR.
2. SO = intorsion. Inferior oblique = extorsion.
3. Orthophoria, heterophoria, and heterotropia.
4. Heterophoria.
5. The diagnostic (muscle) "H" test.
6. Approximately 30º.
7. Possible paresis of LSO.
8. Possible paresis of RMR.
9. (Distance) 20 ft. and (near) 16 inches.
10. The unilateral cover test and the alternating cover test.
11. Orthophoric.
12. The unilateral cover test.
13. (1) unilateral at distance, (2) alternating at distance (if no movement on unilateral), (3) unilateral at near, (4) alternating at near (if no movement on unilateral).
14. To detect the presence of a tropia.
15. LXT Constant Left Exotropia.
16. LHypo (T) Intermittent Left Hypotropia.
17. EP Esophoria.

609

1. Abnormalities in the central 20° of the field of vision.
2. It's like the primary test chart, except it has black lines on a white background.
3. In a well-lit room.
4. The amount of VF tested will be greater than the intended 10° from center and may cause the physiological blind spot to show up in the test results. This could lead the doctor to the false conclusion that there is a macular scotoma present, when in fact, there is not.
5. He or she may have a central scotoma.
6. Pinpointing an area and the number of lines affected by distorted vision.
7. A more thorough examination of the juxta-central area and in cases of high myopia.
8. No. It can be done relatively quickly, without fancy test equipment, and can be performed almost anywhere.
9. The examiner's field of vision (yours).

610

1. It either brings the two images together (fusion) or turns one of the images off (suppression).
2. Test booklet, polarized spectacles, and directions for use.
3. OVT test #5.
4. Keep them on and place the polarized spectacles over the patient's habitual near Rx.
5. No.
6. The animal test.
7. In seconds of arc. You also record the last correct diamond and the total number of diamonds. For example, if the patient gets #1 through #7 correct, but misses #8 and #9, you would record it as "60 seconds of arc, 7 of 9."
8. To detect diplopia or suppression in all nine cardinal positions of gaze.
9. Flying Class I and IA.
10. Pink.

611

1. Red, green, and blue.
2. CCT and VTS–CV (PIP).
3. Monocularly.
4. CCT.
5. 75 or above.
6. A colored letter on a grey background.
7. 14.
8. Macbeth easel lamp or the Richmond Products True Daylight® lamp.
9. 30 inches.
10. Wear the spectacles only if he or she sees better with them on.
11. Children and illiterate patients.
12. 5.
13. As an incorrect response.
14. 10 or more.
15. PIP OD: 9/14 – Patient Fails; OS: 11/14 – Patient Passes.
16. SF 88.
17. The type and degree of color vision defect a person has.
18. 16; 15.
19. Sunlight, Macbeth easel lamp, or Richmond Products True Daylight® lamp.
20. (1) Do not leave the colored caps exposed to light needlessly; always close the case when not in use.

(2) Avoid touching the colored portion with the fingers, because the oils from the skin will discolor the caps.

21. In random order next to the case.
22. Close the lid, turn the case upside down, and open it. Starting with the reference cap “P,” record the numbers on the bottom of the caps, in the order of their arrangement. Then, connect the dots. The diagram created when you connect the dots will reveal what type of color vision defect, if any, the patient has.

612

1. The force of the blood pushing against the walls of the arteries.
2. No, BP increases and decreases throughout the day, depending on a person’s activity.
3. HTN.
4. 200 mm Hg.
5. Systolic: < 120 mm Hg. Diastolic: < 80 mm Hg.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the AFCDA.

12. (606) When performing the swinging flashlight test, you swing the flashlight from the patient's left eye to the right eye, and notice that the patient's right pupil first constricts, then dilates, then constricts again. Which is indicated by this response?
    a. Everything is normal.
    b. The test was performed improperly.
    c. The patient may have a pupillary defect in the right eye.
    d. The patient may be suffering from pretectal nuclei syndrome.

13. (606) Horner's syndrome can only be verified clinically through which type of testing?
    a. Alcaine.
    b. Cocaine.
    c. Xylocaine.
    d. Pilocarpine.

14. (607) According to many noncontact tonometry (NCT) operator manuals, how many readings per eye should be taken on every patient?
    a. One.
    b. Two.
    c. Three.
    d. Four.

15. (607) The doctor may suspect a patient has glaucoma if
    a. there is one reading of 20 millimeters (mm) of mercury (Hg).
    b. there are two current readings of 22 mm Hg, or higher.
    c. there is a difference of 3 mm Hg between the right and left eyes.
    d. the visual readout on the noncontact tonometry (NCT) is flashing.

16. (607) This item is not included in a tono-pen® kit.
    a. Anesthetic medication.
    b. Ocu-film tip covers.
    c. Ocu-cell batteries.
    d. Tonometer.

17. (608) The inferior oblique (IO) muscles are innervated by this cranial nerve (CN).
    a. III CN.
    b. IV CN.
    c. V CN.
    d. VI CN.

18. (608) Which eye test is used for isolating the extraocular muscles (EOM) in certain directions of gaze?
    a. Cover test.
    b. Alternating test.
    c. Muscle "H" test.
    d. Noncontact test.

19. (608) When administering the diagnostic "H" eye test, the patient reports seeing double when looking up and to the right. Which muscles do you suspect?
    a. Left inferior oblique (LIO) and right superior rectus (RSR).
    b. Left superior rectus (LSR) and RSR.
    c. LIO and right inferior oblique (RIO).
    d. Left superior oblique (LSO) and right superior oblique (RSO).

20. (608) When administering the diagnostic "H" eye test, the patient reports seeing double when looking down and to the left. Which muscles do you suspect?
    a. Left superior rectus (LSR) and right inferior oblique (RIO).
    b. Left inferior rectus (LIR) and right superior oblique (RSO).
    c. Left inferior oblique (LIO) and RIO.
    d. Left superior oblique (LSO) and RSO.

21. (608) Which is the correct test distance, in inches, when the cover test is performed at "near"?
    a. 14.
    b. 16.
    c. 18.
    d. 20.

22. (608) You are performing the cover test on a patient. During the *unilateral* cover test, you cover the right eye and the left eye *moves* in. You then uncover the right eye and the left eye *moves* out. You repeat the *unilateral* cover test three more times, getting the same results every time. Which condition does this describe?
    a. Left exotropia (LXT).
    b. Left esotropia (LET).
    c. Left unilateral (LU).
    d. Left alternating (LA).

23. (609) The Amsler grid primary test chart has a
    a. black background with a red grid pattern.
    b. white background with a red grid pattern.
    c. black background with a white grid pattern.
    d. white background with a black grid pattern.

24. (609) This is the proper testing distance, in inches, for the Amsler grid test.
    a. 12.
    b. 16.
    c. 18.
    d. 24.

25. (609) Which chart is used if the patient cannot see the central fixation spot on chart 1 of the Amsler grid test?
    a. Chart #2.
    b. Chart #3.
    c. Chart #4.
    d. Chart #5.

26. (609) Confrontation field tests are designed to detect this type of anomaly.
    a. Small central field defects.
    b. Small peripheral field defects.
    c. Large central field defects.
    d. Large peripheral field defects.

27. (610) This is the test distance, in inches, used during the Titmus stereo fly test.
    a. 12.
    b. 14.
    c. 16.
    d. 18.

28. (610) This notation is used for Titmus stereo fly test results.
    a. Seconds of arc.
    b. Minutes of arc.
    c. Degrees of arc.
    d. Hours of arc.

29. (610) Discontinue the Titmus stereo fly test when the patient makes
    a. one error.
    b. two errors.
    c. two errors in a row.
    d. three errors in a row.

30. (610) How many inches is the testing distance from the fixation point during the red lens eye test?
    a. 12.
    b. 16.
    c. 20.
    d. 24.

31. (610) During red lens eye test, which light(s) will the patient see when occluding an eye without the red lens placed in front of it?
    a. One red.
    b. One pink.
    c. One red and one pink.
    d. One red and one white.

32. (610) While performing the red lens eye test, the patient reports seeing one pink light when the red lens is in front of one eye and both eyes are open. This indicates what?
    a. Photophobia.
    b. Suppression.
    c. Stereopsis.
    d. Diplopia.

33. (611) People *born* with a color vision defect generally have which color variety defect?
    a. Blue.
    b. Red or blue.
    c. Red or green.
    d. Blue or green.

34. (611) This is the test distance, in inches, for the Cone Contrast Test (CCT).
    a. 12.
    b. 16.
    c. 24.
    d. 36.

35. (611) If the score on a Farnsworth D–15 hue test forms a perfect circular pattern, or has only one or two minor errors in essentially the correct pattern, it indicates the patient has
    a. dichromatic color vision.
    b. trichromatic color vision.
    c. monochromatic color vision.
    d. falsified the test and is a malingerer.

36. (612) The adult circulatory system contains on average, how many pints of blood?
    a. 5.
    b. 6.
    c. 7.
    d. 8.

37. (612) Which reading represents the pressure in the arteries when the ventricles of the heart relax?
    a. Systolic.
    b. Brachial.
    c. Diastolic.
    d. Antecubital.

Student Notes

Unit 3. Advanced Clinical Procedures

SO FAR, WE'VE COVERED many of the tasks that you'll use on a daily basis. In this unit, you'll read about some tasks that, depending on your particular ophthalmic clinic, may or may not be part of your everyday duties. However, these skills may be needed on special occasions, in addition to being very marketable should you decide to pursue off-base employment.

3–1. Automated Visual Fields and Optical Coherence Tomography

Most people take their vision for granted. They assume they can clearly see everything in front of their eyes. However, most people are unaware of the physiological blind spot caused by the optic nerve head in each of their eyes.

Therefore, unfortunately, some people are unaware when they develop blind spots caused by disease or trauma. Sadly, by the time a patient does become aware of a blind spot, it's often too late to do anything about the lost vision.

613. Principles of automated visual field results

In this lesson, you'll learn the fundamentals of automated VFs so you'll better understand the diagnostic testing of a patient's central and peripheral VFs. First, however, you need to understand some of the basic terminology.

VF terminology

The VF is the area you can see when your head and eyes are motionless. The VF in normal vision (both eyes) is the *binocular field*; the VF of a single eye is the *monocular* or *uniocular field*.

Fixation point

The VF is measured in degrees away from fixation. The fixation point is the object of focus, which is lined up with the patient's fovea. When a patient is looking directly at a point, the *foveal* or central vision is being used. The patient is said to be fixating on that point. The fixation point lies on the visual axis or line of sight. This point, and any other object on the visual axis, appears at the exact center of the VF.

Isopter

An isopter is a contour (fig. 3–1) line representing the limits of retinal sensitivity to a specific test target.

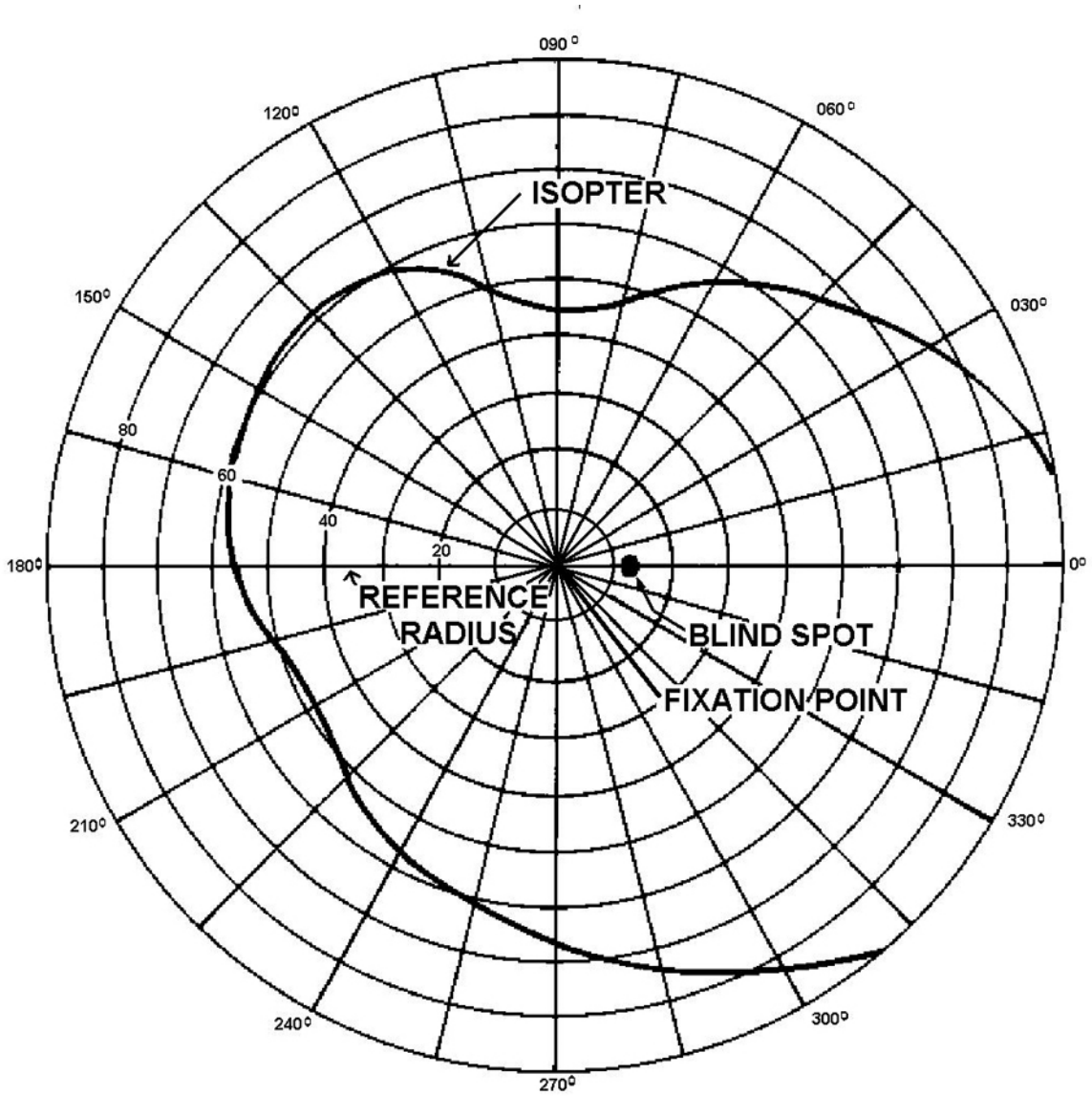


Figure 3–1. Isopter line representing retinal sensitivity.

Isopter sizes vary depending on the size, color, and brightness (illumination) of the target. For example, if the target is larger, the isopter is also larger. Additionally, a brighter target produces a larger isopter, and a white target produces a larger isopter than a colored target.

Central field

The central VF is the area 30° out from the visual axis.

Peripheral field

The peripheral field is the area extending from the outer edge of the central field to the outer limits of the VF.

Normal monocular field

Since VF testing is performed one eye at a time, we only cover the normal extent of a monocular field during the test.

The normal monocular field is as follows:

- 95° temporal.
- 75° inferior.
- 60° nasal.
- 60° superior from fixation (fig. 3–2).

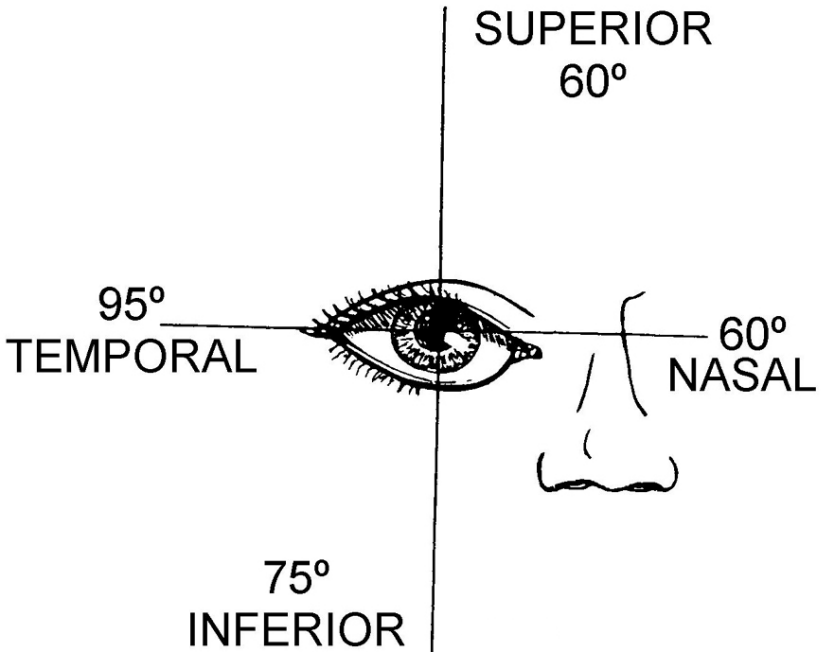


Figure 3–2. Extent of visual field (right eye).

Scotomas

Scotomas are areas of blindness surrounded by areas of normal vision. Scotomas are divided into the following five types:

1. *Central* scotomas involve the fixation area and cause reduced VA.
2. *Pericentral* scotomas affect the area immediately surrounding the fixation area. The fixation area is clear.
3. *Paracentral* scotoma is a depressed VF to one side of fixation. These scotomas are also named by their position—nasal, temporal, superior, and inferior (fig. 3–3 [C]).
4. *Cecal* scotomas involve the area of the normal blind spot (fig. 3–3 [A]).
5. *Bjerrum* scotomas (a.k.a., nerve fiber bundle scotoma) extend from the blind spot around the fixation point in an arc and typically end on the nasal field with a sharp, defined border (fig. 3–3 [B]).

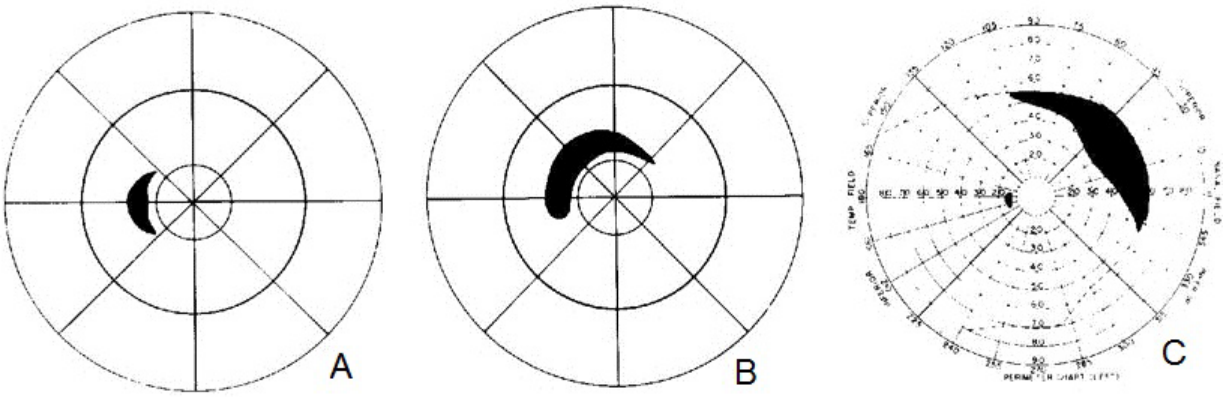


Figure 3–3. Scotoma VFs.

Depressions

Probably the most common VF defects are depressions (or relative scotomas). They represent areas of lowered VA and are located either centrally or peripherally. Depressions can take any shape, and their margins are usually sloping (i.e., they have no sharp borders).

Contractions

Contractions are relatively rare VF defects. They represent a totally blind area (anopsia)—this is a blind area with steep margins (margins with sharp borders or margins presenting the same isopter no matter how large the target). Contractions are usually peripheral, as in a detached retina.

Anopsias

An anopsia is a total loss of vision usually limited to a specific area. This type of defect is generally found in both eyes. The table below lists various types of anopsia, with their description and figure reference.

Anopsia Description		
Defect	**Description**	**Figure 3-4 Item Reference**
Homonymous	Defect is present in the same area of the VF in both eyes, meaning same-sided.	3, 4, 5, 6, and 7
Heteronymous	Defect is present in opposite fields of each eye, or an opposite-sided defect.	2
Hemianopsia	Defect in the right or left half of the VF, half-blind.	
Quadrantanopsia	Defect restricted to one quadrant in each eye, one-quarter-blind.	

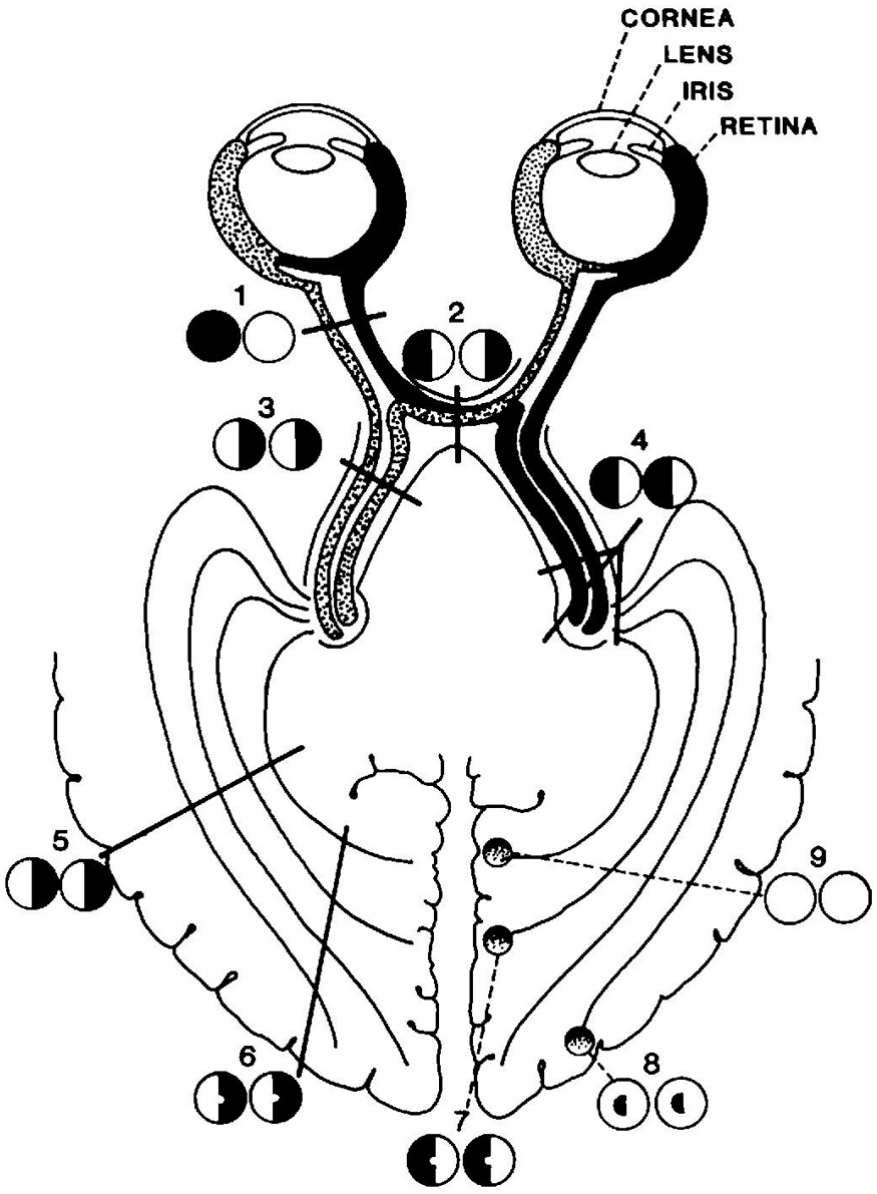


Figure 3–4. Various anopsias.

From this information, you can conclude that a "homonymous hemianopsia" is a defect that presents itself in exactly the same place in each eye. One half (hemi) of the field on the same side (homonymous) of each eye is affected.

Conversely, a "heteronymous hemianopsia" is a defect that presents itself in half (hemi) of the opposite sides (heteronymous) of the VF in each eye. Sometimes a defect of this type affects the temporal halves of each eye; this is called a "bitemporal" field defect (fig. 3–4 [2]).

Reasons for performing VF testing

VF testing has two important functions:

1. *Detecting* abnormalities in the peripheral VF—defects usually missed during routine VA measurements.
2. *Monitoring* changes in a normal or defective VF may indicate the development, progression, or improvement of disease processes affecting the retina and visual pathway.

Many diseases of the retina, optic nerve, and brain interfere with peripheral vision before they affect central vision. An accurate representation of the VF can help identify the nature and location of these diseases. Examples of these diseases include glaucoma, retinitis pigmentosa, retinal detachments, bull's-eye maculopathy, and tumors of the brain and visual pathway. One problem area that can result in vision loss is in the retina.

Retina

The retinal reception of light is directly related to the quality and quantity of visual input available for the brain to interpret as vision. If the retina cannot receive light at a specific area, vision cannot occur in that area. If the retina is not able to complete the conversion of light to nervous impulses, then vision cannot take place.

Everything seen in the VF affects the retina in the opposite location. The optics of the eye function as a camera; because of this, the images seen are always reversed. An image seen in the nasal field relates to an area in the temporal retina. Conversely, an image in the temporal field relates to an area in the nasal retina. Every area of the retina is inversely related to a specific area of the VF.

Determine VA of retinal areas

Our goal in VF testing is to determine the VA of retinal areas other than straight ahead. The easiest way to do this is by using a stimulus-response type of testing. The test provides the stimulus and the patient responds. VF testing takes this concept one step farther and determines the weakest light source (stimulus) the patient can see in different areas of the VF. To do this, the following three primary factors are considered influential in determining a light source's visibility:

1. Size.
2. Background illumination.
3. Brightness of the stimulus (spot).

The etiology (cause) of VF defects

Although you are not to diagnose any pathology from a field defect, you should be able to discuss lesion location and etiology intelligently with your doctors. We'll look at a few typical field defects and the etiology of each. Keep in mind, however, most VF tests are not as simple as the examples shown here.

Media opacities

Many patients complain of seeing little spots or hairs floating around in their field of vision. If there is no eye pathology present, these floaters are due to the shadows of opacities floating in the vitreous body, and may be normal.

Cataracts or generalized media clouding usually result in a generally depressed VF; therefore, large-size targets must be used.

Retina and choroid disease

Both retinal and choroidal lesions can produce a scotoma. The location and shape of these defects vary with the type of lesion. Accurate measurements of the field loss are important in determining the extent and prognosis of the chorioretinal lesion. Most chorioretinal field defects are monocular, but some diseases, such as retinitis pigmentosa, produce a characteristic binocular field defect.

Glaucoma

Glaucoma usually produces a characteristic field loss, depending on the severity of the disease. Let's take a few minutes to study this disease in depth. Refer to callouts "A through I" in figure 3–5 as you read this material.

NOTE: For reasons of clarity and simplicity, VFs obtained by a Goldmann projection perimeter are used in this discussion.

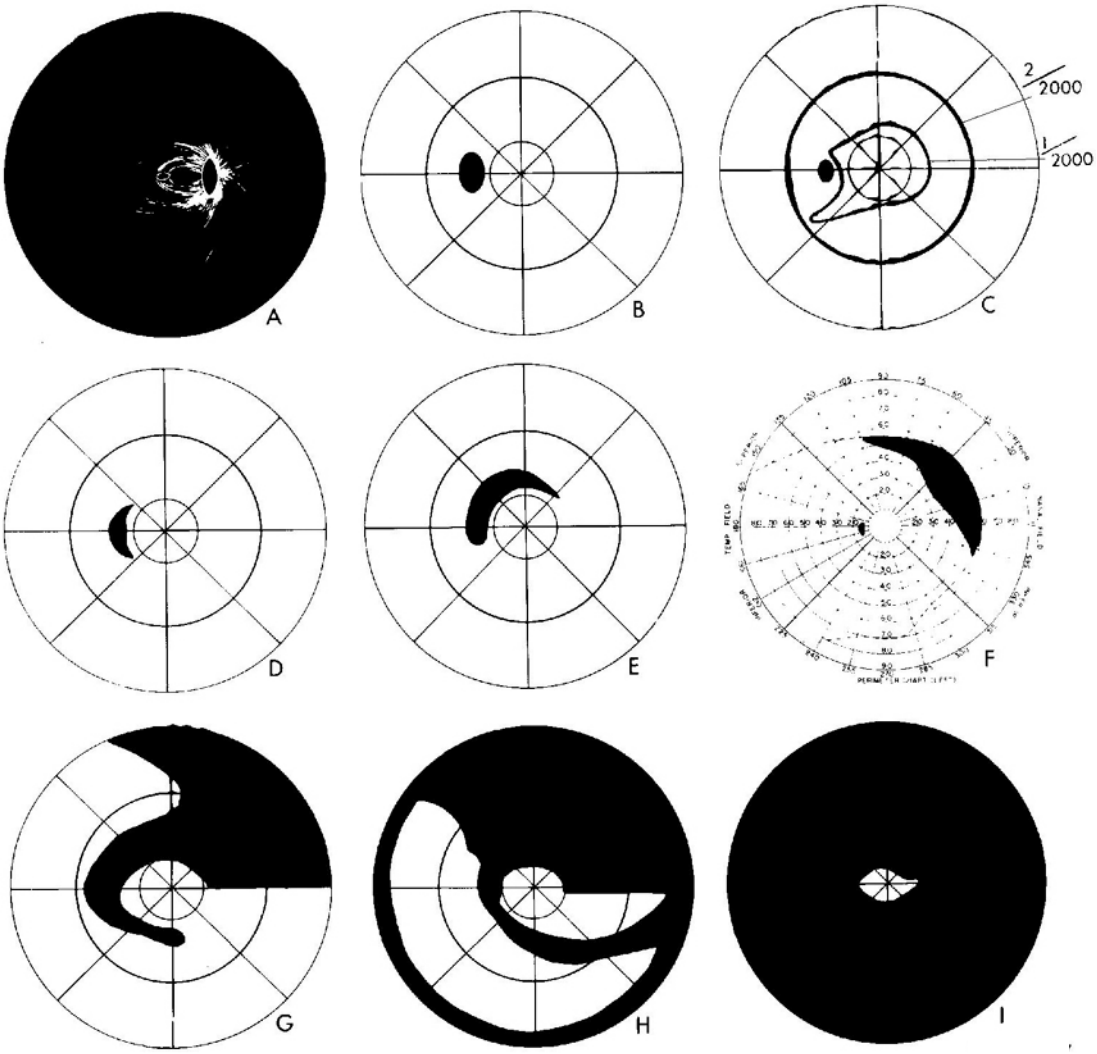


Figure 3–5. Glaucoma progression field.

As you know, the retinal nerve fibers are transparent, but if you could look in a patient's left eye with an ophthalmoscope and see these fibers, you would see something like illustration A in figure 3–5. The white lines in this picture represent the paths of the ganglion fibers as they carry visual information from the rods and cones to the optic nerve. The oval on the right side of the white lines represents the optic nerve head, and the black circle in the center of the white lines represents the fovea.

Illustration B is a plot of the central field of a normal eye. The black oval at the left of center represents the blind spot.

The earliest field defect in glaucoma is shown in illustration C. This defect is called "baring of the blind spot."

Perhaps the field defect you can identify first, during a routine exam, is shown in illustration D. The blind spot is enlarged and has a double arcuate (arc-shaped) scotoma extending from the superior and inferior margins. Sometimes this arcuate scotoma is found only on one of the margins. In either case, this mostly characteristic VF loss is called a "Bjerrum scotoma."

Illustration E shows an advanced Bjerrum scotoma. The shape of this scotoma conforms to the arc of the nerve fiber bundles in illustration A. IOP may be between 25 and 45 mm Hg, and VA is usually 20/20.

Illustration F shows the peripheral field change occurring—a contraction of the superior nasal quadrant. Eventually, if the glaucoma is left untreated, the central and peripheral field changes merge as shown in illustrations G and H.

The patient usually has 20/20 vision but is aware of ocular discomfort. If the opposite eye has not reached this stage, the patient may not be aware of the field loss. The peripheral field breakthrough in these illustrations indicates a well-established glaucoma, and the small central island of vision in illustration I indicates end-stage glaucoma. Central vision may remain 20/20 until the field loss is within 1° of the fixation.

Optic nerve lesions

Many retinal lesions are diagnosed and confirmed by the use of both perimetry and ophthalmoscopy. However, the optic nerve head is the only visible portion of the optic nerve, and perimetry is the only way to localize lesions in and behind the optic nerve.

Typical optic nerve lesions (e.g., papilledema, papillitis, early optic nerve atrophy, retrobulbar neuritis, or multiple sclerosis) usually show fields similar to the one illustrated in figure 3–6. Both the blind spot and fixation spot are affected, and VA may be substantially worse than 20/20, depending on the severity of the lesion.

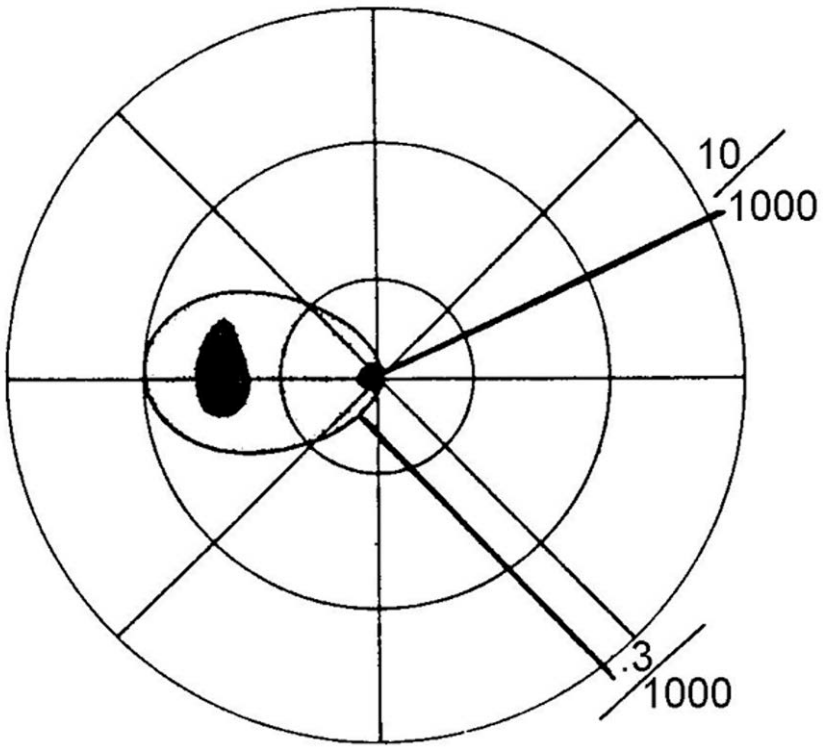


Figure 3–6. Sample field of a patient with an optic nerve lesion.

Optic chiasm lesions

Fibers from the temporal retinas remain uncrossed and travel through the chiasm bitemporally, but fibers from the nasal retinas cross over before they enter the optic tracts (fig. 3–7). This area of the optic chiasm before the nasal retinal fibers cross over is the first place a single lesion could cause binocular field defects. For instance, a lesion in area (1a) of figure 3–7 affects the temporal field of only one eye and results in a VF pattern similar to that depicted in image (1b) at the bottom of figure 3–7. If the lesion spreads across the chiasm or originates at point (2a), a bitemporal VF defect results similar to image (2b) of figure 3–7.

The classic bitemporal VF defect, similar to image (3b), is caused by a pituitary adenoma (a type of cancer of the pituitary gland, located above the chiasm at point [3a] in fig. 3–7). The lesion usually starts as superior bitemporal quadrantanopsia and progresses to a bitemporal hemianopsia as the pituitary gland increases in size. Finally, vision is left only in the superior nasal fields. In many cases, the patient is completely unaware of his or her field defect because the fields of each eye overlap the fields of the other eye.

Occasionally, a patient has an aneurysm of the internal or external carotid arteries causing pressure on the right or left temporal fibers (points [4a] on fig. 3–7). The typical VF defect is a nasal hemianopsia, because the pressure affects the temporal visual fibers (image [4b] of fig. 3–7).

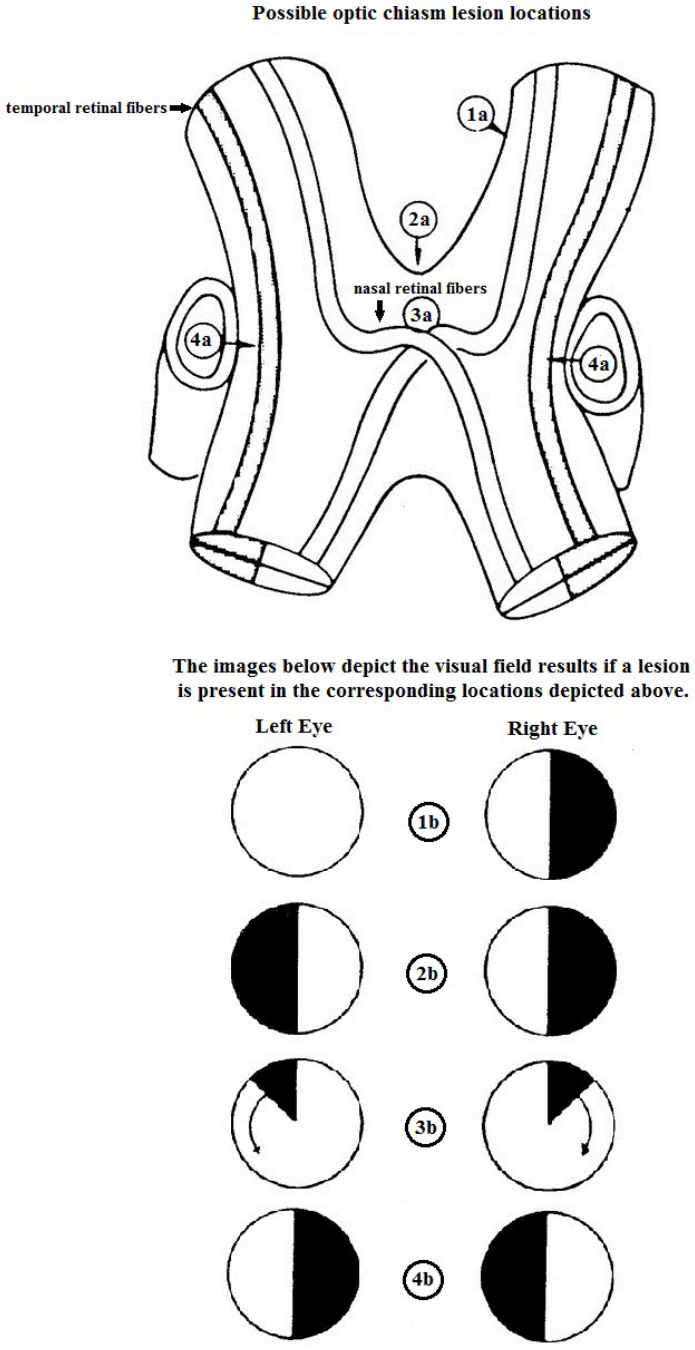


Figure 3–7. Sample field of a patient with an optic chiasm lesion.

Postchiasmal lesions

A general statement can be made about postchiasmal lesions: all postchiasmal lesions produce a homonymous (same-sided, right or left) hemianopsia from a single lesion (fig. 3–8, lesion 5). In figure 3–8, the lesion in location (5a) generates a VF result similar to image (5b).

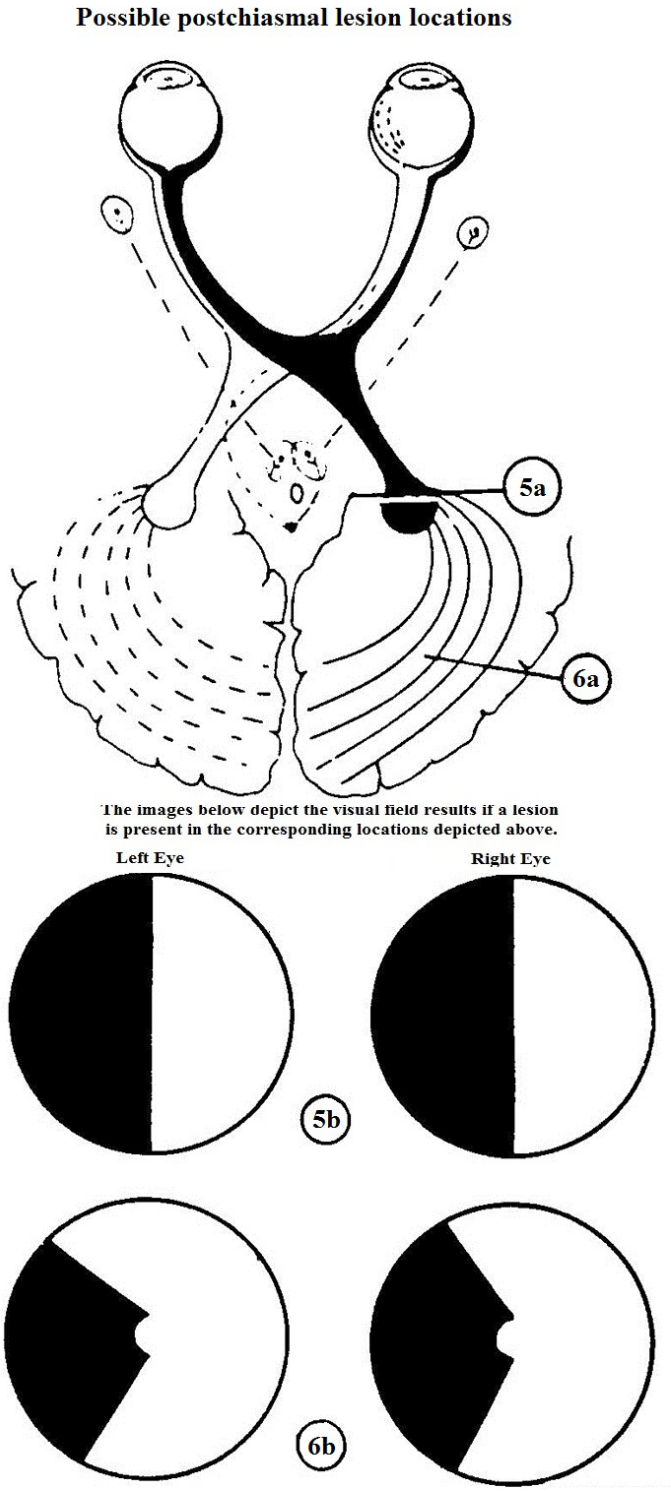


Figure 3–8. Sample field of a patient with a postchiasmal lesion.

As the lesion location changes from immediately behind the chiasm toward the occipital lobes, similar to point (6a) in figure 3–8, the homonymous hemianopsia is more likely to become a homonymous quadrantanopsia, as illustrated in image (6b) in figure 3–8.

NOTE: This particular field was caused by a fracture of the left parietal area of the skull.

614. Performing automated visual fields

The most common instrument available for performing perimetry is the Humphrey® Visual Field Analyzer. This machine is a versatile diagnostic field-testing instrument (fig. 3–9).

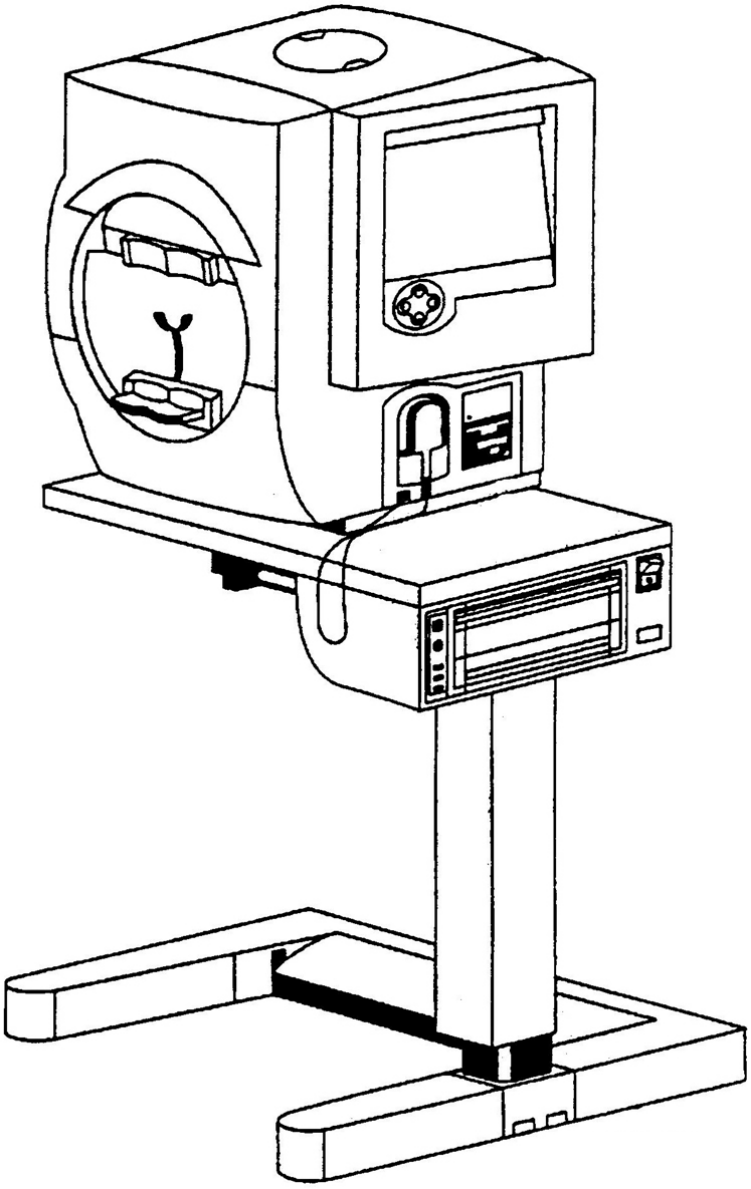


Figure 3–9. Example of a Humphrey® Visual Field Analyzer.

It's a fully automated, programmable VF tester. It has the capability of performing many specific VF exams, such as the glaucoma field, the macula study, and the neurological exam. The Humphrey® Visual Field Analyzer also has an excellent screening program, but it's by no means only a screening tool.

External operation controls

The Humphrey® Visual Field Analyzer has several external operation controls, some of which are the instrument ON/OFF switch, trial lens holder, and a patient-alignment cursor pad (fig. 3–10). Touch-activated icons and pop-up windows on the screen control all other operations. To select entries, simply press your finger against the icons.

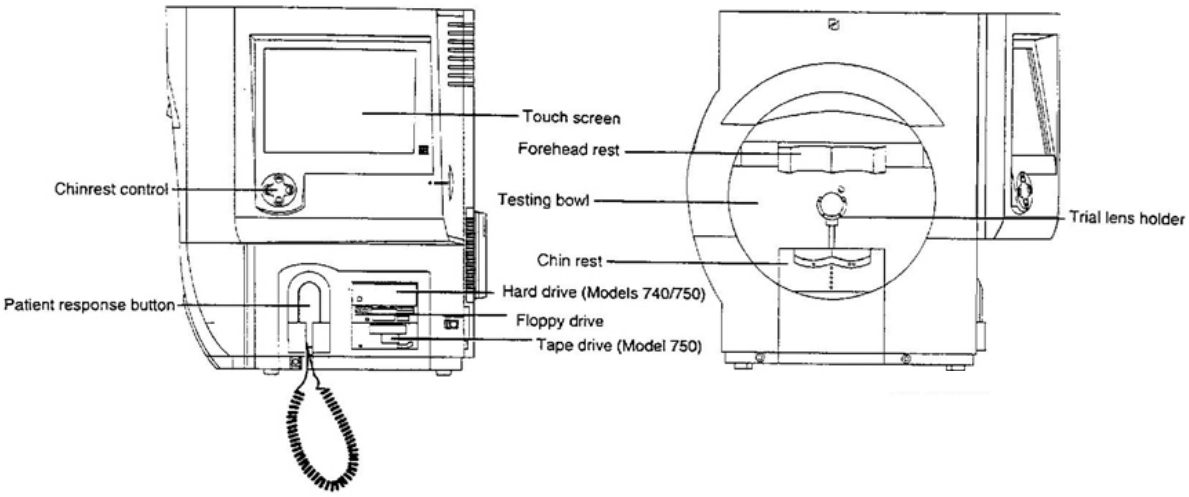


Figure 3–10. Front and side views of Humphrey® Visual Field Analyzer.

Instrument setup

There are five steps to set up the field analyzer:

1. Turn it on and allow it to perform a self-check.
2. Enter the patient's information.
3. Determine if a trial lens is required (if applicable).
4. Select the test.
5. Verify the test parameters.

Turn it on

The field analyzer's ON/OFF switch is under the screen on the back of the power table. After you turn it ON, the field analyzer performs a self-test, checking brightness of the background, brightness of the test spot, and location of the test spot. Following the self-test, the field analyzer's MAIN MENU comes up.

NOTE: Ensure the self-test is allowed to run in a darkened room.

The field analyzer has a screen-saving feature on the monitor. The monitor dims whenever the field analyzer has not been used for 10 minutes. If you press the patient response button or touch the screen, the brightness returns to the screen.

Enter patient data

Each time a field test is performed, enter the patient test information so the printouts of the test results include the patient's name, Social Security number, and other test information.

NOTE: The field analyzer erases patient data previously entered when you touch the PATIENT icon. Make sure all previous data has been saved before you touch the PATIENT icon.

To enter patient information, touch the PATIENT icon on the MAIN MENU screen. This brings up the PATIENT DATA screen (fig. 3–11).

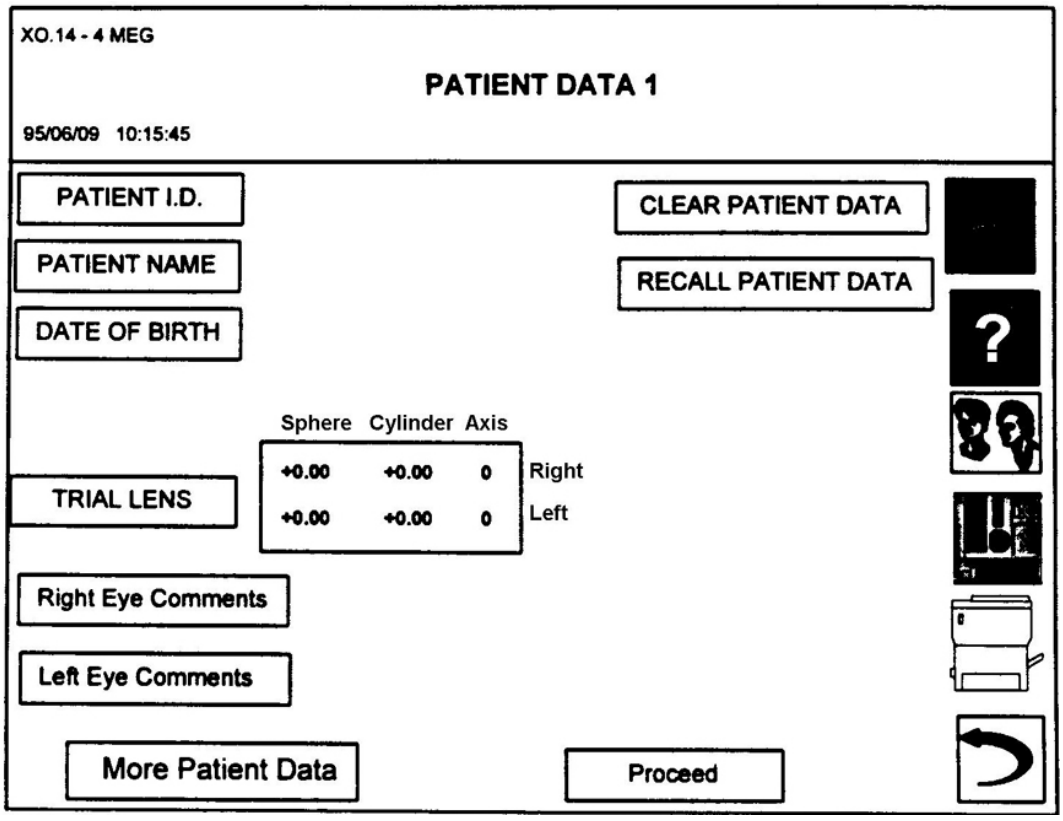


Figure 3–11. PATIENT DATA screen.

Enter the applicable information about the patient you are testing. The table below explains each icon.

Patient Information		
PATIENT ID	Enter the patient's Social Security number using the pop-up keyboard on the screen. Touch the ENTER key on the pop-up keyboard to return to PATIENT DATA screen.	
PATIENT NAME	Touch the NAME pad, and use the pop-up keyboard on the monitor to type in the patient's name. Use the backspace key to erase letters. Touch the Enter key only after you have typed the correct name. The field analyzer automatically returns to the PATIENT DATA screen after you touch the Enter key.	
DATE OF BIRTH	The patient's birth date is needed for the automatic trial lens calculations. Enter the birth date in a numeric month, day, and year format on the pop-up window.	
More Patient Data	Press this icon and the PATIENT DATA 2 screen appears. Enter important information concerning pupil size and VA. You can also enter other useful information from this screen.	
	PUPIL DIAMETER	Information on the pupil diameter, which is measured in mm, is optional. Ask the doctor if this information should be recorded.
	VISUAL ACUITY	VA is an optional entry. Use it if the doctor wants the patient's best-corrected VA to be printed on the printout. If you touch VISUAL ACUITY, a list of VAs from 20/15 through 20/400 comes into view on the pop-up window. The pad next to the RIGHT EYE blinks. Select the VA for the right eye. Then the square beside LEFT EYE blinks. Select the VA for the left eye. Touch RETURN to go back to the PATIENT DATA menu.

Screening Tests	Extent of Visual Field Tested	Application
Armaly Central	30 degrees	Glaucoma
Armaly Full Field	50 degrees	Glaucoma
Nasal Step	50 degrees	Glaucoma
Central 40	30 degrees	General
Central 76	30 degrees	General, glaucoma, neurological
Central 80	30 degrees	General, glaucoma, neurological
Central 166	30 degrees	General, glaucoma, neurological
Peripheral 68	30 to 60 degrees	General, neurological with central exam, retinal, glaucoma
Full-Field 81	55 degrees	General, retinal, glaucoma, neurological
Full-Field 120	55 degrees	General, retinal, glaucoma, neurological
Full-Field 246	55 degrees	General, retinal, glaucoma, neurological
Automatic Diagnostic	55 degrees	General
Threshold Tests		
Central 10-2	10 degrees	Macular retina, neurological, advanced glaucoma
Central 24-1	24 degrees	Glaucoma, general
Central 24-2	24 degrees	Glaucoma, neurological, general
Central 30-1	30 degrees	Glaucoma, neurological, retinal, general
Central 30-2	30 degrees	Glaucoma, neurological, retinal, general
Peripheral 30/60-1	30 to 60 degrees	Retinal, glaucoma
Peripheral 30/60-2	30 to 60 degrees	Retinal, glaucoma
Temporal Crescent	75 degrees	Retinal, neurological, advanced glaucoma
Nasal Step	50 degrees	Glaucoma
Neurological 20	20 degrees	Hemianopsia
Neurological 50	50 degrees	Hemianopsia
Macula	4 degrees	Macular retina, advanced glaucoma
Statistical Data Analysis	**Tests**	**Application**
STATPAC 2	Central 24-1, 24-2, 30-1, 30-2, and 10-2	Statistically analyzes central threshold exams for significant departures from norms. For central 24-2 and 30-2 tests only, the summary and glaucoma change probability greatly enhance ease of interpretation of serial fields.
Other Data Analysis	**Tests**	**Application**
Average	All threshold tests	Averages multiple threshold exams to reduce random variability
Compare	All threshold tests	Compares two tests to measure arithmetic change
Merge	Central 30-1, 30-2, 24-1, and 24-2, Peripheral 30/60-1, 30/60-2, and 68	Combines test results to achieve greater grid resolution and to view full field on a single page

Figure 3–12. Data analyses available.

Trial lens calculations

For *central* field tests and the *central portions* of full field tests, a trial lens is mandatory. The field analyzer automatically calculates the trial lens prescription after you enter the patient's distance prescription. To enter the right eye (OD) and left eye (OS) distance prescriptions, touch TRIAL LENS on the PATIENT DATA menu. From the pop-up window, choose CALCULATE TRIAL LENS, and enter DATE OF BIRTH and prescription information (SPHERE, CYLINDER, AXIS, etc.). Use the numbered squares on the screen to enter the correct information (you can use a keyboard if your unit is so equipped). Press ENTER after typing each value. Then touch CALCULATE TRIAL LENS. The correct trial lens prescription appears in the Rx box of the PATIENT DATA screen.

If applicable:

- Place the sphere lens in the slot closest to the patient.
- Place the cylinder lens in the slot farthest from the patient.

Selecting a test

The VF performs screening and automatic diagnostic and threshold tests. Select from the MAIN MENU the test pattern your doctor requests. Figure 3–12 provides information about some of the test patterns and data analyses available with this analyzer.

Screening tests

A screening test quickly surveys the VF and flags highly suspect areas. Threshold testing further investigates any defects found on screening tests. Screening tests quickly answer the question *"Is there a problem?"*

A threshold or diagnostic test more precisely defines VF problems by calculating the actual retinal sensitivity at each test point. Testing in this mode, the visual field analyzer can detect very small and subtle defects. Threshold testing answers the question *"How severe is the problem?"*

Threshold testing can be used to test the following specific areas of the VF:

- ***Macular***—0–10° from macula.
- ***Central***—0–30° from macula.
- ***Peripheral***—30–60° from macula.

The Humphrey® Visual Field Analyzer also has VF exams to test for specific disorders, which include the following:

- Macula Study.
- The Glaucoma Field.
- The Neurological Exam.

After selecting the test required, the PATIENT DATA screen reappears. You can make last-minute changes, if needed. Then, touch PROCEED.

Verifying test parameters

After you press PROCEED on the PATIENT DATA screen, the test pattern appears on the screen. The patient's name is in the lower right-hand corner of the screen. The name of the test strategy appears on the top of the screen.

Changing parameters

You have the option of either using the standard field analyzer parameters, or changing any of them before you begin the test. The parameters you can change are the fixation target, blind spot check size, test speed, foveal threshold test, central reference level, the fluctuation test, and FASTPAC (computer program).

When you select CHANGE PARAMETERS on the test screen, a listing of the different parameters for the test you selected appears on the screen. Whenever an item on this menu is highlighted, it means the parameter is *not* the analyzer's standard parameter. If you touch RESET TO STANDARD PARAMETERS, the program re-establishes all the standard settings. In the table below are some of the parameters you can change.

Standard Parameters	
Parameter	**Explanation**
FIXATION TARGET	If a patient has a central scotoma and cannot see the central fixation target, you can use either the small diamond or the large diamond fixation target. Touch FIXATION TARGET in the change parameters menu to change to either alternate target. When you're using the diamond targets, tell the patient to look near the center of the four yellow lights. Use the smallest diamond fixation target that still allows the patient to maintain steady central fixation.
BLIND SPOT SIZE and BRIGHTNESS	The field analyzer uses a Goldmann size III stimulus to check the blind spot. If necessary, you may change the parameters. Normally, however, they are left at standard settings.
TEST SPEED	The field analyzer uses a varying time interval between test spots. There are two test speeds, normal and slow. Use the normal test speed for almost everyone. Patients without any significant attention or physical problems (e.g., a young individual with Multiple Sclerosis may need a slower speed) do well with the normal speed. Use the slow test speed for patients who are over 65 and/or who require more time due to an attention or physical deficit. The slow test speed slows the test speed interval.
FOVEAL THRESHOLD TEST	This test gives the doctor an idea of what maximum retinal sensitivity should be for a patient. Measure the foveal threshold by using the foveal threshold test. This test determines the decibel (dB) value of the central part of the macula as compared to a norm reference. The default setting for this test is OFF. To change the default setting, touch FOVEAL THRESHOLD. Start any test with a foveal threshold check and the small diamond fixation target opens in the testing bowl. Instruct the patient to fixate in the center of the four lights. The foveal threshold is measured twice.
CENTRAL REFERENCE LEVEL	At the start of each screening test, the analyzer measures a central reference level. The central reference level is the expected intensity level for the patient.
FLUCTUATION TEST	This test is designed to measure variability of the patient as compared to the norm reference. This information is useful in determining whether a small defect is significant, or whether a defect is growing. It also gives you an indication of the reliability of the test. For testing purposes, fluctuation less than 1.5 dB is considered low. Fluctuation greater than 3.0 dB is considered high. Patients who have abnormal or pathological fields or who do not maintain fixation, often have high fluctuation values.
FASTPAC	The test reduces the total number of times each area is tested, allowing you to decrease the test time on all threshold tests by 40 percent. To turn FASTPAC option on, select CHANGE PARAMETERS on the test screen, and select FASTPAC.

Preparing patient for testing

Once you have completed the system setup, prepare the patient for testing by following these procedures:

1. Seat the patient.
2. Give the response button to the patient.
3. Ensure the patient understands the test procedure.
4. Cover the nontested eye.
5. Position the patient.
6. Align the patient's eye with the target in the center of the video eye monitor on the touch screen.
7. Adjust the trial lens (if applicable).

Seating considerations

Because the test can be lengthy, it's important for the patient to be comfortable. The patient should face the machine. Adjust the power table up or down so the chin cup is level with the patient's chin.

Response button

Allow the patient to hold the response button in either hand. Ensure the patient feels the click and hears the faint beep when the button is pressed. Advise the patient, if he or she should become fatigued and wishes to pause the test, he or she can do this by holding down the response button. The test remains paused until the test button is released.

Explaining the test

Choose the appropriate test and eye. If you need assistance, select OPERATOR ASSISTANCE on the test screen. The following dialogue appears on the screen; read it to the patient:

> Always look straight ahead at the steady yellow light. Other lights flash one at a time off to the side. Some are bright, some dim. Press the button whenever you see one of these flashes. You are not expected to see all of them. If you want to rest, hold the button down. The best time to blink is just as you press the button.

Occlude the nontested eye

The patient should not wear spectacles during the test; however, you can use the trial lens, if needed. Place the eye patch so it completely occludes the nontested eye. Make sure the string of the eye patch is above the eyebrow and not interfering with the vision of the nonoccluded eye.

Proper positioning

Have the patient place his or her chin in the chin rest and forehead against the forehead rest. Make sure the patient is as comfortable as possible. The more comfortable the patient is, the more reliable the test results will be.

Patient eye alignment

Align the patient using the video eye monitor. Touch the EYE MONITOR pad on the test screen until it's ON. The patient's eye appears in the upper left-hand corner of the screen. Adjust the contrast of the image by using the plus sign (+) on the monitor to brighten the image or the minus sign (–) to dim the image. The OFF button turns off the monitor display. To align the patient's eye, move the chin rest as needed with the four-way cursor pad located below the screen. Center the eye in the crosshairs.

Positioning trial lens

Ensure the trial lenses are in the lens holder. Pull the lens holder toward the patient's eye. The lens should be close to the patient's eye but not so close the patient's eyelashes touch the lens.

Help menus/operator assistance

If you need assistance, touch either the HELP menu in the MAIN MENU, or OPERATOR ASSISTANCE in the START TEST menu. Use the operator checklist duplicated below to assist you.

OPERATOR CHECKLIST
__ Place trial lenses in holder.
__ Enter patient data.
__ Choose test and check test parameters.
__ Occlude nontested eye.
__ Instruct and align patient.
__ Dim room lights.
__ Start test.

Administering a threshold test

Whenever you choose a new test, the Humphrey® Visual Field Analyzer checks its motor position and background illumination intensity. Before testing a patient, use the one-minute demo test to ensure the patient understands the test procedures. Test times vary with each patient and type of test performed. When the test has finished, the instrument beeps three times.

Demonstrate the test procedure

Dim or turn off the room lights. Inform the patient the DEMO test is about to start. Touch DEMO on the test screen. The message “DEMO TEST LASTS 1 MINUTE UNLESS START IS HIT FIRST” appears on the screen. During the demo test, the field analyzer presents spots of light, but the patient’s responses are not recorded. Check the patient’s fixation with the video eye monitor. Ensure the patient has no more questions. The field analyzer automatically starts the test after completing the demo test.

The test in progress

During the test, points of light flash on the white, bowl-shaped screen, and each time the patient sees the light, he or she should press the response button. The elapsed time, points seen and missed, false positive errors, false negative errors, and fixation losses (discussed later) are continuously displayed on the screen. As soon as a spot of light is measured, it appears on the video screen first as a symbol and then as a numeric value. (These numeric values are discussed later.)

While testing the patient, use the video eye monitor to check alignment and monitor fixation. Realign the patient as necessary. The field analyzer shines approximately 5 percent of all test spots in the patient’s blind spot. If the patient is not fixating on the yellow light (fixation target), the patient responds to the stimulus displayed in his or her blind spot.

Remember, the blind spot corresponds to the patient’s optic nerve head; the patient should not respond to any light shone in this area. If the patient cannot maintain proper fixation, then reinstruct the patient to always fixate on the center yellow light.

Each fixation loss is recorded on the screen. If the patient presses the response button on two of five fixation checks, the instrument sounds a single beep. If you hear this single fixation alarm, remind the patient to fixate on the yellow light. Also, check the patient’s eye alignment through the video eye monitor. If the patient has numerous fixation losses in the beginning, it may be beneficial to start the test over, realigning and reinstructing the patient.

If the patient tires, or if you need to complete a lengthy discussion on proper fixation with the patient, you may want to pause the test by touching the PAUSE pad on the test screen. Remember also that the patient can pause the field test by holding down the response button. When the patient holds the

response button, the field analyzer continues to beep and the stimulus spot indicator remains in one place.

When the test ends, the Humphrey® Visual Field Analyzer beeps three times. Have the patient sit back.

Saving test results

Immediately after each eye is completed, the VF analyzer prompts you to save the file; ensure you do so. Following completion of all tests, you may print the VF results.

Printing test results

Once the test is complete, print out the results for the doctor's review and placement in the patient's medical record.

Test results overview

When the test ends, the Humphrey® Visual Field Analyzer allows you to print the results in one of two print formats:

1. *Screening Test* option allows you to print each test on a separate sheet.
2. *Both Eyes* option condenses the two test results to one page.

There are six threshold print formats:

1. Single Field Analysis.
2. Overview.
3. Change Analysis.
4. Glaucoma Change.
5. Probability Analysis.
6. 3-in-1.

All of these threshold print formats, except the 3-in-1, are in the STATPAC statistical software format, which allows for immediate expert system analysis of VF test results.

Printing

To print saved test results, select the PRINT icon and then press the PROCEED icon. Next, select the patient file needed for printout. This is done by moving the cursor up and down the file list. (Cursor movement is accomplished with the up and down arrows on the left of the screen.) Once you have selected the patient, the VF analyzer provides the following listing of the different printout options available:

1. *Single Field Analysis*—analyzes the results of a single threshold test.
2. *Overview*—presents the results of up to 16 tests for convenient comparison. (A maximum of three tests print on one page.)
3. *Change Analysis*—compares up to 16 tests and analyzes indices of change in the patient's field over time, flagging significant indicators for your attention.
4. *Glaucoma Change Probability Analysis*—designed specifically for glaucoma patients; distinguishes between random variation and significant changes from test to test.

   NOTE: The above four options are used in conjunction with the STATPAC statistical software. This software helps you judge VF changes by (1) using results from a single test and pointing out suspicious areas not otherwise evident without subsequent tests for comparison; (2) identifying areas looking suspicious, but which, in fact, compare favorably with "normals" data; and (3) providing for a highly sensitive and informative analysis of changes in the patient's VF over time.
5. *3-in-1 Analysis*—used when the threshold test pattern or test parameters do not meet the criteria for a STATPAC analysis. The 3-in-1 printout includes a graytone, numeric, and

defect depth presentation of the results of a single test on one page. (Graytone, numeric, and defect depth presentation is discussed in more detail later.)

Once you have determined and selected the correct printouts, press the response PRINT ALL SELECTED ITEMS.

Administering a screening test

The only real difference between administering a threshold test and administering a screening test is in choosing one over the other (this is related to testing strategies—diagnostic versus screening).

All other steps from inputting patient data, demonstrating the test, administering the test (test in progress), and saving test results to printing test results remain the same.

VF printout interpretation

Interpretation of the VF test printout is best accomplished when you have an understanding of the basic terminology used in a printout and understand why a specific test was used.

Threshold test result printouts

The type of test, patient information, and test parameters are printed on top of the printout. The measured foveal threshold is listed, if appropriate. TIME tells how long the test took. POINTS SEEN is the number of test spots observed compared to the number of test spots presented. POINTS MISSED are the number of test spots missed compared to the number of test spots presented.

The printout includes three indices of the test conditions that can assist the doctor in determining the reliability of the patient's results. These indices are fixation losses, false positive errors, and false negative errors.

1. *Fixation losses*—if a patient presses the response button as a result to a spot presented in the blind spot, a fixation loss is recorded. The fixation loss score on the printout is read as the total fixation losses compared to the total test spots presented in the blind spot. A high-fixation loss number indicates the patient lost fixation many times during the test. It could also mean the blind spot was incorrectly plotted. If fixation losses exceed two of five (or 20 percent), then an "XX" is printed after the score. This indicates a high-fixation loss score. When the test is in progress, the instrument beeps once when the patient responds to two of the last five fixation checks. When this happens, check alignment. You may even have to replot the blind spot for reliable test results.
2. *False positive errors*—during a test, about one in 40 test spots is a false positive error test. The test spot mechanism moves as if to present a test spot, but no spot is shown. A high-false positive error score indicates the patient is "trigger happy" and is pressing the response button when no test spot has been presented. If false positive errors exceed 33 percent of the total number of test spots, an "XX" appears on the screen and on the printout.
3. *False negative errors*—during a test, the Humphrey® Field Analyzer occasionally presents a very bright test spot in an area of previously established sensitivity. If the patient does not press the response button, a false negative error is recorded. If false negative errors exceed 33 percent of the total number of test spots, an "XX" appears after the score and on the printout. A high-false negative error score indicates the patient is inattentive, a poor fixator, or a physical condition exists which makes it difficult for the patient to press the response button. This error is also common in glaucoma patients.

Examples of abnormal threshold test printouts

Before you can truly appreciate an abnormal VF, it's best to have a frame of reference for a normal VF. Look at figure 3–13 as it represents a normal VF.

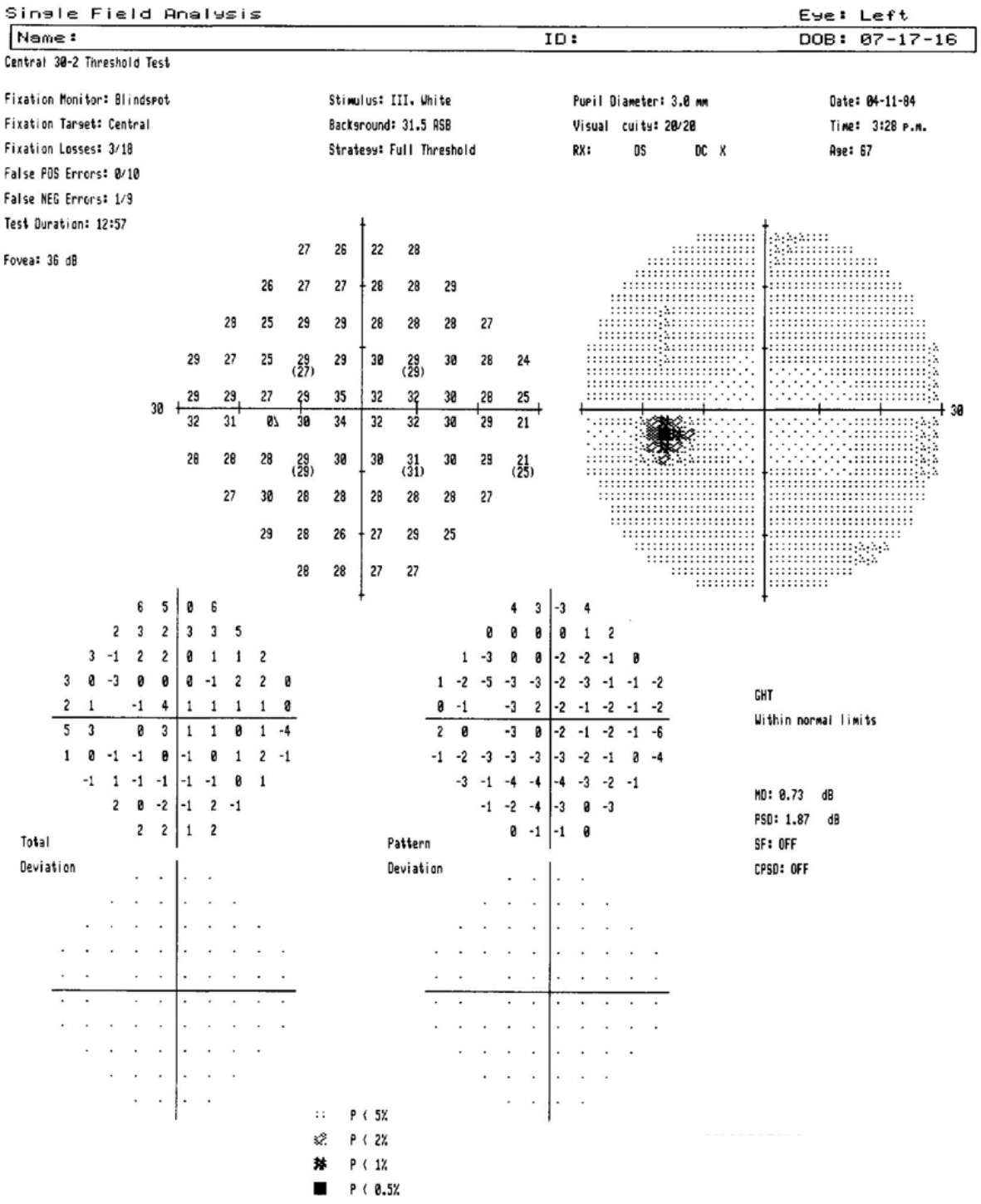


Figure 3–13. Normal visual field.

Figure 3–14 depicts what is referred to as a “trial lens artifact.” In this example, the trial lens was set too far away from the patient’s eye. The blackened area represents the outer edges of the trial lens. A similar artifact would be produced if the patient had been allowed to complete the test wearing his or her spectacles.

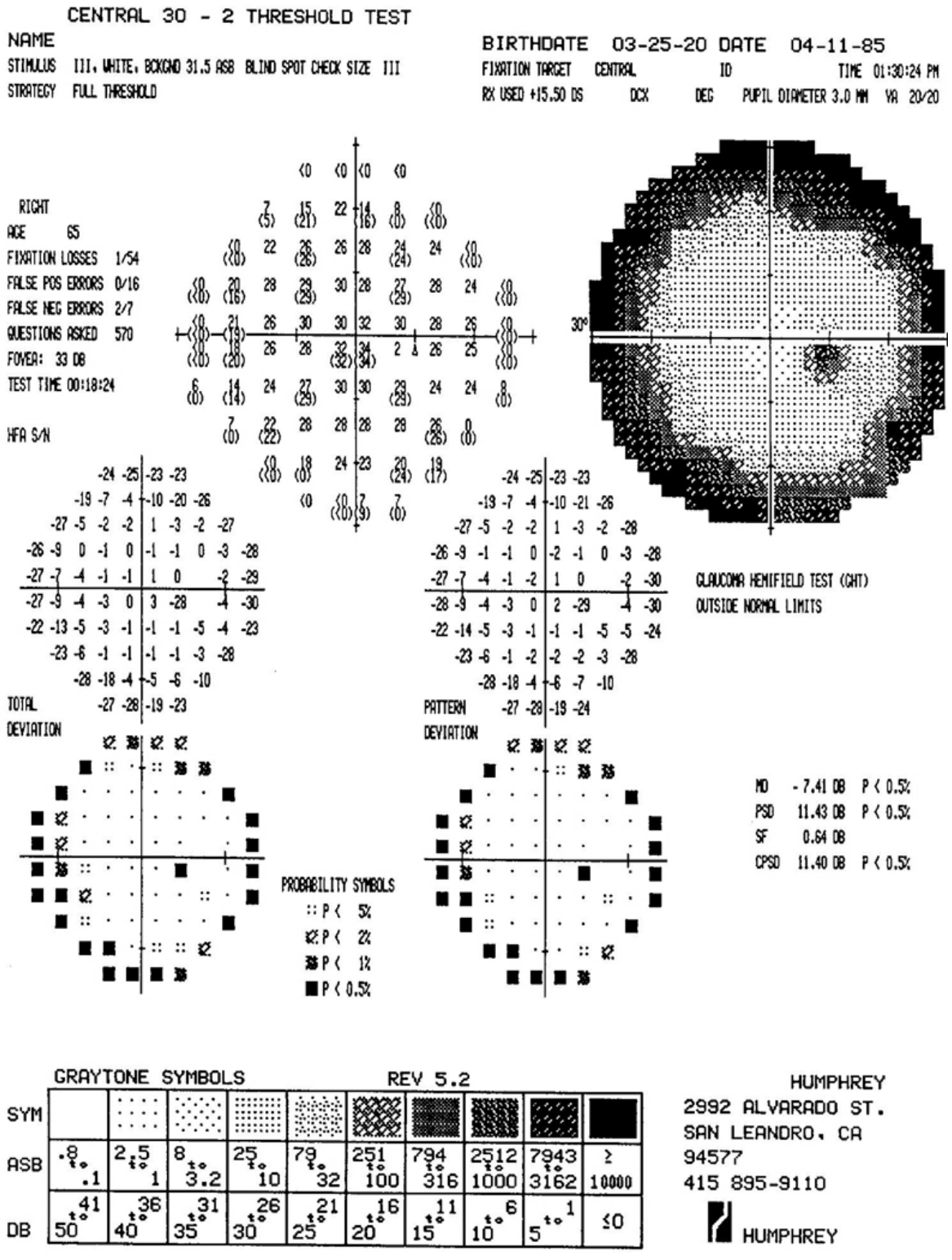


Figure 3–14. Trial lens artifact.

Figure 3–15 represents a field in which the patient has too many fixation losses. Because of this, the field appears to be missing the blind spot. Notice the patient's fixation losses were 6/27 (upper left corner), and the field has been marked as "low patient reliability."

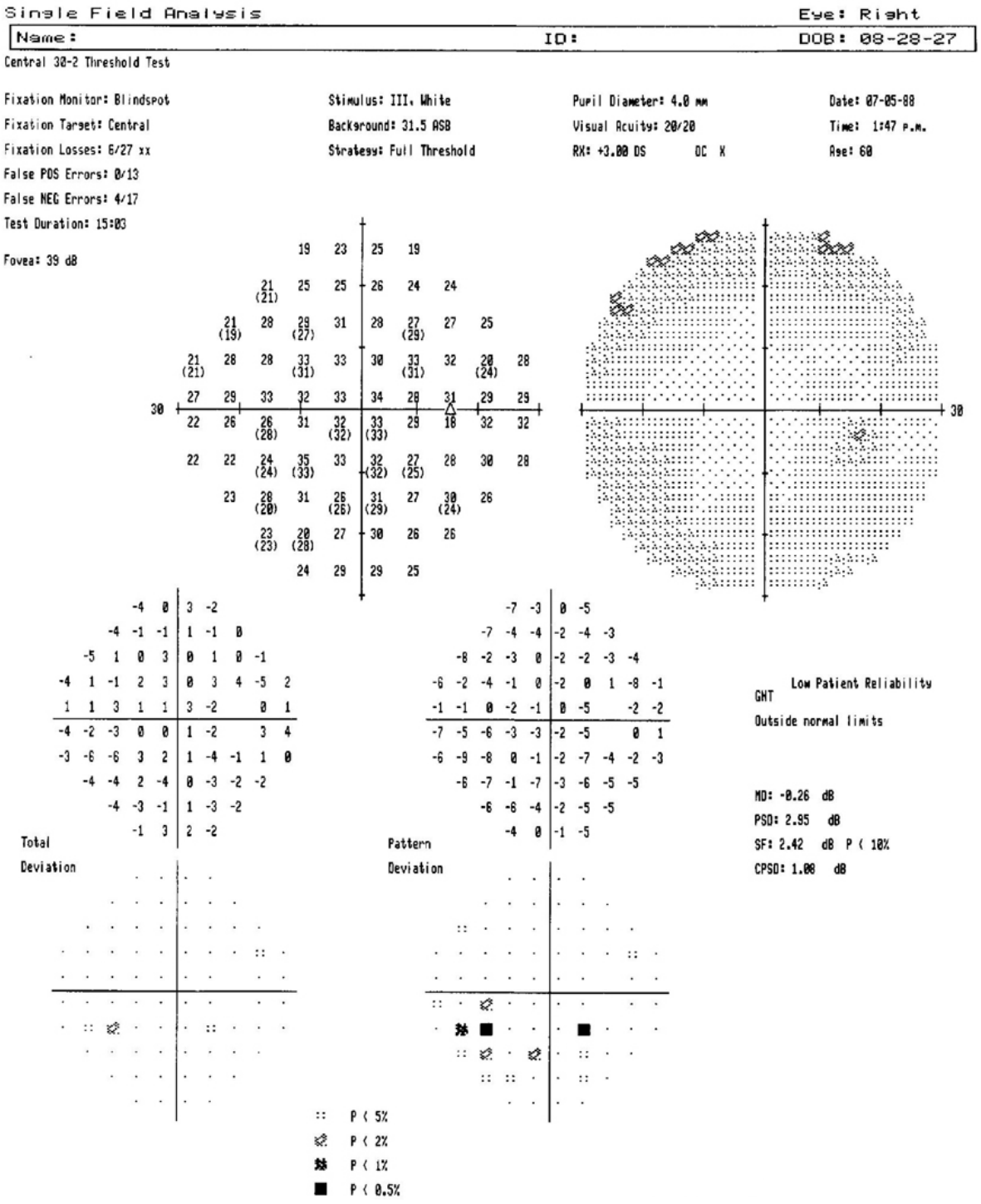


Figure 3–15. Missing blind spot.

Figure 3–16 is a typical representation of beginning glaucoma. The blind spot is enlarged, indicative of changes to the optic nerve head.

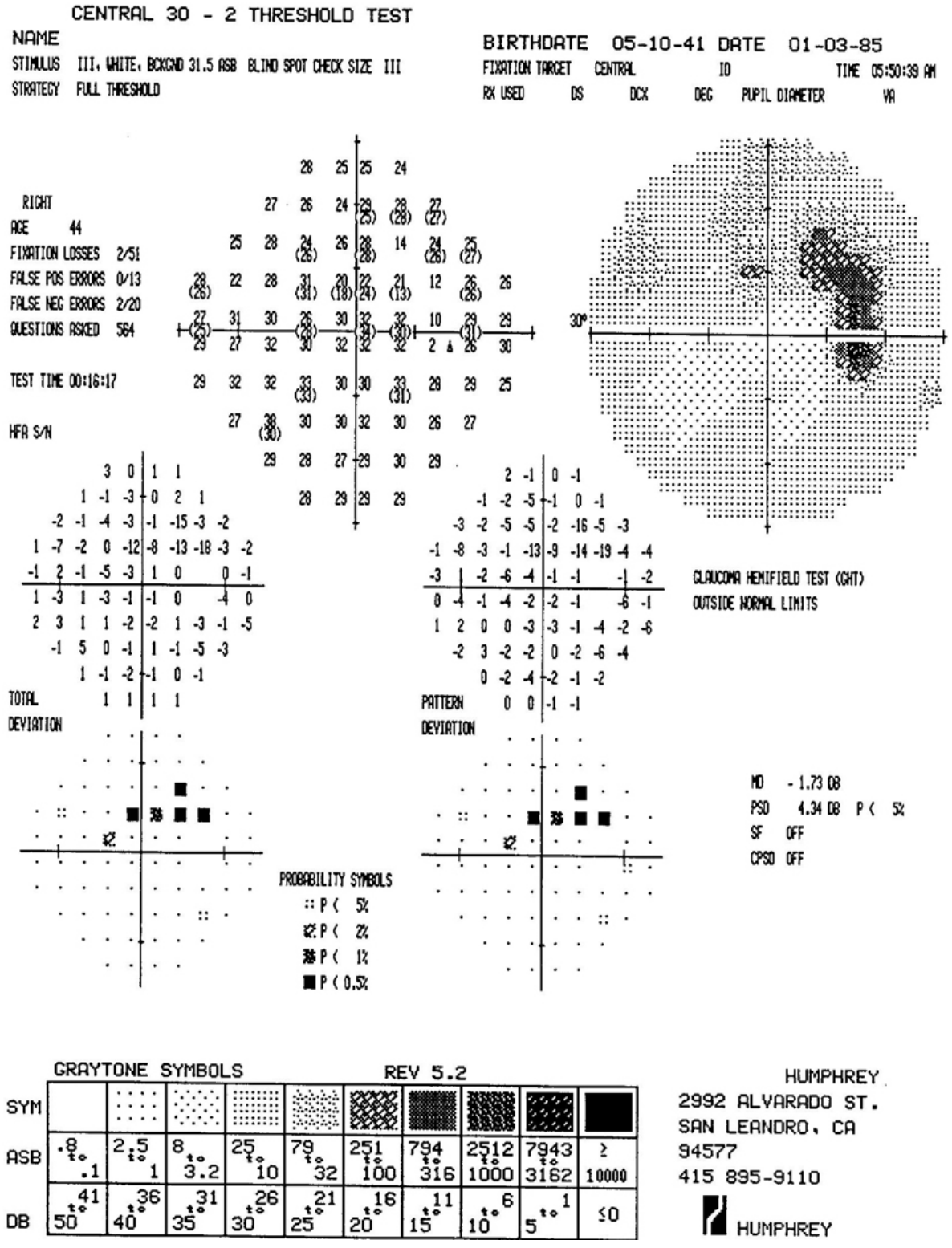


Figure 3–16. Enlarged blind spot.

Figure 3–17 shows the beginnings of a nasal step, which is a VF defect seen in glaucoma. It occurs when a blind spot occurs above and below the fixation point and meet in the nasal field and form a horizontal step-like defect. As the defect starts to spread from the optic nerve head, it begins to affect the retinal nerve layers.

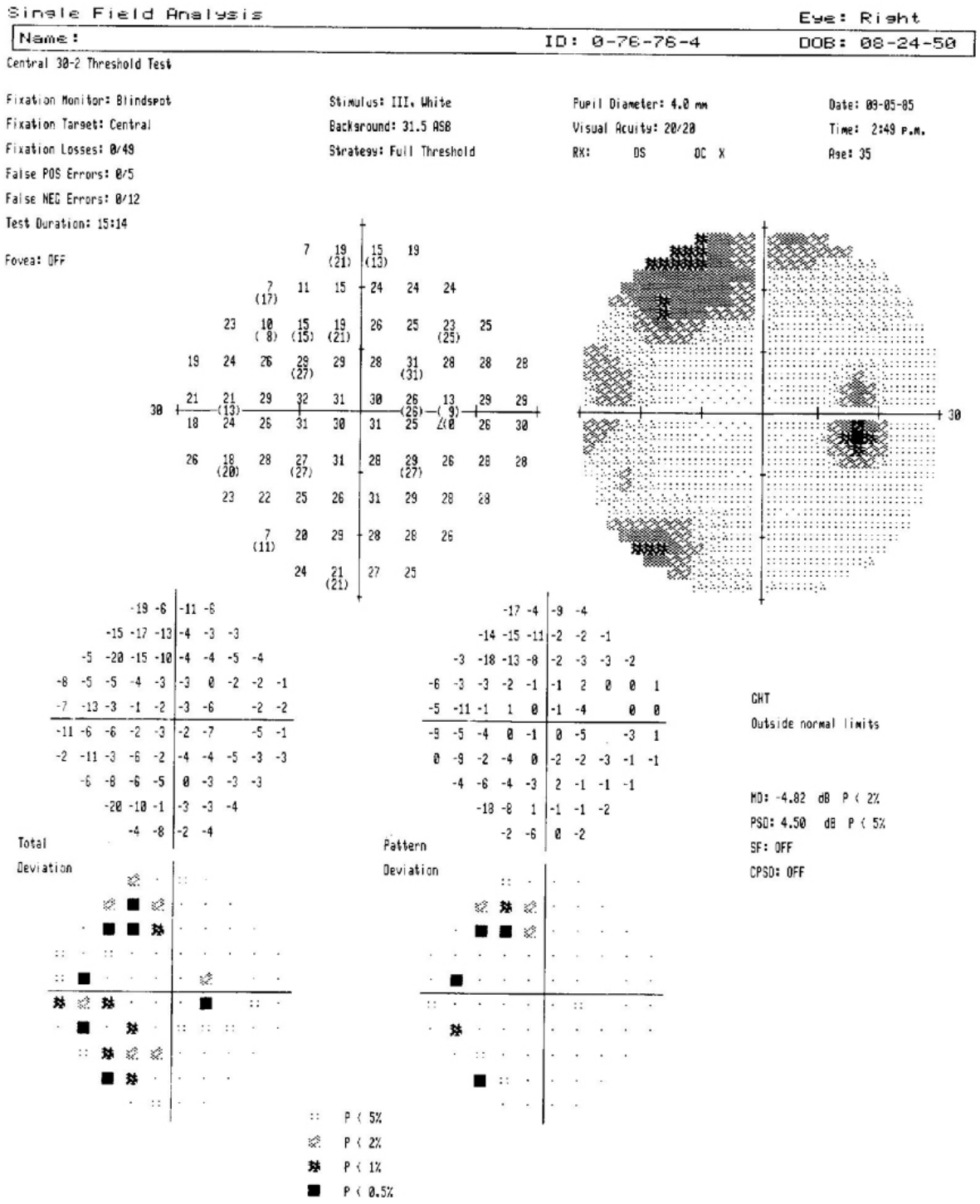


Figure 3–17. Nasal step.

Figure 3–18 represents a superior quadrantanopsia of the left eye.

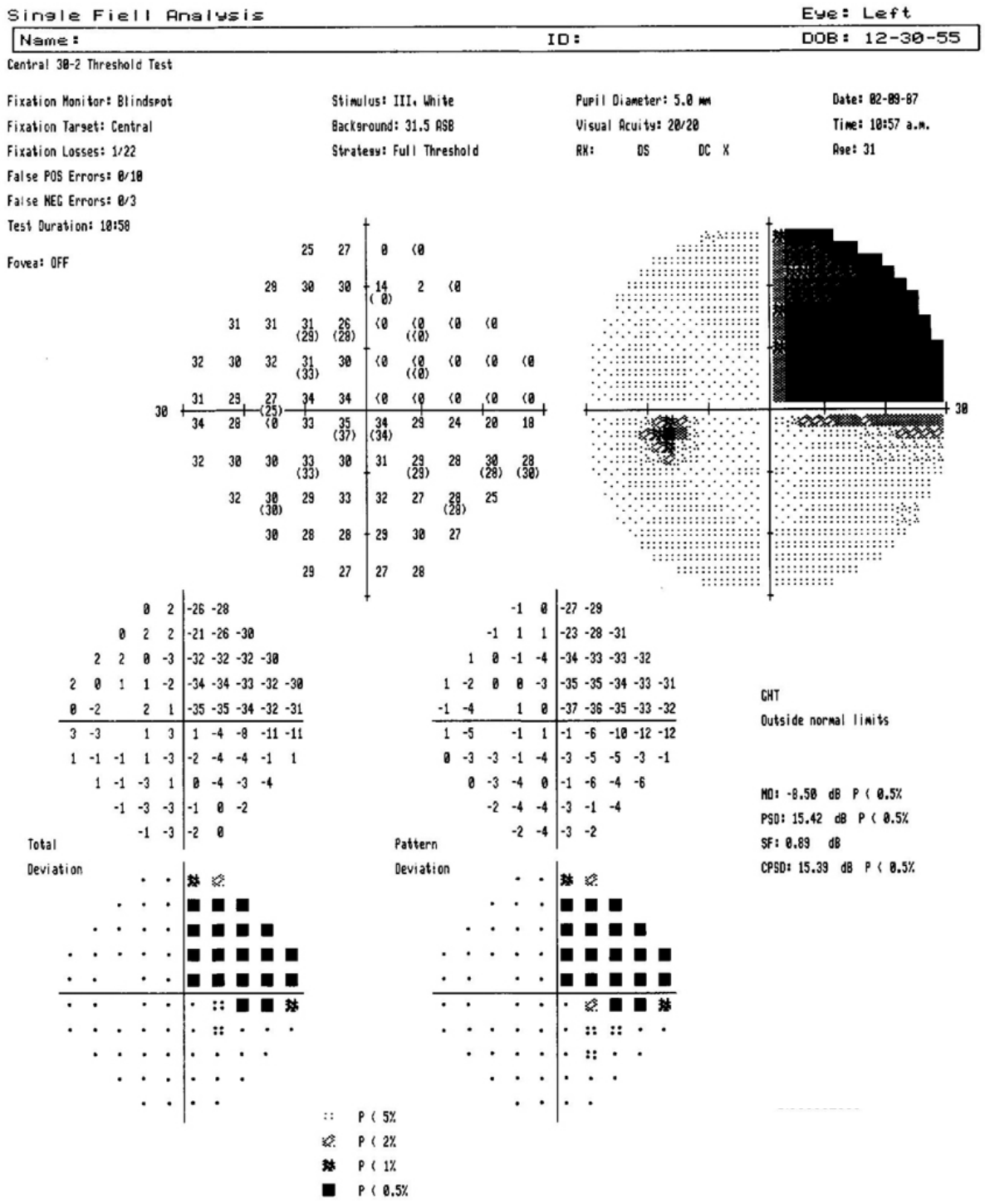


Figure 3–18. Quadrantanopsia.

Frequency-doubling technology

Frequency-doubling technology (FDT) is another way of screening patients for glaucoma and other ocular diseases. It's an efficient and compact, automated VF testing unit. Many clinics are using the FDT when screening patients because of its small size and very short testing time. On average, a patient can be screened in two minutes.

The following are some key features of the FDT:

- Easy to use.
- Pupil size is not a factor.
- Can be used in normal room lighting.
- Full threshold—about four minutes per eye.
- Unit automatically occludes eye not being tested.
- Supra-threshold screening—less than one minute per eye.
- No corrective trail lenses needed. Patients can wear their own glasses.
- Statistically significant correlation to the Humphrey® Field Analyzer.

615. Optical coherence tomography

Optical coherence tomography (OCT) is a noninvasive technique that images the internal structures of the eye. It uses light waves to take cross-sectional pictures of the anterior eye and retina (fig. 3–19).

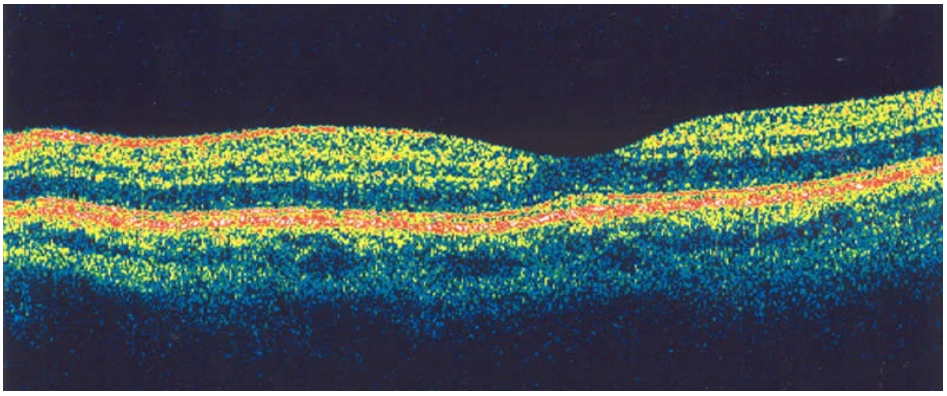


Figure 3–19. OCT scan showing a normal retina.

The OCT allows an optometrist or ophthalmologist to map and measure each of the retina's distinctive layers. Patients are more comfortable with OCT imaging over ultrasound, another technique that can capture internal images, because OCT is a noncontact testing device.

Knowing the thickness of these layers helps the provider with the diagnosis and treatment of glaucoma or retinal diseases, such as ARMD and diabetic retinopathy. Imaging of the retina also allows for the assessment of the optic nerve, any suspicious vitreo-retinal issues, and the macula (fig. 3–20).

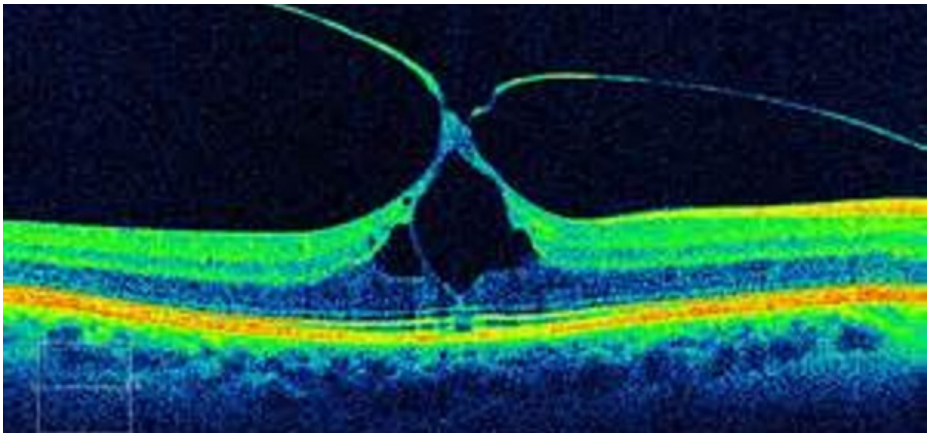


Figure 3–20. OCT scan showing macular degeneration.

An anterior segment OCT can capture images of the cornea, measure corneal thickness, and allow visualization of the anterior chamber angle and associated structures.

If your clinic is acquiring an OCT system, training should come from the distributor. If your clinic has previously had one, training should come from a knowledgeable, previously trained technician. Additionally, many companies offer webinars or online training sessions as well.

OCT system operation

To operate the system, the OCT should be in a room with no sunlight, ideally in a room with an adjustable dimmer switch. It should also be kept in a room with a stable temperature, as extreme temperature fluctuations can have an adverse effect on the system.

Your clinic will decide which scan protocols to use for assessment of the cornea, anterior chamber angle, optic nerve head, nerve fiber layer, and macula.

The provider may request that the patient's eyes be dilated prior to accomplishing an OCT. This makes it easier to scan and capture images of the retina. In an earlier CDC volume, we discussed how to instill ophthalmic medications. Should your provider request that you dilate a patient's eyes, ensure that you document the instillation of medications appropriately. For ophthalmic medications, document the following:

- The name of the medication.
- The form of the medication (if applicable).
    - Solution (sol).
    - Ointment (ung).
- The amount of medication.
    - Drop (gt) or drops (gtt).
    - mm.
- The location of medication instillation.
    - Right eye (OD.)
    - Left eye (OS).
    - Both eyes (OU).
- The time of medication instillation.

For example, if you anesthetized both eyes with 1 drop of alcaine at 1330 and then dilated both eyes with 1 drop each of tropicamide and phenylephrine a minute later, document the instillation of these medications as:

1 gt alcaine OU @ 1330

1 gt tropicamide OU @ 1331

1 gt phenylephrine OU @ 1331

To prepare a patient for OCT imaging, seat the patient in front of the machine on a steady chair (no wheels) that has a stable back. Adjust the table height and chin rest to make the patient as comfortable as possible. Then, enter the patient's demographic data, to include the first and last name.

The technician will activate the test requested by the provider. If this is the patient's first time accomplishing an OCT, his or her OCT results will be compared with the results of normal patients with similar characteristics (such as age). On subsequent OCTs, the patient's results are compared to his or her previous records. This comparison allows the provider to determine if there has been any deterioration between visits. Repeat OCTs allows the system's progression analysis software to compare image thickness calculations. These calculations can be used to monitor disease progression or a patient's response to treatment.

OCT uses

OCT is useful in diagnosing many of the following eye conditions:

- Glaucoma.
- Macular hole.
- Macular edema.
- Macular pucker.
- Diabetic retinopathy.
- Preretinal membranes.
- Central serous retinopathy.
- ARMD.

As previously mentioned, OCT is often used to evaluate disorders of the optic nerve. An OCT image can be helpful in determining changes to the fibers of the optic nerve, such as those caused by glaucoma.

OCT evaluations can accurately measure the thickness of the cornea. Corneal thinning can be a characteristic of keratoconus. Identifying undetected keratoconic conditions is valuable, since keratoconic patients who have laser vision correction may experience progressive corneal thinning and end up with a poor outcome from surgery.

For laser assisted in-situ keratomileusis (LASIK) surgery, an OCT anterior segment evaluation is helpful in measuring the thickness of the flap and the residual corneal bed postsurgery. This is essential since actual LASIK flap thickness versus intended flap thickness may vary.

Additionally, for photorefractive keratectomy (PRK), an OCT assessment can be useful in measuring the epithelial thickness postoperatively. Corneal thickening of the epithelium, known as epithelial hyperplasia, can occur after surgery, especially for PRK. Epithelial hyperplasia may explain why some patients have unexpected surgery results, with significant regression.

With repeat imaging, OCT provides a great overall tool that allows the optometrist or ophthalmologist to determine stability, improvement, or deterioration of any internal eye condition.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

613. Principles of automated visual field results

1. Define VF.

2. What are the normal monocular VF degrees from fixation?

3. What two important functions do VF testing satisfy?

4. Most chorioretinal field defects are monocular; however, what disease process (in the chorioretinal area) produces a characteristic binocular field defect?

5. In glaucoma, what is the most characteristic VF loss called?

614. Performing automated visual fields

1. What kinds of specific exams can the Humphrey® Visual Field Analyzer perform?

2. What parameters can be changed?

3. What are the two possible fixation targets you can use on a patient with a central scotoma?

4. The FASTPAC option decreases test time by how much?

5. What can the patient do to pause the test should he or she become fatigued?

6. What are the three indices of test conditions included on the printout that can assist the doctor in determining the reliability of the patient's results?

615. Optical coherence tomography

1. What type of waves does the OCT use to take cross-sectional pictures of the anterior eye and retina?

2. Why are patients more comfortable with OCT imaging over ultrasound?

3. Why should the OCT be kept in a room with a stable temperature?

4. What can the calculations from the OCT's progression analysis software be used to monitor?

5. What is the OCT helpful in measuring in LASIK patients?

3–2. Refractometry, Keratometry, and Corneal Topography

A technician capable of assisting the provider in all areas of clinical work is a more productive technician. A more productive technician leads to a more productive clinic. Utilized properly, a technician trained in basic refractometry skills can be a great asset to military ophthalmic care.

However, what exactly is meant by the term *refractometry,* and how does it differ from *refraction*? The term *refraction* is used both to define light being bent through different media and the process by which lens correction for a patient is determined. In this section, we use the term *refraction* to define the integration of two separate processes (refractometry and the use of clinical judgment) to arrive at a final spectacles prescription (if any) for the patient.

616. Refractometry and keratometry

Refractometry is the actual, physical process of measuring the refractive error of the patient's eyes. However, determining a patient's refractometry does not complete the patient's evaluation. The refractive error does not include such things as ocular health, muscle balance, occupational requirements, anisometropia, or any other factors. It cannot be stressed enough that the legal definition of refractometry focuses purely on the technical aspect of determining refractive error.

Clinical judgment

The process of clinical judgment is completely different from refractometry. Clinical judgment is the part of refraction that considers factors such as muscle balance, occupational requirements, vision impairments other than refractive issues, types of refractive errors, and so forth. Most legal definitions do not reference clinical judgment because ophthalmic technicians were not recognized as a category of healthcare providers when the law was written. However, it's the exercise of clinical judgment combined with the technical process of refractometry that completes the refractive exam. Because of this, only medical providers can provide clinical judgment.

Ophthalmic technicians can perform refractometry in preparation of the eye exam. Properly trained technicians can perform either automatic refractometry or retinoscopy, possibly refine their findings, and record the result. A doctor can then quickly recheck the result and write the final prescription. It takes some time before an ophthalmic technician achieves this level of functioning. In the end, though, the payoff is better-trained technicians, more productive ophthalmic clinics, and providers with more time to devote to quality eye care.

Objective refractometry

There are many pieces of equipment that can be used when performing refractometry. The equipment is categorized by the amount of patient input required to obtain the desired results. Refractometry can be performed through either objective or subjective means.

Objective refractometry tests are conducted without any patient input to obtain the refractive measurements. Examples of this would be the retinoscope or the automatic refractometer. Neither one of these methods require patient input.

The phoropter's role in objective refractometry

Another way to perform objective refractometry is by using a streak retinoscope and a phoropter. While a spot retinoscope can be used, the streak retinoscope is the most prevalent instrument in use today for manual retinoscopy.

The phoropter (fig. 3–21) is used to provide the lenses utilized in retinoscopy. The phoropter is placed in front of the patient's eyes.

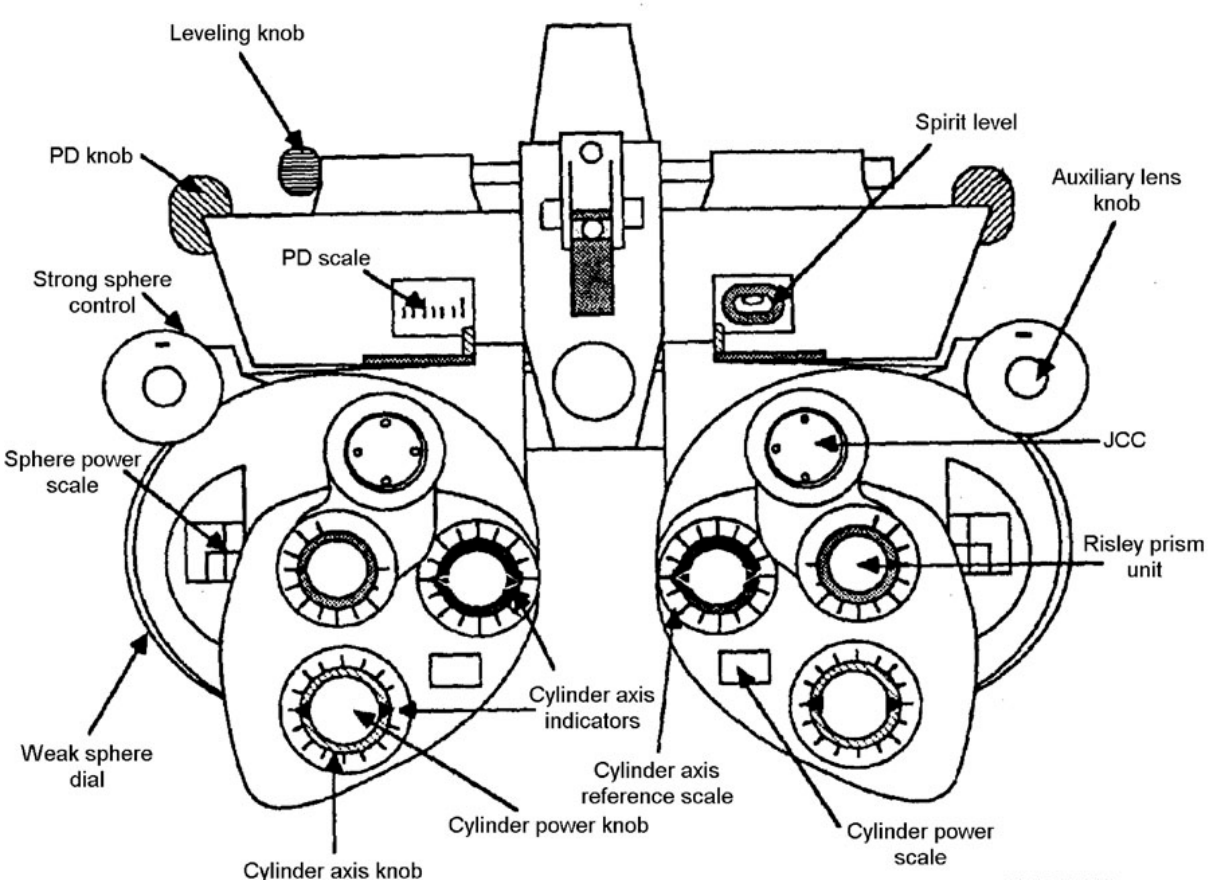


Figure 3–21. Phoropter.

The phoropter is one of the most well-known instruments in the eye clinic. It's a highly specialized piece of equipment allowing the fast and accurate trial of virtually any lens correction.

Its primary use during subjective refractometry is in allowing the examiner to present various lens combinations to the patient for his or her input.

In objective refractometry, a phoropter is used in conjunction with a retinoscope to achieve "neutrality." When you shine a retinoscope into a patient's eye, the light is reflected back into the retinoscope and seen by the technician or provider. Depending on the retinal reflex (RR) seen through the retinoscope (fig. 3–22), a trained ophthalmic technician or optometrist can dial in plus-or-minus lenses from the phoropter until neutrality is reached.

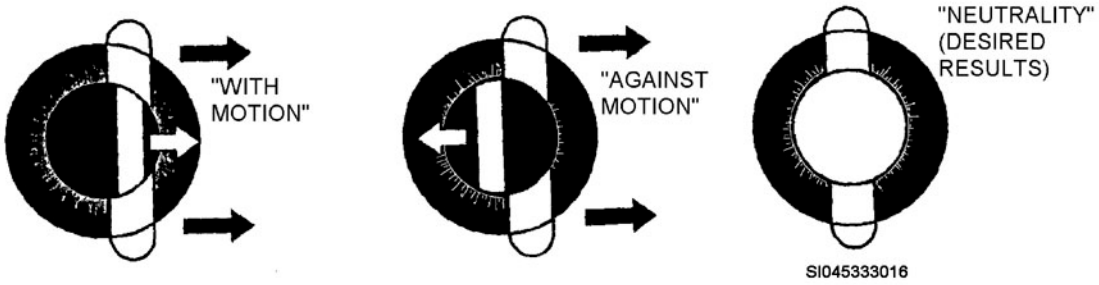


Figure 3–22. With and against motion.

If you see “with motion” (fig. 3–22) through the retinoscope, the patient is farsighted and you will need to dial in plus power. You do so by increasing the plus power by +0.25D steps using the sphere power dial on the side of the phoropter. You continuing adding plus power until the “with motion” is neutralized. It may be helpful to add plus power until the RR is “against motion”, and then dial in minus power in –0.25D steps until the RR is neutralized and there is no motion.

If you see “against motion” (fig. 3–22), the patient is nearsighted and you’ll need to dial in minus power in –0.25D steps until the motion is neutralized. As before, it may be helpful to add minus power past the neutralization point until “with motion” is seen and then dial in plus power in +0.25D steps until the motion is neutralized.

If you rotate the streak 180°, you can also use the retinoscope and phoropter to find the astigmatism power and axis. Because virtually any lens combination can be presented, the final refractive measurements from refractometry performed with a phoropter are extremely accurate.

The autorefractor’s role in objective refractometry

There are basically three types of autorefractors:

1. Subjective.
2. Objective.
3. Combination objective/subjective.

Since the subjective and objective/subjective combination autorefractors require feedback from the patient and greater skill on the part of the technician, most clinics use the objective autorefractor. Given this fact, we’ll narrow our discussion to the objective autorefractor.

NOTE: The terms “objective autorefractor” and “autorefractor” are used interchangeably for the remainder of this lesson.

The objective autorefractor uses infrared light to automatically refract the eye much in the same way a retinoscope does. As with a retinoscope, light is projected into an eye, and the movements of the light’s reflection from the eye are neutralized (eliminated) with lenses. Once the light reaches a “neutral balance,” an objective estimate of the correction needed is assessed.

The operation is simple and results are fast. Most work on the same principle as NCT—line up the target and point, shoot, and wait for the results. All of this takes place in just a few seconds, per eye. As an added bonus, some autorefractors come equipped with an autokeratometer, two measurements with one shot.

In patients with healthy eyes and medium-sized pupils, the results are good. Any time a patient has opacities in the ocular media (e.g., immature cataracts or significant scaring) or pupils smaller than 3 mm, the accuracy decreases dramatically. As with any screening tool, the results from the autorefractor should be considered as preliminary only. While the screening tool results are good enough to establish potential changes in a patient’s Rx and monitor postoperative refractions until they stabilize, these preliminary measurements are not solely sufficient for writing a Rx. Refinement is still needed (this is where *clinical judgment* comes in) before a Rx can be determined.

Objective autorefractors are not without their problems, however. Such things as not being able to maintain alignment with the eye and instrument myopia can make for a frustrating experience. While alignment problems should not be new to you, the term “instrument myopia” may be.

Manufacturers have taken great pains to produce images of optical infinity within the machine, but patients still perceive themselves as “looking into a box.” When this happens, some patients’ eyes naturally accommodate to adjust for the “near” view inside the box. The result is a reading with too much “minus” power. For instance, the autorefractor may produce a reading of –1.50D, when in actuality, the patient requires only –1.00D of correction. This is a case of instrument myopia.

In addition to the D shift created by instrument myopia, the autorefractor itself is generally off by ±0.25D in 80 percent of the patients tested. While it's true that ±0.25D is a relatively small discrepancy, it's not always obvious if the discrepancy is in the sphere or cylinder portion of the Rx.

Keratometry

Keratometry is defined as the measurement of the central anterior curvature of the cornea. The keratometer is useful in eye examinations, especially for detecting and measuring corneal astigmatism.

The measurements gained from keratometry can be used to assess the curvature and power of the cornea, to judge the integrity of the corneal and tear surface (dry eye screen), and to follow the progress of patients with corneal distortion (e.g., keratoconus). Additionally, the keratometer readings are useful for CL fittings, since corneal curvature directly relates to the base curve of a CL.

Automated refractometry/keratometry

A combination automatic refractor/keratometer contains image-processing technology to obtain accurate refractor and/or keratometer measurements of a patient's eyes. It quickly acquires precise data, generating a starting point for the provider during a subjective refraction and providing keratometry readings of the patient's eyes.

The following information covers the proper use of the Nidek TONOREF II™ autorefractor/ keratometer. If your clinic uses a different type of equipment, refer to the operator's manual for its operating procedures.

Steps to Operate the Nidek TONOREF II™ Autorefractor/Keratometer	
Setup:	
1.	Ensure the test is NOT performed under bright lights or in direct sunlight.
2.	Use an alcohol pad to clean the chin and forehead rests.
3.	Ensure the travel lock is disengaged.
4.	Turn the instrument on.
5.	Seat the patient comfortably in front of the instrument. Adjust the table height to an appropriate level for the patient.
6.	Explain the procedure and purpose of the test to the patient.
Procedure:	
1.	For safety purposes, always keep one hand on the instrument.
2.	Set the instrument to R/K mode by pressing the mode button (RKT) at the top left until the box (NT) disappears and the box (R/K) remains. If both boxes are shown (R/K)(NT), the machine will take refraction and keratometry readings first, then switch to tonometry mode.
3.	Ensure the tracking and measurement is set to automatic (3D)(A). If it is not, press the auto button (an A surrounded by arrows) until the boxes for 3D/A are shown at top.
4.	Pull the stage back as far as possible and have the patient place his or her chin in the chin rest and forehead against the forehead rest.
5.	Raise or lower the chin cup so the patient's outer canthus is aligned with the canthus marker using the up/down chin-rest arrows.
6.	Have the patient close his or her eyes. Press down on the safety stopper button and move the tonometer forward until you are 5 mm from the patient's right eyelid. Release the safety stopper and move the machine back again. This sets the forward limit of the machine.
7.	Instruct the patient to open his or her eyes and fixate on the blinking green light when it comes into view.
8.	Carefully move the stage forward until the image of the patient's right eye appears on the monitor.
9.	In the monitor you will see five white dots on the patient's eye.

Steps to Operate the Nidek TONOREF II™ Autorefractor/Keratometer	
Procedure:	
10.	Center the target in the circle using the joystick (fig. 2–8).
11.	Adjust the machine so the middle light is in the center of the alignment circle. a. Rotate the joystick to adjust the vertical position. b. Move the joystick to the left or right to adjust the horizontal position. c. Move the joystick forward or back to adjust the focus.
12.	When moving the machine forward or backward, alignment hashmarks may appear. a. Green hashmarks below the target indicate you need to move forward. b. Purple hashmarks above the target indicate you are too close and must move backward. c. The warning message “TOO CLOSE” will appear if you go too far forward. d. You may also have large red arrows directing you to move the machine up, down, left or right.
13.	If you engaged the automatic tracking and measurement feature in step 3 above, once you have the proper alignment, the blue target will change to yellow (fig. 3–23) and the machine will automatically take a reading. You will still need to move the machine forward and/or backward to get the initial focus. On manual mode, you will have to press the button on the joystick to take a reading.
14.	Repeat the procedure for the other eye.
15.	If the pressure reading is 21 mm Hg and below, proceed to the next step. If the pressure is more than 21 mm Hg, or there is a difference of 4 mm Hg or more between the two eyes, take two more readings in each eye and inform the doctor.
16.	Engage the travel lock in the back left position.
17.	Print the results. To record the results, staple the printout to the exam form or transcribe the data to appropriate locations on the exam form.

Figure 3–23. Nidek TONOREF II™ blue to yellow target alignment change.

617. Corneal topography

Corneal topographers allow us to precisely analyze the radius of curvature and refractive power at thousands of points across the cornea. This is a distinct advantage over the keratometer, which only measures four points. Since the four measured points of a keratometer are located within 3 mm of the optic zone of the cornea, it has many limitations. The topographer measures a much wider area and is an excellent tool for refractive surgery since it measures such a broadened area.

Since the Humphrey® ATLAS™ Corneal Topography system is the instrument that most clinics have, we'll discuss the topographic maps it has available. If you have another brand, please refer to your owner's manual for map descriptions associated with your instrument.

Humphrey® ATLAS™ Corneal Topography system

The ATLAS system has four basic maps:

1. Curvature.
2. Refractive power.
3. Elevation.
4. Irregularity.

Each map can show different things about the cornea and may have different degrees of sensitivity to the pathology or condition being evaluated. No map is the "best," but combining the information from all the maps gives an overall picture about the curvature, refractive state, shape, and quality of the cornea's surface.

Depending on your doctor and the needs of the patient, you may print only one or a few maps. In other cases, you may be printing most if not all of the following maps.

Curvature maps

Curvature maps display the surface curvature of the eye—how fast the surface bends at a certain point in a certain direction. There are two different types of curvature maps: axial and tangential.

Axial map

The axial map is used to describe the sagittal readings in corneal topography. The axial map shows the cornea's curvature measured in diopters (D) and is the most commonly used map. The axial map is a simple description of the cornea's overall shape.

Tangential map

The tangential map is much more sensitive to immediate changes on the corneal surface and can show with much greater sensitivity transitions occurring on the cornea. The tangential map is best when used for locating or identifying corneal pathology, such as keratoconus. In evaluating keratoconus, the exact apex of the cone needs to be established, as the exact point is important in determining quality of vision.

Refractive power map

As the name implies, the refractive power map shows the power of the eye in its refractive state, measured in diopters. The portion of the refractive power map of most importance is related to the central cornea over the patient's pupil. The refractive power map is useful in evaluating visual performance after refractive surgery. A comparison of power postoperatively and the amount of correction desired can be made. The surgeon then has a much better indication of how the surgery affects the visual potential of the cornea.

Elevation map

This map describes the differences in elevations of the cornea. The differences are extremely small; in fact, the differences are measured in microns (µm). The advantage of measuring in microns is small elevations and depressions on the cornea can be carefully documented. This detailed analysis is not possible with other maps.

Irregularity map

Surface irregularity on the cornea is shown when using this map. The biggest benefit of the irregularity map is the ability to define and quantify which areas are most irregular. This can help quantify distortions affecting a patient's quality of vision.

Pathology detection

A key function to a corneal topography system is highlighting conditions of the cornea and associated irregularities. The provided information gives providers insight to the visual problems associated with different conditions.

A brief summary of the uses of corneal topography in disease detection is detailed below:

- Patient follow-up—examine the disease process over time to determine whether a condition is worsening or stabilizing.
- Early detection—identify early indication of pathological condition. This may help tell which course of action is appropriate for each patient.
- Identify poor fitting contacts—identify distortion from poorly fit CLs. With this information, new lenses can be ordered and properly fit.

Performing corneal topography

Corneal topography has many advantages over keratometry and is used more often in clinics. If your clinic has the Humphrey® ATLAS™ Corneal Topography system, the steps below will help you to become familiar with the unit. So, when the doctor asks for topography on a patient, you're ready.

1. Turn on the machine.
2. Select the ATLAS™ software icon.
3. For User Name, you can select "Atlas Operator" from the dropdown menu; there is no password. Then select OK.
4. Search for an existing patient or add a new patient.
5. Select Screening from the Parameter Set.
6. To take a measurement, use the joystick to focus on the eye. Do this by slowly moving the joystick forward so that it moves the camera closer to the eye.
7. Move the joystick in small movements forward and backward to focus the mires until they are as evenly spaced and circular as possible (fig. 3–24[A]).

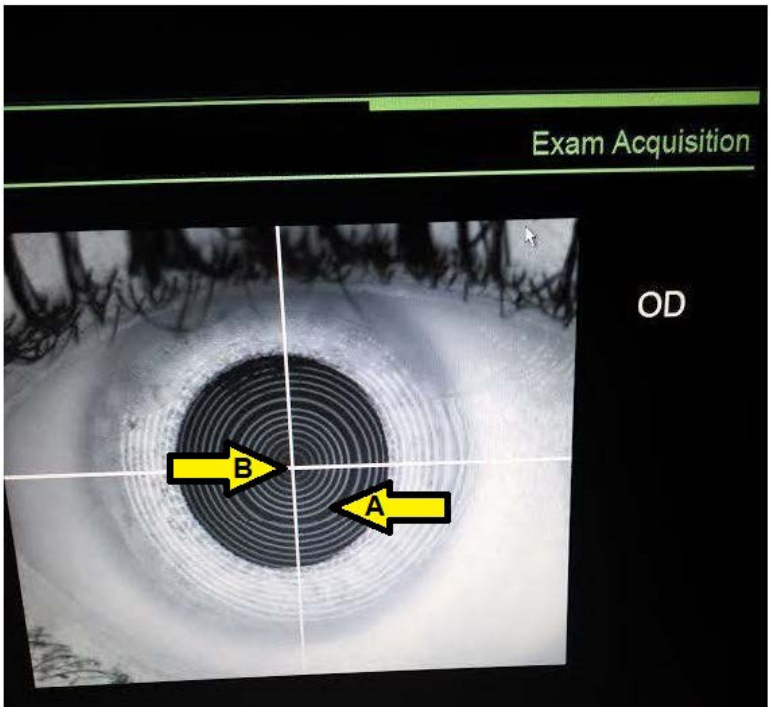


Figure 3–24. Focusing mires on the eye during topography.

8. Spin the handle and make small movements with the joystick until the crosshairs are centered on the pupil (fig. 3–24[B]).
9. Once the mires are aligned and the crosshairs are centered, click the button on the joystick to capture the image.
10. The captured images will appear. Save the images by clicking on Save under each image (fig. 3–25[A]).

Figure 3–25. Captured images during topography.

11. Select Acquire Another to repeat the process and capture images for the left eye (fig. 3–25[B]).
12. Once both eyes have been completed, select Done (fig. 3–25[C]).
13. Click the OK button for the next three pop ups, which brings you to a print window. Select Print to print your images.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

616. Refractometry and keratometry

1. Define refractometry.

2. What does the legal definition of refractometry focus on?

3. What makes up a refractive exam?

4. Refractometry can be performed through which two means?

5. What type of patient input does objective refractometry require?

6. The phoropter is used to provide what in retinoscopy?

7. If you see “with motion” through the retinoscope during retinoscopy, you will need to dial in what type of power from the phoropter? In what increments?

8. Name the three types of autorefractors.

9. Which type of autorefractor is used in most clinics?

10. How does an objective autorefractor automatically refract the eye?

11. In 80 percent of patients, the results given by the autorefractor are off by how many diopters? Is this discrepancy with the sphere or cylinder portion of the prescription?

12. Define keratometry.

13. For what three things can keratometry measurements be used?

617. Corneal topography

1. What does the corneal topographer allow us to analyze?

2. What are the four basic maps of the ATLAS™ system?

3. Summarize the uses of the corneal topographer.

3–3. Additional Specialty Testing

The ability to use the applanation tonometer is a highly valued skill. To use the applanation tonometer, you must also operate the slit lamp with some degree of skill. While these may be new and intimidating instruments to you, this section may remove some of your apprehension about using them.

Furthermore, this section includes instruction on ophthalmic photography, which is an excellent tool for documenting ocular conditions and the appearance of various ocular structures. You may find photography to be a lot of fun.

Finally, the section concludes by covering additional testing procedures to include measuring pupil size, performing pachymetry, and measuring NPC, to name a few.

618. Operating the slit lamp and performing applanation tonometry

The slit lamp should be used in all cases of red eye, ocular pain, sudden onset of blurred vision, and ocular trauma. It's an invaluable tool in the diagnosis of anterior segment eye disease, corneal trauma, foreign body, keratitis, iritis, angle-closure glaucoma, and cataracts.

A slit lamp is used to illuminate and examine, under magnification, the anterior and posterior segments of the eye. It consists of a binocular microscope, a movable light source, and patient chin and head rests. The slit lamp has various lenses, so depending on which structure of the eye needs to be examined, magnification can be changed.

Using a slit lamp, the observer can binocularly view the following components of the eye for disease and injury occurring in these areas:

- Iris.
- Sclera.
- Retina.
- Cornea.
- Macula.
- Choroid.
- Vitreous.
- Optic nerve.
- Conjunctiva.
- Lids and lashes.
- Crystalline lens.
- Anterior chamber.

Attachments can be added to the slit lamp, providing for applanation tonometry, videography, and photography. Other attachments, such as the Hruby lens, permit the examination of intraocular structures like the vitreous body, optic nerve, and retina. You can also add a teaching tube so a second observer can also view the examination.

Slit lamp basic components

Although slit lamps vary considerably from one manufacturer to another, the major components in all of them are similar (fig. 3–26). The lamp's major components are: illumination arm, microscope arm, and the slit lamp position controls.

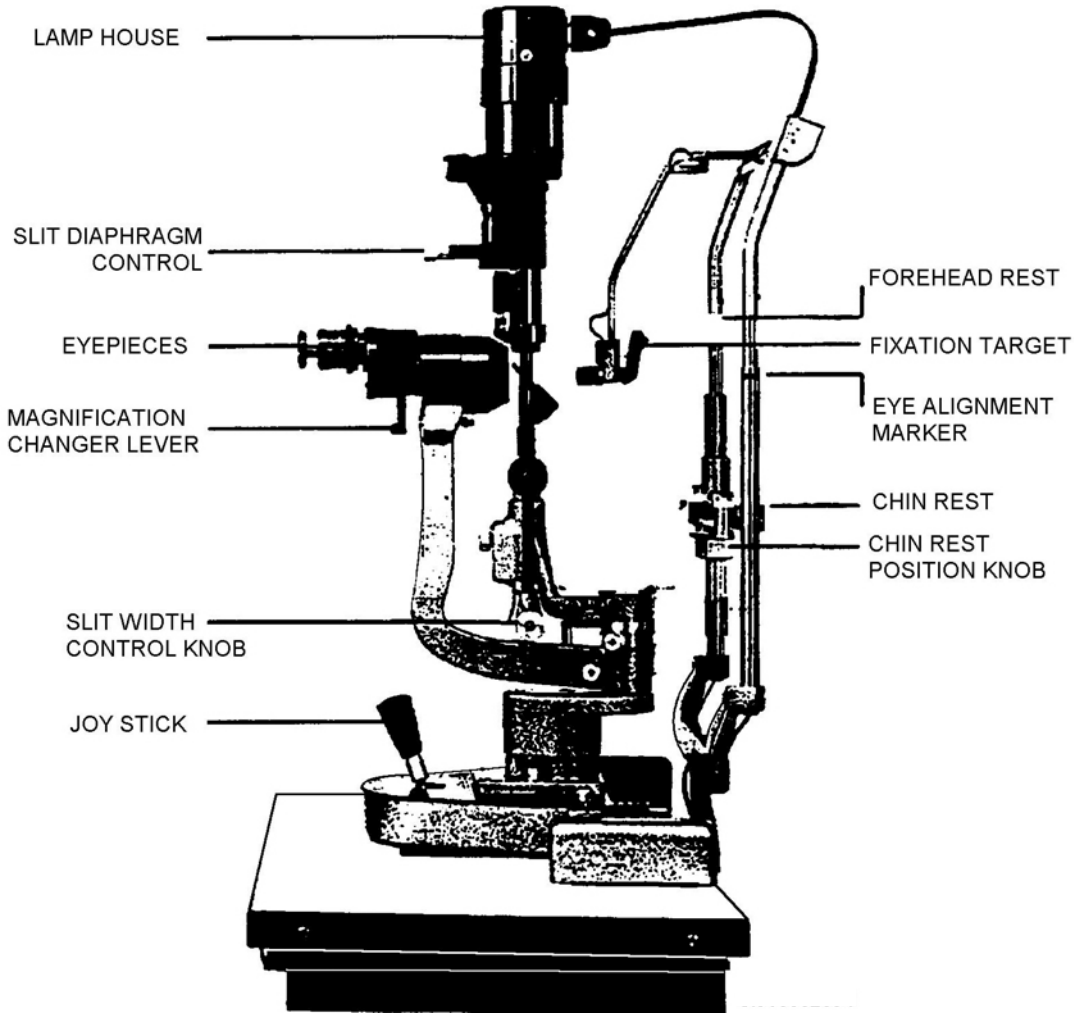


Figure 3–26. A slit lamp.

Illumination arm

The illumination arm contains the illumination system. From the straight-ahead position, the angle of the arm can be varied 0–90°. The illumination arm has three main components: 1) slit controls, 2) click stop, and 3) filters.

Slit controls

The slit (beam of light) can be adjusted vertically and horizontally. There are two size controls: one size control varies the slit width, and the other size control varies the slit height. There is also a control that varies the orientation of the beam.

Click stop

The click stop alters the position of the reflecting mirror to adjust the angle of the beam with respect to the viewing system. When the mirror is "in click stop," the focus of the slit beam corresponds with the focus of the viewing system.

Filters

The filters are used to alter the appearance of the slit beam. The majority of slit lamp models contain a cobalt blue filter, a green or red-free filter, and at least one neutral density filter.

Microscope arm

The microscope arm contains the viewing system. The viewing system consists of the objective and ocular lenses. Although the microscope arm is normally kept in the straight-ahead position, the angle of the arm can be varied. The microscope arm has two main components: oculars and a magnification changer.

Oculars

The oculars can be adjusted to match his or her PD as well as the technician's or doctor's refractive error.

Magnification changer

The magnification changer allows you to adjust the magnification. You can increase the magnification power of the objective from 6× to 40×. . Magnification of about 15× is the normal setting for routine use.

Slit lamp position controls

The two primary controls to a slit lamp are a joystick and an elevation knob. However, these may be a single control or two separate controls. They are located on the instrument base.

Joystick

The joystick controls the left, right, forward, and backward movement of the slit lamp. The forward and backward movements control the focus of the slit lamp. On some instruments, the joystick also acts as the elevation knob.

Elevation knob

The elevation knob controls the vertical alignment of the microscope.

Set-up procedures

Prior to performing a slit lamp exam, ensure the patient and all instrumentation are set up properly. The following steps should help in this process:

1. The patient should not wear correction when being examined except when a CL evaluation is performed.
2. Room lighting should be dim.
3. Adjust the instrument table to a comfortable height for both the patient and you.
4. Set the reflecting mirror at the click-stop position.
5. Have the patient place his or her chin in the chin rest and forehead against the forehead rest.
6. Line the patient's lateral canthus up with the eye-level marker by adjusting the chin rest.
7. Set the magnification on a low setting (this is also the setting used for the initial exam). Do not use any filters at this point.
8. Have the patient close both eyes. Focus the oculars by turning them all the way counter-clockwise (the highest plus setting) and slowly focus on the patient's eyelashes by turning the oculars clockwise. Stop as soon as you see the first clear image. Do this one at a time for proper adjustment of the oculars for each of the patient's eyes.
9. Adjust the width of the oculars so that they match your PD. Doing so allows for a binocular viewing.
10. Use one hand to operate both the joystick (to align and focus the microscope) and the elevation knob (to align the microscope) and the other hand to operate the slit controls, to vary the angle between the lamp and the microscope, and to open the patient's eyelids, as needed.

Technique for performing a slit lamp examination

The anterior segment of the eye is usually examined in an anterior to posterior sequence. The structures are generally examined in the following order: (1) lids and lashes, (2) conjunctiva, (3) cornea, (4) anterior chamber, (5) iris, and (6) crystalline lens.

Lids and lashes

1. Start with the illumination arm approximately 30° from the straight-ahead position and use diffuse illumination. (Diffuse illumination is generally gained by using a diffuser filter attached to the slit lamp.)
2. Set the magnification on a low setting.
3. Have the patient close both eyes. Scan across the upper lid and lashes.
4. Have the patient open both eyes. Scan across the lower lid and lashes. Pay close attention to the tear film, the placement of the lid in relation to the globe, and the openings of the meibomian glands.

Conjunctiva

1. Use a wide beam with the illumination arm set at approximately 30° from the straight-ahead position.
2. Keep the magnification on a low setting.
3. Have the patient open both eyes and look up.
4. Let the patient know you're going to touch his or her lower lid. Place your index finger close to the patient's lower-lash margin and gently evert the lower lid. (This can also be done with a cotton swab.) Scan the inferior palpebral and bulbar conjunctiva. Look for anything out of the ordinary, such as elevations, depressions, or discolorations. Also evaluate the openness of the inferior punctum.
5. Next, have the patient look down.
6. Let the patient know you're going to touch his or her upper lid. Place your thumb close to the upper-lash margin and elevate the lid. (Once again, this can be done with a cotton swab.) Scan across the superior bulbar conjunctiva.
7. Have the patient look first to the left and then to the right, while you scan across the nasal and temporal bulbar conjunctiva.
8. If indicated, evert the upper lid. This is usually done when checking for FBs suspected of being imbedded in the upper lid or when checking a CL patient for giant papillary conjunctivitis (GPC).

Cornea

1. Use a narrow beam, approximately 1–3 mm wide. Set the illumination arm approximately 30–45° from the straight-ahead position.
2. Set the magnification on a medium level setting (16× or 20×).).
3. Have the patient look straight ahead. Scan across the central portion of the cornea. Look for any opacities (areas not reflecting light) or irregularities.
4. After you reach the apex of the cornea, swing the illumination arm to the other side. Be careful not to miss scanning part of the cornea when you move the illumination arm. If necessary, back up slightly after shifting the arm.
5. Have the patient look down. Let the patient know you're going to elevate the upper lid. Scan across the superior one third of the cornea. Remember to shift the illumination arm when you reach the corneal apex.

6. Have the patient look up. Let the patient know you're going to pull down the lower lid. Scan across the inferior one third of the cornea. Once again, shift the illumination arm when you reach the apex.

Anterior chamber

The following technique for estimating the depth of the anterior chamber angle is the Van Herrick technique:

1. Either set the illumination arm 60° to the temporal side of the patient's line of fixation, or set the illumination arm 30° to the temporal side and the microscope 30° to the nasal side, for a 60° total angle.
2. Set the magnification at a medium level.
3. Narrow the beam to an optic section.
4. Have the patient look straight ahead.
5. Focus the light sharply on the cornea at the very edge of the temporal limbus.
6. Compare or contrast the thickness of the "shadow" formed on the iris (representing the depth of the anterior chamber) to the width of the optic section (representing the thickness of the cornea).

   NOTE: The "shadow" is actually a dark interval between the light on the cornea and the light on the iris, which represents the optically empty aqueous in the anterior chamber.

Iris

1. Use a wide beam and set the illumination arm 30–45° from the straight-ahead position.
2. Set the magnification setting on medium.
3. Scan across the iris surface. Look for any irregularities. While scanning, note the pupillary light reflex; the pupil should constrict when the slit beam reaches the pupillary margin (unless the patient has been dilated).

Crystalline lens

1. Use a narrow beam and set the illumination arm to 20–30° from the straight-ahead position.
2. Set the magnification setting on medium.
3. Slowly move the slit lamp closer to the patient until the light is directed through the pupil and becomes sharply focused on the anterior surface of the lens. Continue to slowly move the biomicroscope closer to the patient to examine the deeper layers of the lens.
4. Focus on the posterior surface of the lens. Look for any opacities or discolorations within the lens.
5. Swing the illumination arm to the opposite side, set at the proper angle, and again examine the lens from the anterior to posterior surface.

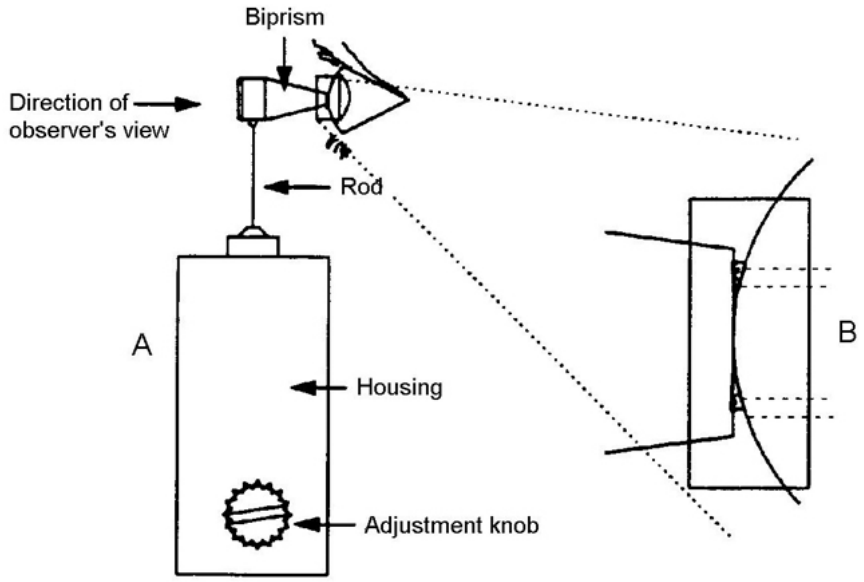
Recording the results

When recording the results, follow these steps:

1. Record each eye separately.
2. List each structure evaluated.
3. Record the results. This does not necessarily mean only the abnormalities but any findings within normal limits (WNL).
4. If it would enhance your description, create drawings to make your findings more clear.

Applanation tonometry background

The most prominent attachment found on the slit lamp is the Goldmann applanation tonometer (fig. 3–27).



Goldman type of applanation tonometry. A, Basic features of tonometer, shown in contact with patient's cornea. B, Enlargement of A shows tear film meniscus created by contact of biprism and cornea

Figure 3–27. Goldmann applanation tonometer.

In the world of ocular tonometry, the Goldmann applanation tonometer is the most accurate instrument for measuring intraocular pressure. Originally, the Goldmann applanation tonometer could only be used in conjunction with a slit lamp; however, hand-held applanation tonometers are quite common now, representing portable technology.

Applanation tonometry works by corneal flattening. The amount of pressure it takes to flatten a 3.06-mm diameter circle of cornea equals the IOP. The higher the IOP (the harder the eye), the more pressure it takes to flatten the cornea. The key here is the cornea is flattened and not indented as in other tonometric methods.

In methods using corneal indention, a larger diameter of the cornea is indented than with applanation methods. Thus, varying degrees of scleral rigidity directly affect IOP readings. This is less of a factor with obtaining accurate results with the Goldmann.

Set-up procedures

When setting up the slit lamp, follow these steps:

1. Set up the slit lamp in the same manner as for normal slit lamp use.
2. Set the magnification on the low (10×) or medium (16×) setting.
3. Explain the procedure to the patient. Example: “Sir/ma’am, I am going to be checking the pressure in your eyes. Before I can actually do so, I need to put a drop of medication in your eyes.”
4. Either instill one drop of an anesthetic with liquid fluorescein (Fluress®) in the patient’s lower fornix (fig. 3–28), or use a topical anesthetic with fluorescein strips. If you use the strips, instill the anesthetic first, then wet the fluorescein strip with a drop of sterile saline and have the patient look up while you pull down the lower lid; touch the moistened end of the strip to the inferior bulbar or palpebral conjunctiva.

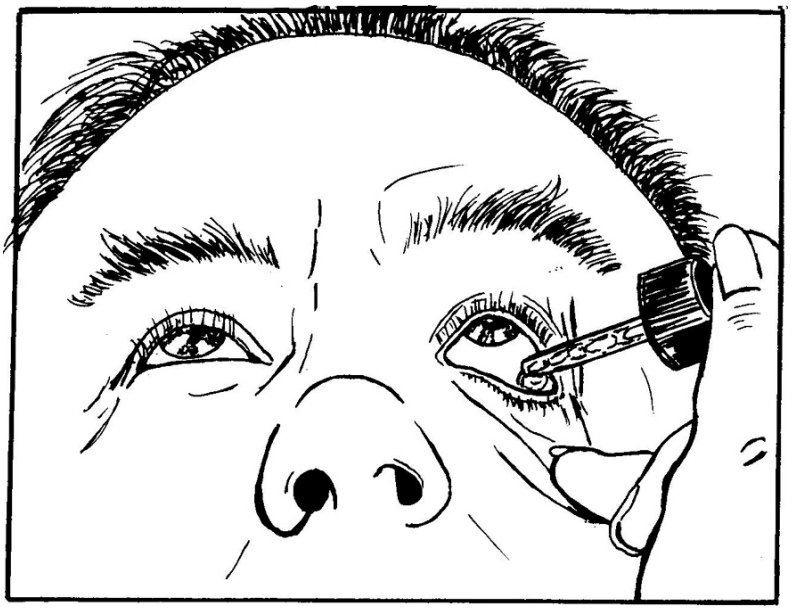


Figure 3–28. Instillation of Fluress®.

5. Using the cobalt blue filter with the illumination set at the highest setting, scan across the cornea to check for pre-existing corneal staining prior to performing tonometry. If the patient has a sufficient abrasion or scar, the results may not be as accurate.

Technique for performing applanation tonometry

The steps for applanation tonometry follow:

1. Move the light source, with the cobalt blue filter still in place, to the appropriate side. If you are doing the right eye, the light source is on the left side at a 60° angle while the microscope is directed straight ahead.

   NOTE: Use the cobalt blue filter when taking pressure readings with the Goldmann applanation tonometry.

2. Rotate the applanation prism to align the “0” or “180” with the white marking on the prism holder (fig. 3–29).

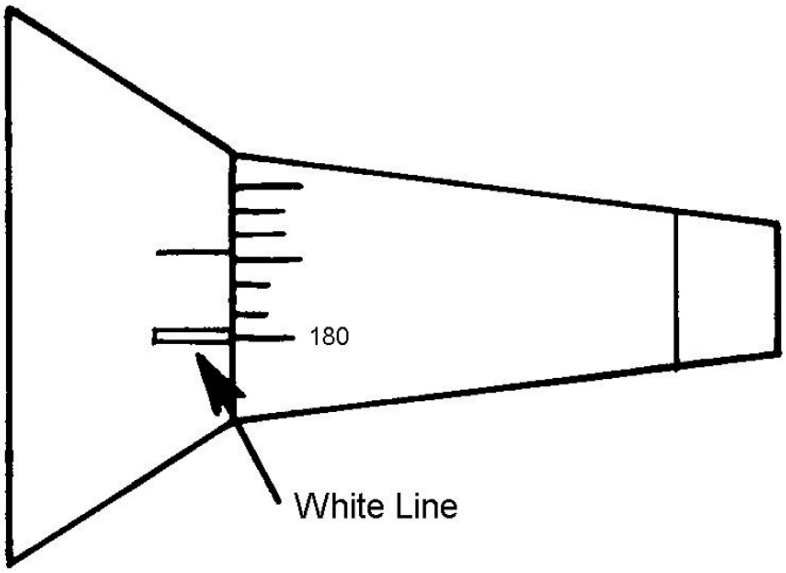


Figure 3–29. White mark on prism holder.

3. If the patient has 3 diopters or more of astigmatism, rotate the prism until the red mark on the prism holder is aligned with the axis mark corresponding to the patient's minus cylinder axis (fig. 3–30). Remember your optical cross? Setting the tonometer tip axis at this point ensures the flattened area needed to gain an accurate tonometer reading. Example: if the patient's right Rx is –1.00 –3.00 × 090. Line the 180° mark of the tonometer tip with the red line of the holder.

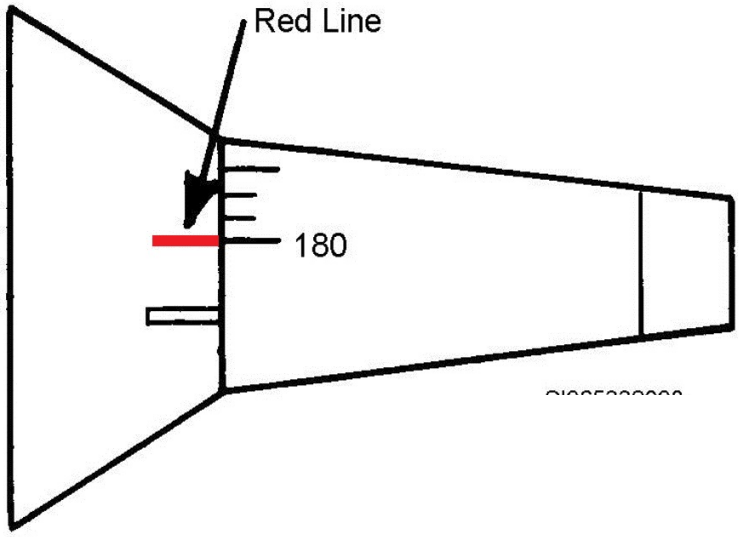


Figure 3–30. Red mark on prism holder.

4. Now swing the applanation tonometer into position. It automatically locks into place. You can feel it click into place as you rotate it.
5. Adjust the beam width to its brightest and widest setting.
6. Rotate the measuring drum to set the pressure at 1gram (g). (The applanator has a measuring drum with a scale from 0–8g.)
7. Set the magnification to the lowest power setting.
8. Position the patient in the slit lamp as you would for a normal exam (fig. 3–31).

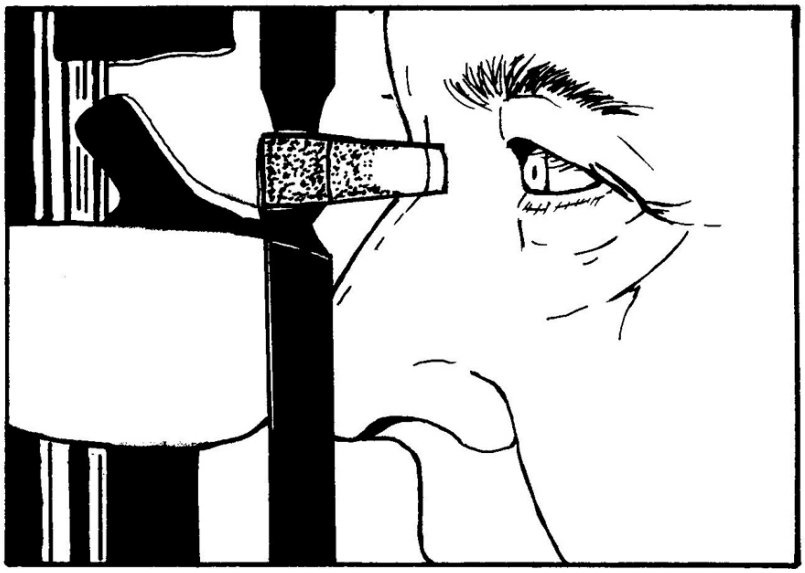


Figure 3–31. Patient positioned for applanation tonometry.

9. Ask the patient to blink. This distributes the fluorescein over the eyes. Then ask the patient to keep both eyes wide open; if eyelashes touch the tonometer tip, it causes a blink reflex.
10. With the tonometer probe positioned slightly inferior to the visual axis, move the tonometer toward the cornea. When the probe is 2–3 mm from the cornea, elevate the tonometer to align the probe with the corneal apex and slowly move the joystick forward until the prism is in contact with the cornea (fig. 3–32). When the prism applanates the cornea, the limbus glows; this can be observed from outside the oculars.

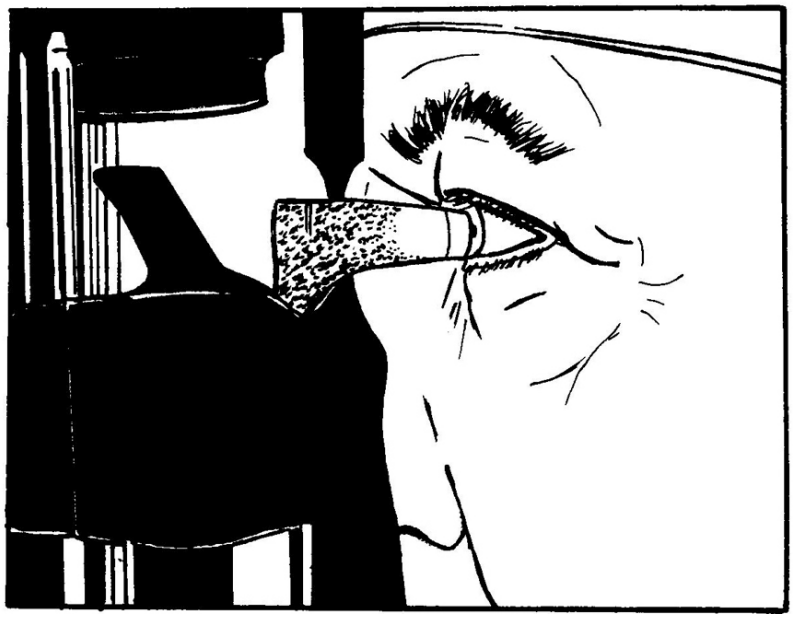


Figure 3–32. Tonometer probe in contact with cornea.

11. Once the prism is in contact with the cornea, look through the left eyepiece and center the semicircles horizontally and vertically using the joystick (fig. 3–33). All microscopes are different. Some use the left ocular and some the right. It all depends on the scope you have. Determine which one it is beforehand.

Figure 3–33. Correct and wrong views of semicircles (as seen through the slit lamp).

12. Rotate the measuring drum in the proper direction until the semicircles touch on the inside of each circle. The circles may seem to move. This is caused by the movement of the eye due to the pulsing of the heartbeat pulsing through the ophthalmic artery. The semicircles may slightly overlap with each pulsation.
13. Once measured, the technician immediately pulls straight back on the slit lamp.

14. The pressure is observed on the drum and multiplied by 10. If the measurement were 1.8g, this would be a reading of 18 mm Hg. Record all results in mm of Hg.
15. Move the light source to the other eye. Wipe the applanator head to remove any excess fluorescein and/or tears. Measure the other eye in the same manner.

Problems and solutions for applanation tonometry

The two problems most commonly encountered with applanation tonometry are wide fluorescein patterns and narrow fluorescein patterns.

Wide fluorescein pattern problem and solution

Look at figure 3–34. This problem arises when there is too much fluorescein to accurately perform the test. This causes the pressure reading to be much higher than the actual pressure.

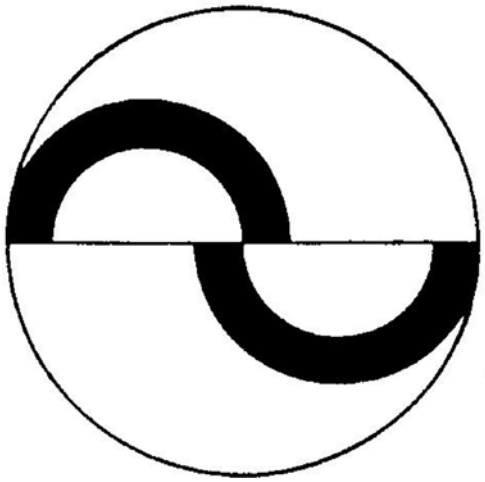


Figure 3–34. Wide fluorescein pattern (as seen through the slit lamp).

The solution is to remove the applanator and wipe off the excess fluorescein with a soft cloth. The patient can also gently wipe off his or her eyes.

Narrow fluorescein pattern

The other common problem is not enough tears or fluorescein remaining on the cornea (fig. 3–35). The reading will be much lower than the actual IOP.

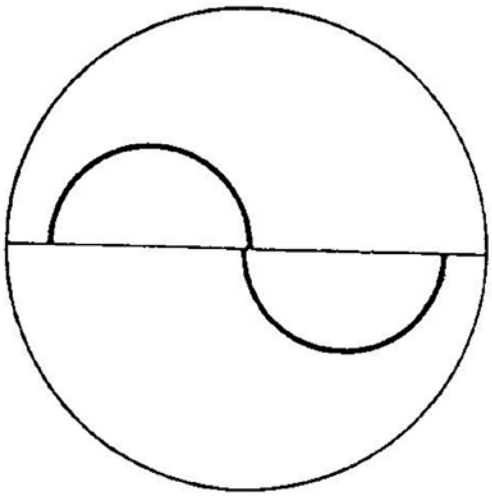


Figure 3–35. Narrow fluorescein pattern (as seen through the slit lamp).

A solution consists of having the patient blink and see if this resolves the problem. If not, you may have to add another drop of fluorescein.

619. Administering the Schirmer tear test

The Schirmer tear test measures the amount of tears produced by the lacrimal gland and tells you if there is an aqueous deficiency. The test is indicated for patients who have symptoms of dryness, burning, or a sandy or gritty feeling in the eyes. It's also useful in determining whether a patient has a sufficient amount of tears for comfortable CL wear.

Test procedures

The test equipment consists of two pieces of filter paper (test strips) 5 mm wide and 45 mm long (total length) in a sterile package. There is a notch on one side of the filter paper; it's 5 mm from one end (fig. 3–36).

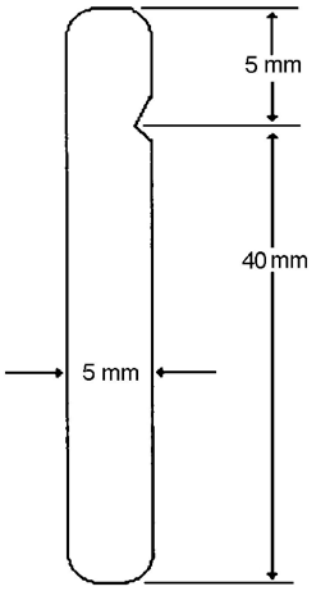


Figure 3–36. Schirmer tear test strip (for the left eye).

The procedure for administering the test is simple:

1. Seat the patient comfortably—preferably with the patient's head against a headrest.
2. Tell the patient what you're going to do; this relieves apprehension.
3. While the test strip is still in the package, make a wick by bending the rounded end of the filter paper at the notch about 90°.
4. Cut the package at the end opposite the wick and remove the paper strips.
5. To avoid any error, the end of one of the filter strips is *cut diagonally*. This strip is to be used in the *right eye*.
6. Instruct the patient to look up.
7. Gently pull the lower lid downward.
8. Hook the rounded, bent end of the sterile strip (wick) over the lower eyelid margin, just nasal to the center (fig. 3–37).

   NOTE: Be sure not to touch the cornea at this time. This would cause pain and reflex tearing, making the test inaccurate.

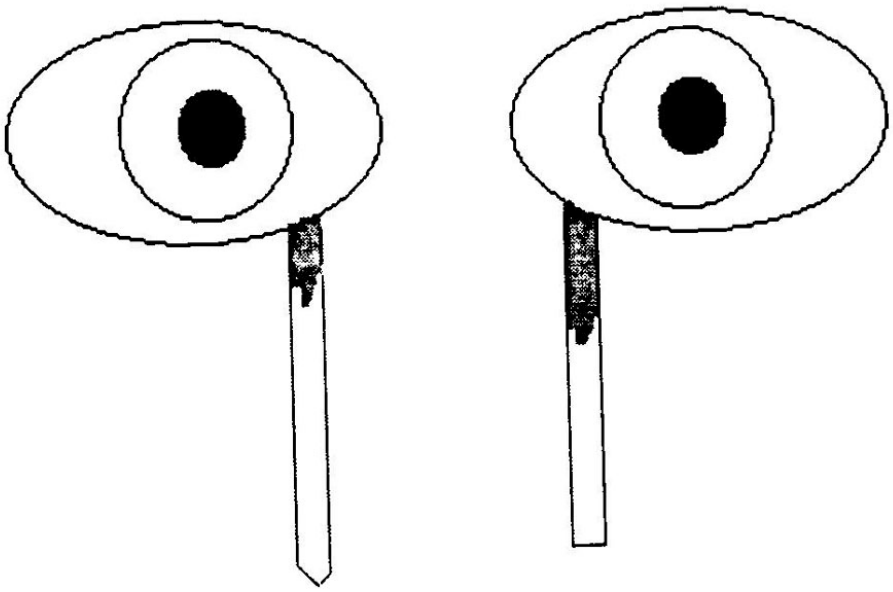


Figure 3–37. Schirmer test strips in the eyes.

9. NOTE THE TIME!
10. Tell the patient to either continue blinking or close his or her eyes during the test. (Discourage squeezing the eyelids.)
11. After five minutes have elapsed, remove the strips and measure the moistened area, beginning at the notch. There is a mm scale on the test package. (If the scale is lost, a PD ruler with a mm scale is used.) You may find it helpful to hold the strip up to the light to make the moistened area more visible. If the strip is soaked beyond the normal range before five minutes are up, remove the strip. Record the measurement and the actual elapsed time.
12. Record the measurement in mm.

    For example:

    Schirmer Test @ five minutes.

    OD 16 mm.

    OS 18 mm.

Measurements and their meanings

The standard (or normal) for patients age 40 and younger is to have a moistened area of *at least* 15 mm in each eye within five minutes. As people get older, their tear production decreases; therefore, for patients over age 40, 10–15 mm in each eye at five minutes is considered normal. A measurement of less than 10 mm after five minutes in any patient needs careful consideration, as it's usually indicative of insufficient tear production.

When a diagnosis of insufficient tearing is established, the treatment usually consists of prescribing artificial tears (methylcellulose) for the patient to use as needed in the affected eye. There are many brands of artificial tears on the market, most of which are over-the-counter medications.

Schirmer tear test #2

A variation of the test exists; it's called the Schirmer tear test #2. It involves the exact same test procedures as before, except a drop of anesthetic solution is put in the eye before the test. It's administered to eliminate any reflex tearing caused by the paper.

620. Checking the anterior chamber angle

The anterior chamber angle is the anatomical angle created by the root of the iris and the peripheral corneal vault.

Especially before dilating a patient's pupils, it's important to check the anterior chamber angle of the eye. This will help to detect if the eye is at risk from angle closure. Pupil dilation relaxes the iris and causes the tissues of the iris to bunch up. This can block off all other angle structures.

A condition called iris bombe can be triggered if iris displacement leads to the pupil becoming stuck to the anterior lens capsule or if the pupil is blocked by a part of the vitreous body that has slipped forward. With this condition, the pupil is blocked, causing the aqueous pressure from the posterior chamber to push the iris forward, further blocking the angle of the anterior chamber and preventing the outflow of aqueous. Should this occur, a fully developed attack of acute angle-closure glaucoma could occur within 30–60 minutes.

To prevent this occurrence, there are numerous methods that can assess the anterior chamber angle: the pen torch method, Smith's method, Van Herrick's technique (discussed previously in the section covering the technique for performing a slit lamp examination), split limbal technique, OCT (as previously discussed), and gonioscopy. One of the quickest and easiest methods an ophthalmic technician can perform is the pen torch method. For that reason, it's the method discussed in this lesson.

To perform a check of the anterior chamber angle using the pen torch method perform the following:

1. Shine a pen torch (you can use a pen light or a transilluminator) into the patient's eye from the temporal canthus. Angle the light in such a way that the light source lies in the same plane as the eye.
2. If the anterior chamber is deep, the iris lies flat and therefore the whole iris will be illuminated, as in Grade 1 in figure 3–38.
3. If the anterior chamber is shallow, the iris lies forward, blocking some of the light, and very little of the iris will be illuminated, as in Grade 2 thru 4 of figure 3–38.
4. If very little of the iris is illuminated (as in Grades 2 thru 4 of fig. 3–38), inform the doctor and await further instruction, especially before proceeding with the instillation of medication for eye dilation.

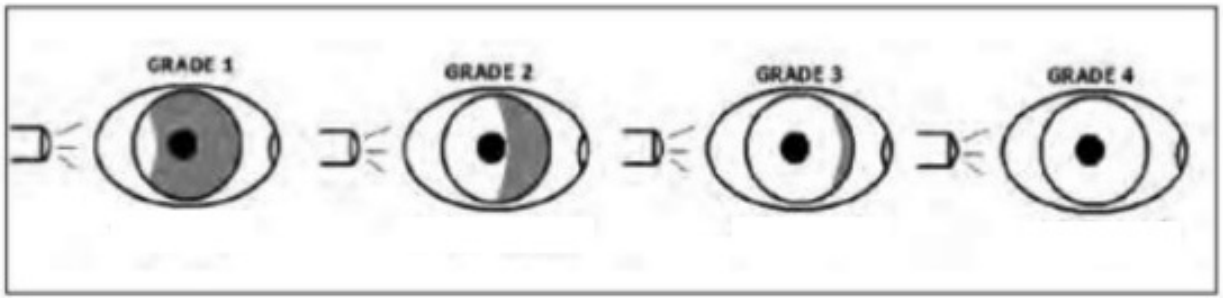


Figure 3–38. Grading of anterior chamber angle.

NOTE: The depth of the anterior chamber naturally decreases with age due to an increase in size of the crystalline lens. With this decrease comes an increased risk of narrow- and closed-angle glaucoma.

621. Ocular photography

Ophthalmic photography is an invaluable tool in documentation and in many cases, diagnosing ocular anomalies. It can be a very challenging task to master; however, it can also be one of the more interesting skills you'll perform in the clinic. Continued practice and a willingness to learn will make you a better technician and enhance the effectiveness of your clinic.

Purpose of fundus (retinal) photography

The fundus camera (fig. 3–39) is designed to take photographs primarily of the retina, but most modern fundus cameras can also take decent external photographs of the eye. Generally, there are two reasons for taking fundus and external photos:

1. To document the appearance of the fundus or the external eye.
2. To aid in the diagnosis of an ocular condition.

Figure 3–39. Fundus camera.

Documentation is the primary reason most photos are taken. Without photography, the doctor would have to try to describe the location, size, and appearance of any retinal abnormalities he or she sees. In some cases, such as ocular histoplasmosis, numerous retinal scars exist, making this an almost impossible task.

A photograph really can be worth a thousand words. It allows any doctor who examines the patient on future visits to see exactly what was going on with the patient's eyes in the past. Comparisons are more accurate, and treatment decisions are made sooner with greater decisiveness if the current doctor can see what previous doctors saw. This eliminates trying to read and interpret hand-drawn pictures.

You may take fundus photographs to document the appearance of the posterior pole or the peripheral retina. It depends on what area of the fundus your doctor wants documented. You may need to take external photos to show the appearance of the sclera, lids, canthus area, surrounding facial skin, or any other external area of the eye or face needing documentation.

Fundus camera components

Different media have been used in the past, but most instruments are now digital, allowing for easier integration into the electronic medical record. There are many different models of retinal, or fundus, cameras. You will need to become familiar with the model at your clinic upon arrival.

Many cameras will have multiple adjustment knobs/levers. Some of the more common adjustments are:

- Angle-changing lever—used to change field of view and magnification.
- Diopter compensation knob—used to compensate for the patient's prescription.
- Filter-switching knob—used for filters, such as the red-free filter, which can be helpful when trying to get a good contrast between the blood vessels of the eye and the rest of the fundus.
- Focusing knob—used to focus the image.
- Fixation light—may be viewed by the patient internally or externally on the equipment.

- Illumination controls—to adjust the brightness of the flash/photograph.

Performing ocular photography

Since all cameras function differently, review the user manual for your clinic's camera prior to use. The following steps are a general guideline to perform fundus photography:

1. Prepare the patient.
2. Explain the procedure and purpose of the test to the patient.
3. Dilate the patient's eyes (if necessary).
    - The larger the pupils, the easier it is to get a good photograph.
    - With a mydriatic camera, a minimum dilation of 6 mm (pupil diameter) is necessary to achieve a good photo.
4. Prepare the equipment and enter the patient's data.
5. Focus the eyepiece (if so equipped).
    - The eyepiece must always be adjusted for your eye, otherwise you're not focusing correctly on the patient's fundus and your pictures will be blurry.
6. Adjust the filters to the desired setting, as needed.
7. Adjust the angle-changing lever as needed.
8. Position the patient.
9. Have the patient close both eyes while you bring the camera to a position in front of the eye being photographed.
10. Position the fixation light as needed.
11. Have the patient open both eyes and look at the fixation light.
12. Look into the camera screen (or into the camera eyepiece) to ensure you can see the fundus (fig. 3–40).

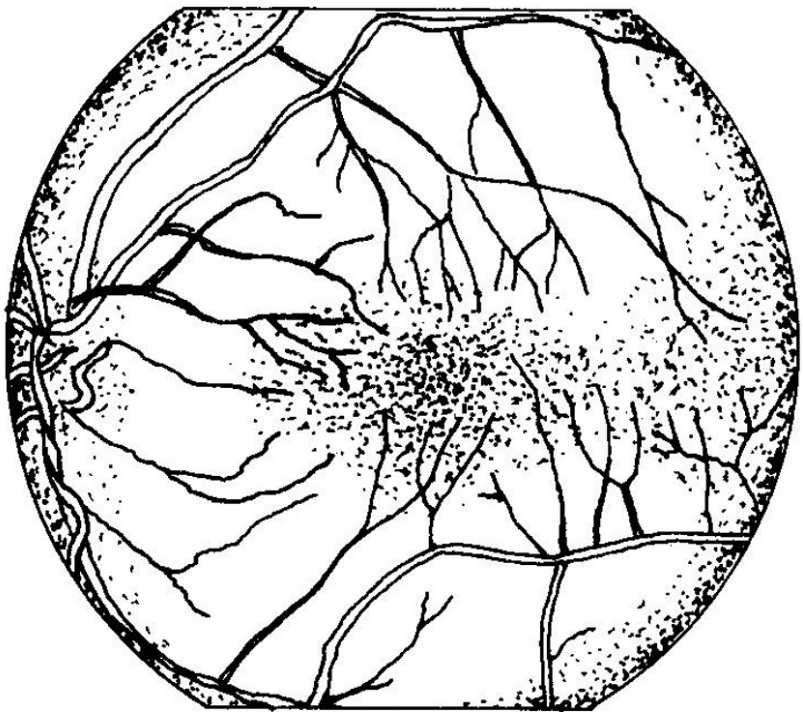


Figure 3–40. Example of patient's fundus.

13. Adjust the fixation light, and have the patient follow it with both eyes, until the portion of the fundus you want photographed is centered.
14. Fine-focus the view by turning the focus knob or joystick of the camera.
15. Press the shutter release or joystick button to take the photo.
16. If you're performing fundus photography and your patient cannot keep his or her eye open, you'll need a helper to hold the patient's eyelid open while you take the photograph. This is usually done with a long cotton swab.

Evaluating and troubleshooting the pictures

The majority of the fundus photos you'll take care of are the macula or optic disc (fig. 3–41). If you're not trying to get a picture of these areas, still try to capture these landmarks in your pictures so the location of what you are trying to photograph can be determined relative to known landmarks.

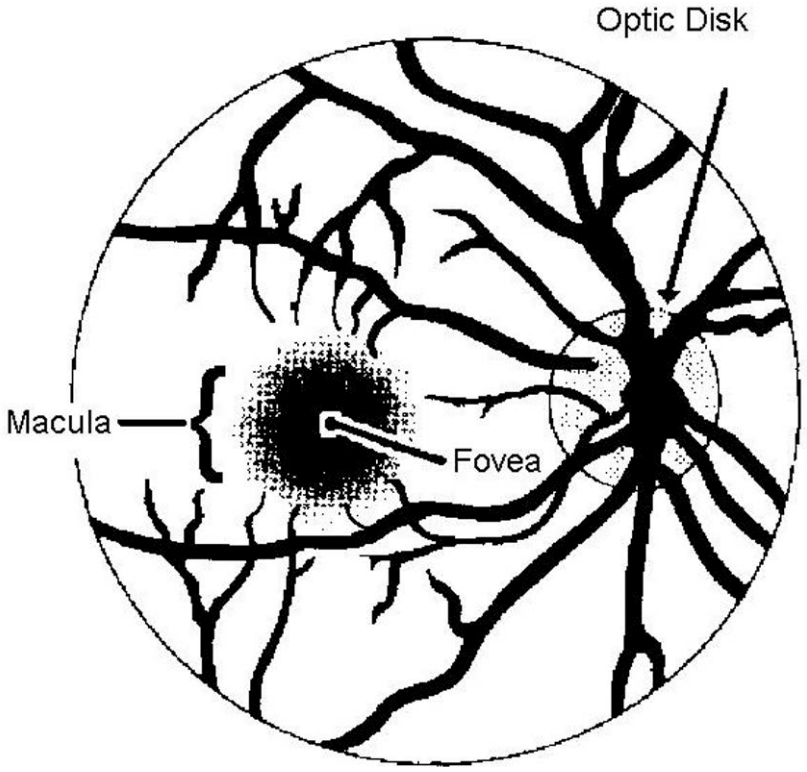


Figure 3–41. Illustration of the macula (with fovea in its center) and the optic disc.

When photographing a patient, capture as many images as needed. The patient would rather you get everything now, instead of having to return at a later time.

Evaluate your pictures. If the fundus is not centered, try readjusting the fixation light for the patient. If the pictures seem to be coming out a little dark, increase your flash intensity. If the pictures look washed out, decrease the flash intensity. If the pictures are not clear, refocus the eyepiece or try a little more illumination to ensure you can see clearly enough to focus the camera properly.

Once you find the settings that seem to work best, write them down. Document things such as which setting of the eyepiece gives the sharpest results, which flash setting works best, and what seems to be the lowest illumination setting you can use and yet still see clearly enough to take good pictures. By documenting your successes and working to fix your failures, you can take exceptional photos in a short amount of time, with less wasted time and happier patients (since they will not have to sit through repeated attempts). Figure 3–42 shows some fundus photography problems and the possible causes and corrections.

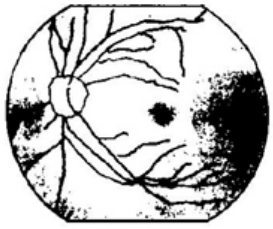
1) Photograph of the retinal peripheries is dark. 	*Check whether the distance between the patient's eye and the main body is longer than 40mm working distance.
2) Photograph of retinal center is dark 	*Check whether the pupil of the patient's eye dilated more than Ø6mm.
3) Photograph is influenced by overall flare 	*Check whether the distance between the patient's eye and objective lens is shorter than the proper 40mm working distance.
4) Vague white dots are seen through the finder and also on the photograph 	*Check whether there are tears on the objective lens surface.

Figure 3–42. Common fundus photography errors and/or problems and their correction.

The most common ophthalmic photography problem seems to be leaving the flash setting too high, which causes your photos to be “washed out,” especially the optic nerve head (fig. 3–43).

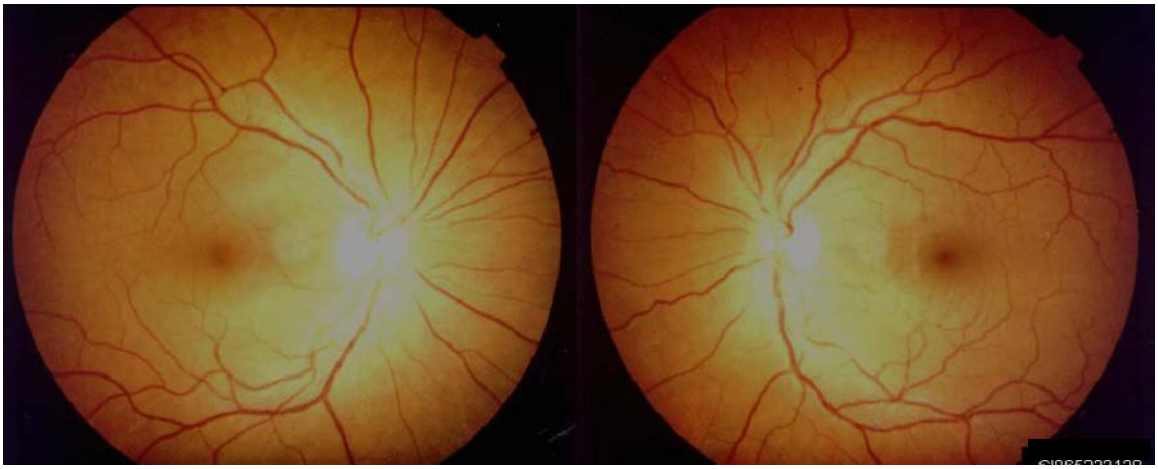


Figure 3–43. Too much flash causing a “washed out” effect of the optic disc.

The simple fix for this is to turn down the flash-control knob one increment at a time until the pictures come out properly exposed. If you do not make an adjustment, your pictures are useless to anyone who tries to get an estimate of the patient’s cup/disc (C/D) ratio.

The C/D ratio is often what a doctor is hoping to document with the photos. A “washed out” optic nerve also makes it hard to notice changes in glaucoma patients, since it becomes difficult to differentiate abnormalities, such as neovascularization of the optic disk or myelinated nerve fibers around the disc.

External photography

On occasion, you may need to take an external photograph using the fundus camera. External photographs are an excellent means of documenting disorders of the surface of the eye and surrounding adnexa. Depending on the problem, you may even be able to document changes to the iris and crystalline lens of the eye.

External photographs can be used to get an entire shot of a patient’s face. This is useful for showing rashes, ptosis, dermatochalasis, heterotropia, and exophthalmos. External photos can also show how much a droopy lid is covering the pupil, redness of the sclera, corneal ulceration, FBs, pterygiums, pinguecula, GPC, skin lesions, and much more. Document these conditions by taking a good external photograph. Since many conditions may change over time, making a record of their appearance at the time the patient was in your clinic is very important for medical and legal reasons.

Anterior segment photography

An external photograph cannot take the place of an anterior segment camera. Only an anterior segment camera, mounted to a slit lamp, can take highly magnified pictures showing great detail of the cornea, surrounding adnexa, and inside the anterior chamber of the eye.

With the knowledge you have gained in slit lamp operation, the information covered on ophthalmic photography, and a little practice, you should be able to accomplish anterior photography with minimal effort.

Instead of images of damaged retinas (internal) and droopy eyelids (external) as produced by the fundus camera, the anterior camera produces photos of highly magnified areas representing the cornea, surrounding adnexa, and the anterior chamber in all their detailed glory. Simply focus the slit lamp in on the desired area and activate your anterior camera according to manufacturer instructions.

When using the photo slit lamp, you have many options when it comes to illumination. Lighting is classified primarily as diffuse, direct, or indirect.

Diffuse illumination

For an overall low-contrast inspection of the eye and its surroundings, diffuse illumination is well suited. Use a diffusion lens to help soften the light coming from the slit lamp.

Direct illumination

Using the slit lamp's internal aperture, the size and shape of the beam may be changed from a pinpoint of light to a full circle, or it can form a narrow sliver of light. No matter what the shape is, pointing the light at the object lights it directly. The following paragraphs list various types of direct illumination.

Narrow beam

Use the narrow beam to illuminate the optical section of the eye. Normally it's used for locating changes in the cornea.

Broad beam

Use the broad beam similarly to a narrow beam, but it's more effective in determining the extent of the affected area.

Tangential

To accentuate the surface texture of the eye, place the light off to the side (tangential) with the light still aimed and centered on the area being viewed.

Pinpoint

Cells and flare in the aqueous are seen more easily with a small circle of light (pinpoint). Pinpoint light tends to be used more by the clinician than the photographer due to the low reflectivity of the cells and flare.

Specular reflection

Mirror-like quality reflections are called specular reflections. The smooth surface of the cornea accentuates the slit lamp's main light source. It's best to de-emphasize the reflection off the cornea to ensure it does not cover any underlying pathology of the cornea. Specular reflection is used to view individual cells of the endothelium.

Indirect illumination

Transparent objects are seen better with indirect illumination than with direct illumination. A good example is with a patient wearing a CL. If you shine the slit lamp light directly at the CL, it seems as if it disappears. However, moving the light source off to the side of the eye toward the limbus, you can see the contact with great detail.

You also do not want the slit lamp light to be in the center of every object being photographed. Therefore, place the light off-center to have a clear photo without the light reflecting back. The following paragraphs list various types of indirect illumination.

Proximal

A light placed near an object, instead of directly on it, can sometimes be the best way to highlight the object. Try proximal lighting if you are having a hard time viewing an object.

Sclerotic scatter

Sclerotic scatter refers to aiming the light source towards the limbus to see subtle changes.

Retro illumination

Silhouette light could be another name for this type of illumination, because the light source illuminates the subject from behind. The best time for this method is when you need to outline the

shape of a lesion on the lens or cornea. Light coming off the retina is very effective for retro illumination.

622. Measuring pupil size

The pupilometer is a precision instrument designed to measure pupillary dilation in low light. It's lightweight and fits comfortably in the user's hand, facilitating quick, accurate measurements. The following instructions are for a Colvard pupilometer, but other models function similarly.

You are trying to reproduce nighttime or low-light conditions. Therefore, turn off all room lights. Crack a door or use adjustable lighting so there is enough light to examine the patient safely.

Depress the ON/OFF button located on the instrument handle. Keeping the button depressed enhances the image seen through the eyepiece.

Instruct the patient to focus at a distant object with the eye not tested. While looking though the eyepiece, move the instrument back and forth (slightly) to bring the image of the iris and pupil to a sharp focus. The enhanced image is normally somewhat grainy with a green phosphorescent glow. Nevertheless, you should see the pupil with ease.

A reticule with an mm ruler is superimposed over the pupil and iris allowing for easy measurement of the pupil diameter. Read the scale and write down the eye measured along with the diameter.

The pupilometer's electronics contain a protective mechanism to shield the sensitive light amplification instrumentation from sudden exposure to high-energy light levels. However, release the light-enhancement button before turning the room lights on.

Use only a soft cloth to clean the pupilometer. The cloth may be moistened with isopropyl alcohol. Dry the instrument completely with a dry, soft cloth.

Keep the pupilometer in its protective case when not in use. Keep the instrument dry at all times. Moisture or excessive humidity could damage the electronics. Avoid temperatures below freezing and above 150° Fahrenheit.

623. Performing pachymetry

Pachymetry is the ultrasonic measurement of corneal thickness. Corneal thickness measurements are used in a number of different ways including but not limited to: PRK, LASIK, and glaucoma screenings.

If the cornea is left too thin after refractive surgery, it loses structural integrity. This can cause corneal distortion and irregular, blurry vision that may not be correctable with glasses or CLs. This is why patients with thin corneas are poor refractive surgery candidates.

For glaucoma evaluations, the average corneal thickness is 555µm. Patients with thin corneas will have falsely lower IOPs, while patients with thick corneas will have falsely higher IOPs.

Figure. 3–44. Pachmate® handheld pachymeter and calibration box.

Calibration

There are several pachymetry units available, from larger units, such as the DGH 550 Pachette 2®, to smaller, handheld units, such as the Pachmate® (fig. 3–44). This lesson will focus on the handheld Pachmate®. Prior to performing pachymetry the instrument should be checked for calibration. Use the supplied calibration box. The calibration box (CalBox) does not calibrate the pachymeter but generates precise, predetermined thickness that can be measured by the pachymeter. Using these values, the operator can quickly verify the instrument is properly calibrated.

To verify the instrument is properly calibrated, perform the following:

1. With the Pachmate® and CalBox turned off, connect the Pachmate® to the CalBox.
2. Hold the "DEL" key and press the "PWR" key on the Pachmate.
3. The Pachmate® will display "Entering CalBox mode."
4. Press the CalBox "POWER/START" key (the LED should light).
5. Calibration will begin immediately.
6. Observe the CalBox measurement values of 200 µm thru 1,000µm in steps of 100µm.
    a. Readings will look similar to this: "#7 = 798µm."
    b. Readings can be reviewed by pressing the up and down arrows on the Pachmate.
    c. Values are based on a corneal velocity of 1,640 meters per second and should be within ±5 µm.
    d. Any measurement out of tolerance needs to be reported to DGH Technology, Inc®.
7. Exit the CalBox mode by pressing the "CLR" key, and confirm the readings are no longer stored by pressing the up arrow on the Pachmate.
8. Disconnect the Pachmate® from the CalBox.

Obtaining measurements

Measurements are taken automatically when the pachymeter probe tip is applanated on the cornea correctly. This allows you to concentrate on probe positioning and alignment.

Use the following instructions to perform corneal pachymetry testing:

1. Gather the equipment and materials you'll need:
    a. Corneal Pachymeter (the Pachmate® for this lesson).
    b. Anesthetic eye drops.
2. Explain the procedure to the patient.
3. Verify that the patient has no allergies to anesthetic eye drops.
4. Instill a drop of anesthetic in both eyes.
5. Turn the Pachmate® on (if not already on) by pressing the "PWR" key.
6. Recline the chair and/or have the patient tilt his or her head back to look towards the ceiling.
7. Take a measurement:
    a. Gently place the Pachmate® on the central cornea of the right eye.
    b. Aim for the center of pupil.
    c. The probe must be perpendicular to the corneal surface (fig. 3–45).
    d. Measurements will be taken automatically if the probe is placed correctly.
8. After all measurements are taken, the Pachmate® will emit two long beeps.
9. Press clear and repeat for the other eye.
10. Record the results.

a. Select the eye to review by pressing the “OD” or “OS” key.

b. The average measurement should look similar to this: “Ave 25: 540µm/Std Dv: 0.3 µm.” In that example, it would indicate that 25 readings were taken and the thickness was 540µm with a standard deviation of 0.3µm.

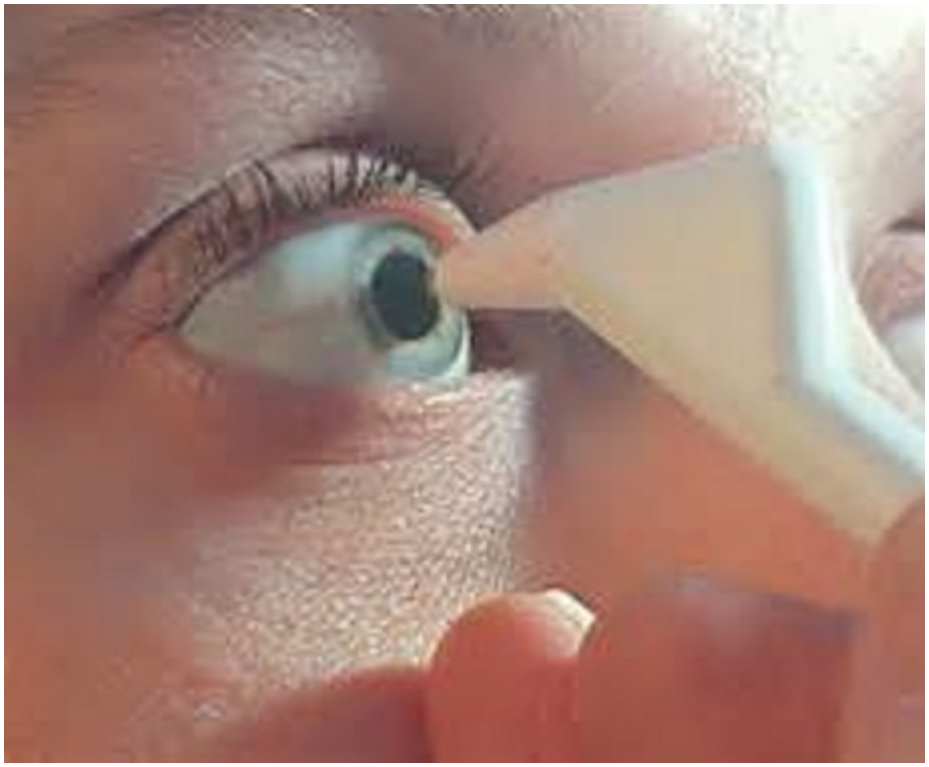


Figure 3–45. Proper pachymeter placement.

Depending on the instrument you have, there may be more options and modes than described here. For more operating information or details, refer to the owner’s manual.

624. Measuring near point of convergence (Prince ruler)

The Prince ruler is merely a plastic or wooden stick marked off in cm increments (fig. 3–46). It’s usually about 50–60 cm long.

Figure 3-46. The Prince ruler.

It can be used to measure accommodative power of an eye and the convergence capabilities of the eyes. While the equipment might not be "high tech," the information gained from testing accommodation and NPC can be quite useful in gaining a clinical understanding of a patient's overall visual functioning.

Administering the accommodation test using the Prince ruler

Measuring accommodation tells you and the doctor how much a patient can increase the D power of his or her eye. As we age, the degree to which we can accommodate decreases. For each age there is an expected degree of accommodation possible. By comparing your patient to these "norms," you'll have a better idea whether the patient is *hyperopic*, *myopic*, or experiencing *accommodative disorders*.

The accommodation test should be administered to each eye individually and then with both eyes together. Before performing the accommodation test, measure the patient's NVA *while the patient uses his or her distant Rx* (if he or she has glasses for distant vision). Determine which line of letters the patient can see clearly at 16″ with his or her distant Rx. Then use the next larger line of letters for testing. For example, if the patient could read the 20/40 line at near (with his or her distant Rx), use the 20/50 line of letters for testing.

Performing the test is simple. Just follow these instructions:

1. Attach the near card to the Prince ruler.
2. Have the patient wear his or her normal distant Rx (if applicable). The patient is not to wear NVO spectacles nor look through the segment portion of multifocals if he or she wears them. Again, only use the distant Rx for this test.
3. Have the patient occlude his or her left eye. This is so you can test his or her right eye first.
4. Slide the card to the distant end of the ruler (past the 50 cm mark). Now place the near end ("zero" marked end) of the ruler just below the patient's eye on the face and have him or her hold that end of the ruler. This is to steady the ruler, and it enhances safety. We do not want to hurt the patient.
5. Instruct the patient to focus on the appropriate line of letters (as described above). Tell him or her to "*keep the letters clear*" and to inform you "*when the letters become and remain blurry.*"
6. Slowly move the card toward the patient's eye until he or she reports that the letters are blurry. When the letters get blurry, have the patient refocus and try to make them clear again if he or she can keep going. Once the letters get blurry and stay blurry, stop moving the card. Note the distance from the eye, in cm, as marked on the Prince ruler.
7. You now have a measurement, in cm, of the patient's accommodative range for one eye. Switch the occluder to the other eye and test it. When you finish the second eye, remove the occluder and test both eyes together.

Once both eyes are tested together you should have three measurements, all in cm, representing the patient's accommodative power for the left, right, and both eyes. Unfortunately, you want the measurement in diopters, so convert the cm measurement to a D measurement.

Converting focal length reading to a D reading

To refresh your memory, D power is inversely proportional to focal length (FL) and vice versa. What this means is, if you know the D power of a lens or the eye, you can calculate its focal length. Conversely, if you know the focal length of a lens or an eye, you can calculate its D power.

In your testing, you measured the patient's eyes and determined his or her focusing power in cm, which is the FL. The formula for converting FL (in cm to D power) is to divide *100 cm* by the FL measured on the patient, or:

$$\frac{100\ \text{cm}}{\text{FL}} = \text{D power}$$

Here is an example. You perform the accommodation test on a 50-year-old (y/o) patient's right eye and get a measurement of 40 cm.

To convert to a D power, divide 100 cm (the constant in the formula for converting) by 40 cm (the measured FL):

$$\frac{100}{40} = \textbf{\textit{2.50D}}$$

This indicates this 50 y/o patient has accommodative power of "***2.50D***" in his or her right eye and is perfectly normal for a 50 y/o person.

Let us say the left eye had a FL measurement of 45 cm.

$$\frac{100}{45} = \textbf{\textit{2.22D}}$$

The rule of thumb says to round off your measurements to *the nearest half diopter*. In this case, you would round "***2.22D***" down to "***2.00D***."

Now we'll say that when both eyes were left unoccluded and the patient was tested last time, he or she had a FL of 35 cm.

$$\frac{100}{35} = \textbf{\textit{2.86D}}$$

Rounding "***2.86D***" to the nearest half diopter increment would take the measurement to "***3.00D***." At this point, you have taken your FL measurements of the accommodative power for each eye independently and both eyes together. You converted the FL measurements into D readings and so you're now ready to record the results. For the previous example, record your results as follows:

Accommodative Power (Prince ruler): OD = 2.50D OS = 2.00D OU = 3.00D

Some general "rules of thumb" are:

- The accommodative power of the two eyes should be within ± ***1.00D*** of each other.
- The binocular accommodative power is *usually* ***+ 0.50D*** greater than the monocular findings.

Expected ranges of accommodative power

The doctor now has the information needed to determine if the patient's accommodative power falls within the expected range. Several books show what the expected level of accommodation should be, based on age, but they do not all agree. The reference we use is the accommodation power chart that can be found on the Air Force Medical Service Knowledge Exchange at https://kx.afms.mil/kj/kx4/FlightMedicine/Pages/directorysupportingvisualexaminations18mar13.aspx, a link to which can be found in AFI 48–123, *Medical Examinations and Standards*. The power chart is shown in the table below.

Accommodative Power			
Age	**Diopters**	**Age**	**Diopters**
17	8.8	32	5.1
18	8.6	33	4.9
19	8.4	34	4.6
20	8.1	35	4.3
21	7.9	36	4.0
22	7.7	37	3.7

Accommodative Power			
Age	**Diopters**	**Age**	**Diopters**
23	7.5	38	3.4
24	7.2	39	3.1
25	6.9	40	2.8
26	6.7	41	2.4
27	6.5	42	2.0
28	6.2	43	1.5
29	6.0	44	1.0
30	5.7	45	0.6
31	5.4		

Applying the results of the accommodation test

The chart is used as a rough gauge to determine if a person is myopic (nearsighted) or hyperopic (farsighted). For instance, you test a 20 y/o patient and find he or she has an accommodation power of 10.00D. This seems to indicate that the person is myopic (nearsighted) and probably needs some minus (–) lenses to help correct his or her distant vision. Once the patient has the proper Rx, he or she probably ends up much closer to the "expected" power (for a 20 y/o) of 8.1. If the patient still does not measure near the expected range, you may begin to suspect an accommodative disorder.

Let's say another 20 y/o comes in and is tested. This patient is found to have an accommodative power of only 6.00D. This seems a bit low for a 20 y/o. This is a good indicator the patient is hyperopic (farsighted). The patient probably needs some plus (+) lenses to correct distant vision, allowing the eyes to relax when looking in the distance. Given the proper distant Rx, the patient would probably end up much closer to the "expected" power of 8.1D. If not, an accommodative disorder would be suspected.

Measuring the NPC using the Prince ruler

The Prince ruler is also used to measure a patient's NPC. NPC is how close to the eyes an object may be brought before the patient either sees double (diplopia) or stops converging on the object (i.e., the eyes quit moving in with the target, or one eye breaks fixation and deviates outward).

NPC needs to be measured on all personnel being examined for flying qualifications in flight classes I, IA, and II. Candidates for pilot training wear corrective lenses while being tested for NPC. While it should be apparent, it must be stated: the *NPC test is done binocularly only*.

Administering the NPC test

To test for NPC, follow these steps:

1. Tell the patient what you're going to do.
2. Place the zero mark of the Prince ruler toward the patient. The ruler goes against the patient's forehead, between his or her eyes, just above the bridge of the nose. The patient holds the end of the Prince ruler that is against his or her forehead. You hold the other end of the Prince ruler, ensuring the ruler is parallel (level) with the floor.

   NOTE: When performing the NPC on a patient undergoing a flying class I, IA, or II flight physical, hold the Prince ruler at a slight downward angle (15–20º) from the patient's level line of sight.
3. The target, which is usually the J3 (20/40) letter of a near eye chart, is started at the end of the ruler, farthest away from the patient.

4. Instruct the patient to focus on the target and report when it becomes double. The target may become blurry, as you get closer to the eyes. That's fine, as long as it has not doubled. The target does not have to remain clear and sharp as it did during the accommodative power test previously described.
5. Slowly and smoothly move the target toward the patient until the patient reports diplopia, you see one of his or her eyes suddenly diverge, or the eyes stop converging on the target even though it's still getting closer. Note the point on the mm scale of the Prince ruler; however, this is NOT the patient's final score on the test.

Add 15 mm to the final reading to account for the fact the zero mark is against the patient's forehead. This is approximately 15 mm farther out than the cornea, which is theoretically where the measurement should be made, but obviously placing the Prince ruler against the eyes themselves is not feasible!

For example, you get a reading of 55 mm on the ruler. Add 15 mm to that measurement to account for the difference in distance between the zero mark of the ruler and the cornea. Your result is 70 mm (i.e., 55 mm + 15 mm = 70).

Recording the results

If the test is being done just for clinical information on a routine patient, record the results on whatever exam form you use in your clinic. Simply record "**NPC = *(score)***." Therefore, in our example above, it would be **NPC = 70.** You do not have to put "mm" after the numbered score, as it's understood the score is in millimeters.

If the test is being done for a patient undergoing a flight physical and a hard copy SF 88, Report of Medical Examination, is being completed as the patient undergoes testing, record the results under the heading "**PC**" in item 31 on the form. Notice the "mm" is not put with the measurement. Again, it is understood the measurement is always in millimeters, so "mm" is not recorded.

Things to consider regarding the NPC test

If correcting lenses are normally worn, the patient can wear them during the NPC test. The only exception would be pilot training candidates. They do not wear corrective lenses.

If the patient fails the test the first time, allow a few moments for his or her eyes to relax and try again. If the patient still fails, have him or her leave and return the next duty day to try again. If he or she still fails on the second consecutive duty day then, and only then, is the failure recorded. Keep in mind, repetition of the test tires the EOMs and the patient tends to do worse. Try to conduct the test as perfectly and correctly the first time to give the patient the best chance of succeeding.

The NPC test cannot be performed on everyone. A person with a *heterotropia* (i.e., "eso," "exo," "hyper," or "hypo"-tropia) is not able to do the test correctly due to his or her physiological eye misalignment. If the test were performed anyway, the results would not be valid; a person with a heterotropia is only able to fixate with one eye at any given time. Both eyes must align on the fixation target *at the same time* for an NPC measurement.

625. Administering the Worth 4-Dot test

If further depth perception workup is required, especially for Flying Class I/IA physicals, it's common to perform the Worth 4-Dot test. The Worth 4-Dot test is used to assess a patient's flat fusional ability.

The need to administer the test is indicated any time a patient's previous stereopsis falls below 50 seconds of arc, on those patients with suspected strabismus, and on preschool children. The Worth 4-Dot test is also useful in evaluating cases of reduced monocular vision that does not improve during the pinhole test.

Performing the test

The Worth 4-Dot test can be administered using a Worth 4-Dot flashlight (fig. 3–47) or using Project-O-Chart™ slides.

Figure 3–47. Worth 4-Dot flashlight.

With either source, perform the following steps:

1. Have the patient wear the Anaglyph glasses. These are spectacles with a red-free green lens for one eye and a green-free red lens for the other eye (fig. 3–48). The glasses should be placed over the patient's best correction, if applicable. Place the red lens over the right eye.

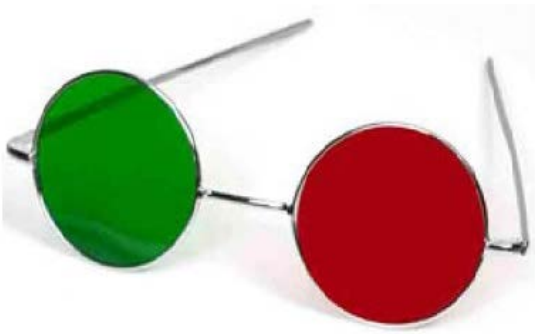


Figure 3–48. Anaglyph glasses for worth 4-dot testing.

2. In a slightly dimmed room, use the Worth 4-Dot flashlight or Project-O-Chart™ slide to present to the patient one white dot, one red dot, and two green dots.

   NOTE: If using the flashlight, it should be approximately 16 inches from the patient and slightly below the level of sight.
3. Use an occluder to cover the right eye first and ask the patient how many dots he or she sees. The patient should report seeing 3 green dots.
4. Cover the left eye and again ask the patient how many dots he or she sees. The patient should report seeing 2 red dots.
5. With both eyes uncovered, ask a third time how many dots the patient sees. If the patient has normal flat fusion, he or she should report seeing 4 dots.

Abnormal results

If the patient reports only 2 red dots when both eyes are uncovered, it indicates the patient is suppressing the left eye.

If the patient reports seeing 3 green dots when both eyes are uncovered, it indicates the patient is suppressing the right eye.

If the patient reports seeing 5 dots, the eyes are not fusing and a muscular imbalance is suspected. If the patient is experiencing diplopia, you can further determine the type by asking which side are the green dots. If on the right, the patient has eso deviation. If on the left, it would be an exo deviation. If the green dots are above or below the red dots, then a vertical deviation exists. The green dots above the red dots would indicate a hyper deviation.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

618. Operating the slit lamp and performing applanation tonometry

1. What can the slit lamp be used to diagnose?

2. When using a slit lamp, what type of magnification should be used for a patient's initial examination?

3. When using a slit lamp, what order are the structures of the eye examined?

4. When measuring the anterior chamber with a slit lamp, what does the "shadow" formed on the iris represent?

5. Why do tonometric methods that use indentation lead to less accurate readings when they are used for taking IOPs?

6. Which filter do you use on the slit lamp when taking pressure readings with the Goldmann applanation tonometer?

7. When performing applanation tonometry, what setting do you use for the beam width?

619. Administering the Schirmer tear test

1. What is the Schirmer tear test designed to measure?

2. For a normal Schirmer tear test, the tear test strips should be removed after how long?

3. What is the normal moistened area on the Schirmer tear test for people over 40 years of age?

4. What is the *primary* difference between the regular Schirmer tear test and the Schirmer tear test #2?

5. What does the Schirmer tear test #2 eliminate?

620. Checking the anterior chamber angle

1. What is the anterior chamber angle?

2. What does checking the anterior chamber angle help to detect?

3. If the anterior chamber is deep, what will you see when you shine a pen torch into the patient's eye from the temporal canthus?

4. What causes the anterior chamber to naturally decrease with age?

621. Ocular photography

1. In addition to taking photographs of the retina, what else can the fundus camera be used to photograph?

2. What are two reasons for photographing both the internal and external ocular structures?

3. Which component of a fundus camera is used to change field of view and magnification?

4. What two ways can the fixation light be viewed?

5. Why should the patient's eyes be dilated for good fundus photography?

6. Why is it critical that you ensure the fundus eyepiece is properly focused?

7. If a patient has difficulty keeping an eye open for the photo, what can you do?

8. Why can't you use the external photo capability of the fundus camera to replace an anterior segment camera?

622. Measuring pupil size

1. When measuring pupils with a pupilometer, how should you set the exam room lighting?

2. With a Colvard pupilometer, how do you enhance the image seen through the eyepiece?

3. With Colvard pupilometer, what should be done prior to turning the room lights on?

623. Performing pachymetry

1. What are some of the ways that corneal thickness measurements are used?

2. What should be done to the instrument prior to using the pachymeter?

3. Describe the correct positioning of the pachymeter's probe when measuring corneal thickness.

624. Measuring near point of convergence (Prince ruler)

1. What two things can the Prince ruler be used to measure?

2. List the three refractive deficiencies that can be assessed when comparing your patient's accommodation to the expected "norms."

3. After administering the accommodation test to a 20 y/o patient, your readings on the Prince ruler were as follows: OD–12 cm; OS–14 cm; and OU–12 cm. What are the corresponding D power readings for these FL measurements?

4. Define NPC.

5. Which flying class physical exams require the measurement of NPC?

6. Why do you add 15 mm to the measurement taken from the Prince ruler when administering the NPC test?

7. If the exam is being routed by hard copy, where and on what form, are the results of the NPC test recorded for patients undergoing flying class physical exams?

8. A person with what type of physiological eye condition could not accurately have his or her NPC measured?

625. Administering the Worth 4-Dot test

1. What is the Worth 4-Dot test used to assess?

2. What indicates the need to administer the Worth 4-Dot test?

3. What type of special glasses must the patient wear during testing?

4. During testing, if the patient reports seeing only 2 red dots when both eyes are uncovered, what does this indicate?

Answers to Self-Test Questions

613

1. That part of space that one can see when the head and eyes are motionless.
2. 95° temporal, 75° inferior, 60° nasal, and 60° superior from fixation.
3. Detecting abnormalities in the peripheral VF, and monitoring changes in a normal or defective VF.
4. Retinitis pigmentosa.
5. A Bjerrum scotoma.

614

1. The glaucoma field, the macula study, and the neurological exam.
2. Fixation target, blind-spot check size, test speed, foveal threshold test, central reference level, the fluctuation test, and FASTPAC.
3. Either the small diamond or the large diamond fixation target.
4. By 40 percent.
5. Hold down the response button.
6. Fixation losses, false positive errors, and false negative errors.

615

1. Light waves.
2. Because OCT is a noncontact testing device.
3. Extreme temperature fluctuations can have an adverse effect on the system.
4. Disease progression or a patient's response to treatment.
5. The thickness of the flap and the residual corneal bed postsurgery.

616

1. The actual, physical process of measuring the refractive error of a patient's eyes.
2. The technical aspect of determining refractive error.
3. Clinical judgment combined with the technical process of refractometry.
4. Objective and subjective.
5. None.
6. Lenses.
7. Plus power; in +0.25D steps.
8. Subjective, objective, and combination objective/subjective.
9. Objective.
10. It uses infrared light to automatically refract the eye much in the same way a retinoscope does.
11. +/–0.25D. It could be in either.
12. The measurement of the central anterior curvature of the cornea.
13. To assess the curvature and power of the cornea, to judge the integrity of the corneal/tear surface, and to follow the progress of patients with corneal distortion.

617

1. The radius of curvature and refractive power at thousands of points across the cornea.
2. Curvature maps, refractive power maps, elevation maps, and irregularity maps.
3. Patient follow-up—examine the disease process over time to determine whether a condition is worsening or stabilizing. Early detection—identify early indication of pathological condition. This may help which course of action is appropriate for each patient. Identify poor fitting contacts—identify distortion from poorly fitted CLs. With this information, new lenses can be ordered and properly fitted.

618

1. Anterior segment eye diseases, corneal trauma, FBs, keratitis, iritis, angle-closure glaucoma, and cataracts.
2. Low.

3. (1) Lids and lashes.
   (2) Conjunctiva.
   (3) Cornea.
   (4) Anterior chamber.
   (5) Iris.
   (6) Crystalline lens.
4. The depth of the anterior chamber.
5. Because of the varying amounts of scleral rigidity.
6. Cobalt blue.
7. The brightest and widest setting.

619

1. The amount of tears produced by the lacrimal gland.
2. Five minutes.
3. 10–15 mm in each eye at five minutes.
4. The Schirmer tear test #2 is administered after an anesthetic is put in the eyes.
5. Reflex tearing.

620

1. The anatomical angle created by the root of the iris and the peripheral corneal vault.
2. If the eye is at risk from angle closure.
3. The whole iris will be illuminated.
4. An increase in size of the crystalline lens.

621

1. External eye photos.
2. To document the appearance of the fundus or the external eye and to aid in the diagnosis of ocular conditions.
3. The angle-changing lever.
4. Internally and externally on the equipment.
5. The larger the pupil, the easier it is to photograph the fundus (retina).
6. The pictures will be blurry if it is not.
7. Have an assistant use a long cotton swab to hold the lids open.
8. Only the anterior segment camera can take highly magnified pictures for greater detail of the cornea, surrounding adnexa, and inside the anterior chamber of the eye.

622

1. You are trying to reproduce nighttime/low-light conditions. Turn off all room lights. Crack a door or use adjustable lighting so there is enough light to examine the patient safely.
2. Depress the ON/OFF button located on the instrument handle. Keeping the button depressed enhances the image seen through the eyepiece.
3. Release the light-enhancement button before turning the room lights on.

623

1. They are used in a number of different ways including but not limited to: PRK, LASIK, and glaucoma screening.
2. The instrument should be checked for calibration.
3. It must be perpendicular to the corneal surface.

624

1. 1) Accommodative power of an eye.
   2) Convergence capabilities of the eyes.

2. Hyperopia, myopia, or accommodative disorders.
3. OD = 8.50D. OS = 7.00D. OU = 8.50D.
4. How close to the eyes an object may be brought before the patient: 1) sees double (diplopia), 2) stops converging (i.e., his or her eyes quit moving in with the target), or 3) has one eye break fixation and deviate outward.
5. Flying class physical exams I, IA, and II.
6. To account for the difference in distance between the zero mark of the ruler and the cornea.
7. Under the heading “PC” in item 31 on the SF 88.
8. A patient with a heterotropia.

625

1. A patient’s flat fusional ability.
2. Any time a patient’s previous stereopsis falls between 50 seconds of arc, on those patients with suspected strabismus, and on preschool children. It is also useful in evaluating cases of reduced monocular vision that does not improve during the pinhole test.
3. Anaglyph glasses, spectacles with a red-free green lens before one eye and a green-free red lens before the other eye.
4. The patient is suppressing the left eye.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the AFCDA.

38. (613) This is a contour line that represents the limits of retinal sensitivity to a specific test target.
    a. Isopter.
    b. Diopter.
    c. Anopsia.
    d. Hypoxia.

39. (613) Which scotoma is a depression to one side of fixation?
    a. Cecal.
    b. Central.
    c. Paracentral.
    d. Pericentral.

40. (613) Which visual field (VF) defect is relatively rare?
    a. Contractions.
    b. Depressions.
    c. Anopsias.
    d. Cecals.

41. (613) This causes floaters in the visual field (VF).
    a. Shadows of opacities floating in the vitreous.
    b. Holes on the retina.
    c. Scleral defects.
    d. Iris lesions.

42. (613) Lesions in which structures can cause a scotoma, resulting in visual field (VF) defects?
    a. Retina and choroids.
    b. Retina and sclera.
    c. Choroid and sclera.
    d. Choroid and iris.

43. (613) All postchiasmal lesions produce a
    a. bitemporal hemianopsia.
    b. binasal quadrantanopsia.
    c. homonymous hemianopsia.
    d. homonymous quadrantanopsia.

44. (614) The FASTPAC allows the visual field (VF) testing to be decreased by which percentage?
    a. 20.
    b. 25.
    c. 40.
    d. 50.

45. (615) An optical coherence tomographer (OCT) is not helpful in the diagnosis and treatment of this condition.
    a. Glaucoma.
    b. Blepharitis.
    c. Diabetic retinopathy.
    d. Age-related macular degeneration (ARMD).

46. (615) When dilating a patient's eyes for an optical coherence tomography (OCT) assessment, you must document the name of the medication, the form of the medication (if applicable), the amount of medication, location of medication instillation, and the
    a. medication cabinet from which the dilation drops were stored.
    b. time the patient will be ready for the OCT assessment.
    c. eye lane from which the dilation drops were stored.
    d. time of medication instillation.

47. (615) For photorefractive keratectomy (PRK), an optical coherence tomography (OCT) assessment can be useful in measuring the
    a. epithelial thickness.
    b. residual corneal bed.
    c. thickness of the flap.
    d. fibers of the optic nerve

48. (616) Which type of manual retinoscopy is the most prevalent instrument in use today?
    a. Spot.
    b. Streak.
    c. Parallel.
    d. Inverted.

49. (616) In retinoscopy, the phoropter is used to provide
    a. the lenses.
    b. a fixation point.
    c. a retinal magnifier.
    d. an illumination source.

50. (616) Objective autorefractors use which type of light to automatically refract the eye?
    a. Laser.
    b. Visible.
    c. Infrared.
    d. Ultraviolet.

51. (616) During autorefraction, "instrument myopia" is evident when the patient's eyes
    a. relax.
    b. abduct.
    c. diverge.
    d. accommodate.

52. (616) The keratometer can be used to evaluate contact lens fit, since corneal curvature directly relates to the
    a. base curve of a contact lens.
    b. optical zone of a contact lens.
    c. peripheral curve of a contact lens.
    d. power meridians of a contact lens.

53. (617) This topography map is best used for identifying corneal pathology.
    a. Axial.
    b. Elevation.
    c. Tangential.
    d. Irregularity.

54. (617) Which topography map measures in units as small as microns (µm)?
    a. Axial.
    b. Elevation.
    c. Tangential.
    d. Irregularity.

55. (617) When performing corneal topography, click the joystick button to capture an image when
    a. the mires are aligned and the crosshairs are centered.
    b. the mires are oblong and the crosshairs are centered.
    c. the mires are aligned and the crosshairs are over the highest keratometry point.
    d. the mires are oblong and the crosshairs are over the highest keratometry point.

56. (618) When measuring the anterior chamber using the Van Herrick technique, set the *total* angle of the illumination arm, which includes the microscope angle, at which degree?
    a. 30.
    b. 45.
    c. 60.
    d. 90.

57. (618) When scanning the iris surface with the slit lamp, look for any irregularities and note the
    a. Zonule attachments.
    b. pupillary light reflex.
    c. Canal of Schlemm angle.
    d. geniculocalcarine radiations.

58. (618) When performing applanation tonometry in conjunction with the slit lamp, which is one of the magnification settings used?
    a. 10x.
    b. 20x.
    c. 30x.
    d. 40x.

59. (619) Schirmer tear test #2 involves the use of
    a. miotics.
    b. antibiotics.
    c. mydriatics.
    d. anesthetics.

60. (620) This is the anatomical angle created by the root of the iris and the peripheral corneal vault.
    a. Posterior chamber.
    b. Anterior chamber.
    c. Peripheral-iris.
    d. Ciliary body.

61. (621) This is the minimum millimeter pupil dilation required to get a good ocular photo with a mydriatic camera.
    a. 2.
    b. 4.
    c. 6.
    d. 8.

62. (621) This type of illumination softens the light from the slit lamp.
    a. Direct.
    b. Diffuse.
    c. Indirect.
    d. Proximal.

63. (621) Which type of illumination is used to see individual cells of the endothelium?
    a. Tangential.
    b. Specular.
    c. Sclerotic.
    d. Retro.

64. (622) When measuring pupil dilation, which is the patient's fixation point for the eye not being tested?
    a. A near object.
    b. A distant object.
    c. An internally fixed object.
    d. An externally attached object.

65. (623) This type of medication is instilled in the patient's eyes before taking a pachymetry measurement.
    a. Miotic.
    b. Mydriatic.
    c. Antibiotic.
    d. Anesthetic.

66. (623) During corneal pachymetry, the patient should be looking towards
    a. a near object, such as the tip of a pen, held 12 inches from the eyes.
    b. the 20/20 E on a Snellen chart.
    c. the pachymeter probe.
    d. the ceiling.

67. (624) The amplitude of accommodation for a 20-year-old (y/o) patient is 6.00 diopters (D). Therefore, you would suspect the patient might be
    a. myopic.
    b. hyperopic.
    c. amblyopic.
    d. presbyopic.

68. (624) Candidates for pilot training should be given the near point of convergence (NPC)
    a. binocularly with correction.
    b. monocularly with correction.
    c. binocularly without correction.
    d. monocularly without correction.

Unit 4. Ophthalmic Programs and Aerospace Optometry

THERE ARE A VARIETY of ophthalmic programs available. The accessibility of these programs often depends on your clinic's mission, while other programs depend on the patient's Air Force Specialty Code (AFSC).

AASD are personnel assigned to perform their primary career duty in-flight, including career aircrew who are temporarily assigned to nonflight duties, such as staff or educational duties, while remaining qualified to return to flight duty. Once selected, applicants to AASD careers are also managed IAW AASD standards. Because of the nature of their duties, AASD members are held to more rigid vision standards. Therefore, it falls on the ophthalmic clinic to closely monitor any programs geared to AASD personnel. This often includes having stricter program policies for AASD members.

All AF personnel not specifically identified by both career status (AFSC) and aviation service code (ASC) for AASD management, fall under Warfighter program management. Warfighters often have less rigid vision requirements. Although this can be a good thing, the AF often prioritizes our flying mission, and Warfighters may find they fall into a lower priority when it comes to eligibility for specialized programs. In the next few lessons, we'll discuss the ophthalmic programs available and the differences, if any, in program requirements for Warfighter and AASD personnel.

4–1. Contact lenses

While most people think of CLs as a relatively new innovation, the idea for a contact-type spectacle was actually pondered by Leonardo De Vinci as early as 1508, and by Descartes in his 1636 treatise entitled "Ways of Perfecting Vision." The real history of contacts began, however, in the 19th century simultaneously with the development of spectacles.

With the introduction of anesthesia in 1884, CL technology advanced. Anesthesia allowed for more accurate moldings of patients' corneas to be performed without the discomfort previously experienced. The early lenses were scleral—fitted under the eyelids—mainly because they had to be made of glass, which is too heavy to allow constant centering like today's corneal-type lenses. In the 1930s, the availability of plastics that were lightweight, transparent, chemically stable, unbreakable, scratch-resistant, and easy to work with, changed the course of technology in visual correction.

Although the majority of patients choose CLs to enhance their appearance, some patients are fitted with CLs for "visually essential" type problems for which spectacles are not the best answer. Patients with anisometropia, monocular aphakia, and keratoconus fall into this "visually essential" category.

Because CLs are so popular and readily available today, you need to know how to assist the doctor with the inspection and verification of CLs, as well as provide advice concerning hygiene and patient training in insertion and removal techniques and selection of the proper solutions.

626. Contact lens characteristics

There are literally thousands of brands and types of CLs available to patients who want an alternative to spectacle correction. We'll cover two general categories of CLs in this lesson: (1) RGP CLs and (2) SCLs.

RGP CLs

RGP CLs were introduced in the mid-1980s; they are actually a newer technology than soft lenses. RGP CLs became very popular when they were first introduced and remain a favorite of many contact lens wearers. The table below lists the advantages and disadvantages of RGP CLs.

Advantages of RGP CLs	
Advantage	**Result**
Oxygen (O_2) transmissibility	Surprisingly, RGP CLs transmit more O_2 to the eye than most SCLs do.
Clear, crisp vision	RGP CLs provide very clear, crisp vision compared to SCLs.
Durability and deposit resistance	RGP CLs, if cared for properly, are worn for 2–5 years before replacement becomes necessary. The rigid, plastic material is resistant to deposits, and degradation of the material is minimal over time.
Easy maintenance	RGP CLs are very easy to maintain. Bacteria and contaminants cannot penetrate the lens material. Cleaning and disinfecting is a simple process, and the lenses can be stored dry or in solution.
Relatively inexpensive	Because the lenses have a long lifetime and require few maintenance solutions, the cost over several years is less than SCLs.
Disadvantages of RGP CLs	
Disadvantage	**Result**
Require "custom" fitting	RGP CLs must be carefully fitted. The lens shape and size must be very close to the patient's corneal shape and size. Any degree of "slop" in the fitting results in suboptimal vision and comfort.
Initially uncomfortable	When an RGP CL is first placed on the eye, the patient experiences an "FB" sensation, much like when an eyelash is in the eye. The eye usually waters and may turn red. These effects are temporary and usually subside within 10–15 minutes of wear. Daily wear (DW) "desensitizes" the cornea and the patient becomes less and less aware of the lens over time. Full adaptation usually takes 1–2 weeks. If a patient stops wearing the lens for a few weeks, he or she must go through the adaptation process again.
Spectacle blur	The cornea is 80 percent water; it's a very moldable material. RGP CLs perform a certain amount of corneal molding—they reshape the cornea slightly. When RGP CLs are removed, it can take several minutes to several hours for the cornea to return to its natural state. Until it does, some patients experience temporary "spectacle blur." This means they may not initially see clearly through their spectacle Rx.
Not compatible with many sports	RGP CLs are easier to dislodge during vigorous physical activity than are SCLs. They are not recommended for wear during contact sports, such as football, basketball, and martial arts. Additionally, a blow to the eye while wearing an RGP CL could cause corneal damage from the contact lens.

RGP CL materials

RGP CLs are made of polymers or plastics that do not absorb water. The material a lens is made of affects many properties of the lens and the CL fitter must consider the patient's specific needs when considering which lens material is most appropriate. The material a lens is constructed of may affect properties of the RGP CL. These properties are discussed in the following paragraphs.

O_2 permeability

O_2 permeability refers to the ability of gases (air) to permeate (travel through) the lens material. RGP CLs allow O_2 to pass right through the lens. Less dense materials have higher O_2 permeability and are healthier for the eye as well as more comfortable.

Lens "wettability"

Some polymers are hydrophilic ("water-loving") and some are hydrophobic ("water-hating"). Hydrophilic materials allow the patient's tears to adhere to the lens surface and improve comfort and vision. The *degree* to which a hydrophilic lens material allows the tears to adhere is referred to as *"lens wettability."*

Lens durability

All plastic materials degrade over time; some faster than others. Chemical solutions used to clean and disinfect the lenses and even the patient's own tears accelerate this process. Usually, the more durable an RGP CL material is, the less O_2 permeable it is. The CL fitter must find an appropriate balance between these properties for each patient.

RGP CL parameters

Many parameters are used to describe the properties of a specific RGP CL. Refer to figure 4–1 as we discuss the various parameters.

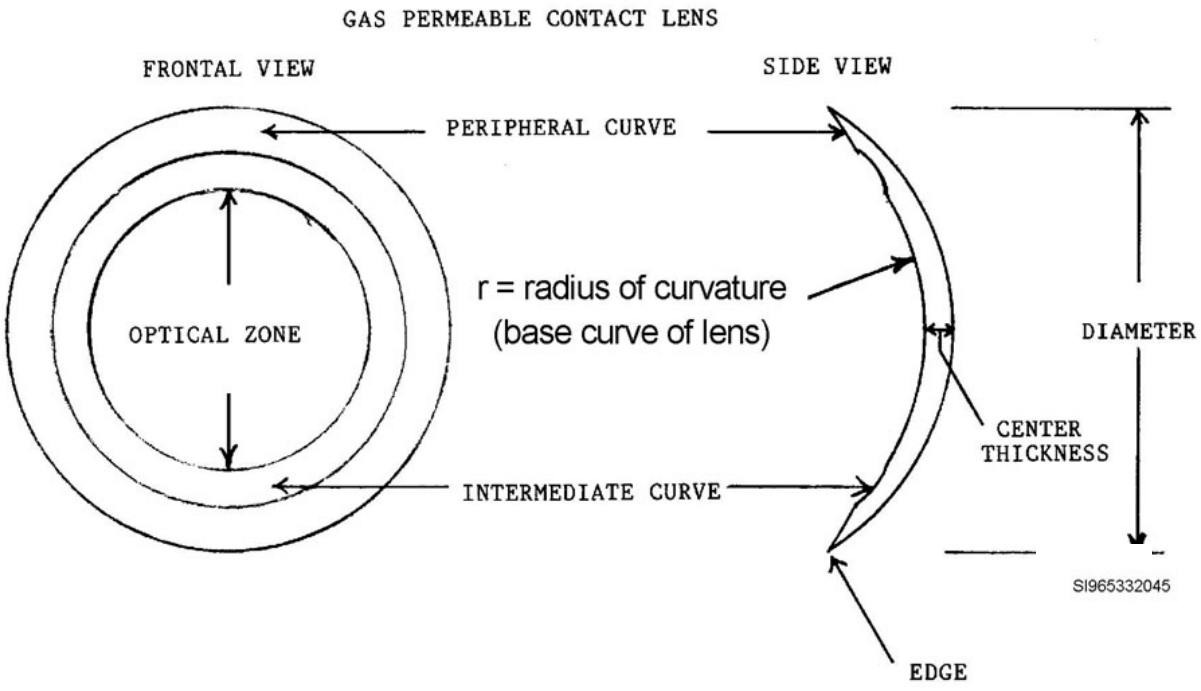


Figure 4–1. Parameters of an RGP CL.

The table below lists and describes RGP CL parameters.

RGP CL Parameters	
Material	The specific polymer used to make the lens. Most CL fitters simply specify the brand name of the lens. Several brand-name lenses are made of the same material.
Power (PWR)	The dioptric PWR of the CL.
Diameter (DIA)	The overall DIA of a CL. The DIA is also referred to as the *overall DIA* or *OAD* and is always specified in mm.
Base Curve (BC)	The back surface curve of a CL. The BC is always given in mm (radius of DIA) rather than diopters. The BC is determined by the front curvature of the patient's central cornea.
Optical Zone (OZ)	The central viewing portion of a CL. The OZ contains the actual corrective PWR, while the peripheral portion of the lens varies in PWR.
Peripheral Curve	The back surface curvature at the periphery of the lens. The peripheral curve allows the edge of the lens to stand off the cornea very slightly. Each time the patient blinks, the RGP CL moves and the edge-lift created by the peripheral curve allows O_2-rich tears to circulate under the lens.
Intermediate Curve	Any back surface curve in between the BC and the peripheral curve. To enhance fit and make the RGP CL shape closely mirror the patient's corneal shape, many CL fitters specify one or two intermediate curves added to the lens.
Center Thickness (CT)	The thickness in mm at the center of the lens. Most RGP CLs are in the range of 0.10–0.18 mm in thickness. That is 10–18 *hundredths* of a mm—very thin!
Edge	The edge design of the RGP CL. CL fitters may specify the edge be smooth, rolled, or tapered. Edge design is the most important factor in RGP CL comfort, and most labs choose the best edge design for the particular lens.
Blend	The smoothing out of the transition from BC to peripheral curve to eliminate any sharp surfaces.

RGP CL prescription

A CL fitter may specify all of the parameters discussed previously. At the very least, the RGP CL Rx must specify the following parameters: (1) brand name or material of lens, (2) PWR of the lens, (3) lens DIA, and (4) the BC. Unless the lens is an ultra-custom lens designed for a patient who is a challenge to fit, most CL fitters allow the fabricating lab to use their standard values for the rest of the parameters. The CL Rx is normally given an expiration date of one year. The written Rx looks similar to this:

OD: Boston ES 9.2 / 7.45 / –4.00

OS: Boston ES 9.2 / 7.23 / –3.75

In this example, the specific brand name of the lenses prescribed is Boston ES. The DIA of the lenses is 9.2 mm for both eyes, and the BCs are 7.45 mm for the right lens and 7.23 mm for the left lens. (The BC is given in radius of curvature rather than diopters). The PWR of the right lens is –4.00D and the PWR of the left lens is –3.75D. The table below lists and describes the wear schedule and correction type of RGP CLs.

Types of RGP CLs	
Wear Schedule Type	**Description**
Daily Wear (DW) RGP CLs	DW RGP CLs are lenses that have been approved by the Food and Drug Administration (FDA) for DW only. This means the wearer is expected to remove his or her lenses nightly for cleaning and to give the eyes a "rest" from CL wear.

Types of RGP CLs	
Wear Schedule Type	**Description**
Extended Wear (EW) RGP CLs	EW RGP CLs are lenses determined by the FDA to be safe when worn on a continuous schedule. Most EW RGP CLs are approved for seven days/six nights of wear, but at least one lens has been approved for up to 30 days of continuous wear.
Correction Type	**Description**
Single Curve	A single-curve lens is a lens with the same BC in all meridians. By definition, we know this is a spherical lens. A single-curve lens is used to correct simple myopia and simple hyperopia. It can also be used for patients who have small amounts (<1.00D) of astigmatism. The lens “masks” the astigmatism by gently molding the cornea from a football shape into a basketball shape.
Bitoric	A bitoric lens is an RGP CL with two BCs oriented 90° away from each other. It’s used to correct the vision of patients who have larger amounts (>1.00D) of corneal astigmatism. The bitoric lens is either a cylinder or a spherocylinder lens.
Bifocal	RGP CLs are available in bifocal designs also. Some are made with a near segment looking a lot like a spectacle bifocal segment. When looking straight ahead, the patient looks through the distance portion of the lens. When the patient looks down to read, the eyelids hold the lens in place as the patient’s eyes move down so the patient looks through the near segment. These lenses are referred to as *translating* RGP bifocal CLs (fig. 4–2).

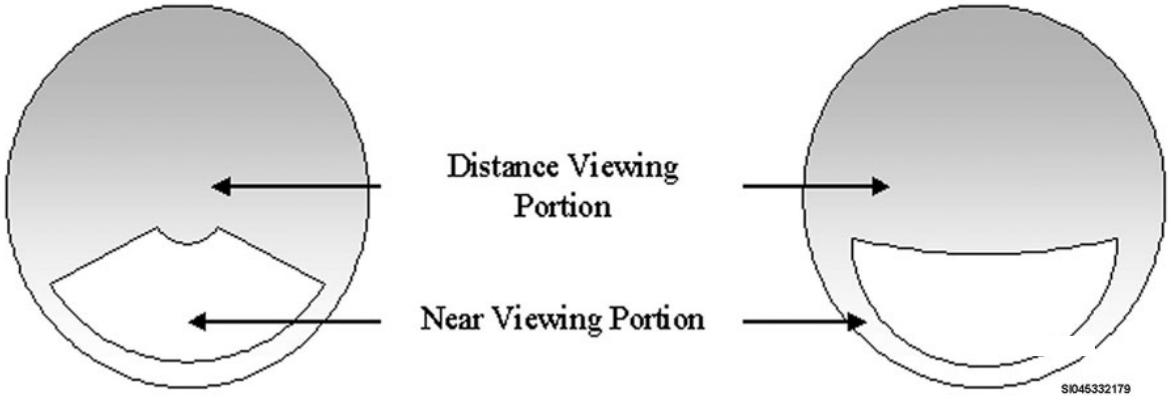


Figure 4–2. Bifocal contact lenses.

Alternative designs are concentric circles of PWR and aspheric designs (fig. 4–3). Lenses with concentric circles of PWR have a near focus at the very center of the lens, a ring of distance focus, then a ring of near focus, and so on. An aspheric lens design gradually changes PWR from near focus (in the center) to distance focus (toward the periphery), much like a progressive addition spectacle lens (no-line bifocal).

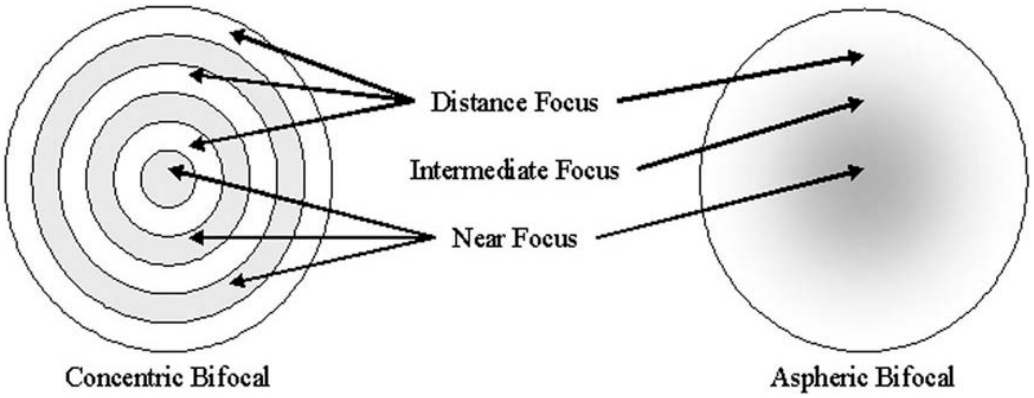


Figure 4–3. Concentric and aspheric designs.

NOTE: Single-curve, bitoric, and bifocal lenses are available as both DW and EW RGP CLs.

RGP CL replacement schedule

RGP CLs typically need to be replaced every 2–5 years, more frequently if the patient's Rx changes. The lifespan of the lens depends on the lens material and how carefully the patient handles and cares for the lens. Remember, the more O_2 permeable a lens is, the less durable it is. Poor lens care can lead to permanent deposits and scratches in the lens affecting both vision and comfort.

SCLs

Most of the patients receiving CL care in your clinic will be SCL wearers. The table below lists the advantages, disadvantages, and characteristics of SCLs and discusses each one.

Advantages of SCLs	
Advantages	**Discussion**
Relatively easy to fit	Soft lenses conform well to the surface of the eye. They are fit with a BC that is approximately 0.5–1.5 mm flatter than the actual corneal surface. Therefore, there is a range of BCs that work for most patients.
Quick adjustment period	SCLs are comfortable for most patients from day one. If there is any initial FB sensation, it usually resolves within 5–10 minutes.
Not easily dislodged	It's quite difficult to accidently dislodge an SCL. For this reason, they are the preferred lenses for vigorous activity and contact sports.
May be used for cosmetic purposes	An SCL may be tinted to enhance or change eye color. Custom designed specialty SCLs can mask iris defects. If a patient has no iris (aniridia) or an iris damaged by trauma, a colored CL with an open pupillary zone gives the patient's eye a more "normal" appearance and enhances his or her vision (remember the pinhole effect).
Disadvantages of SCLs	
Disadvantage	**Discussion**
Must be cleaned and sterilized carefully	Because SCLs contain a considerable percentage of water, they absorb bacteria and other contaminants. There is a significant increase in the risk of eye infection when a patient wears SCLs. Negligence in the care of the lenses could potentially result in loss of vision or even loss of an eye.
Less durable—must be replaced more frequently than RGP CLs	The lifespan of an SCL is at most 12–18 months. The more frequently the lenses are replaced, the lower the risk for infection.

Disadvantages of SCLs	
Disadvantage	**Discussion**
Risk of infection is higher with SCLs than RGP CLs	As discussed above, this is due to the water content of the lens. Contaminants can easily penetrate the material and colonize the lens and anything the lens touches (like the cornea).
SCL Characteristics	
SCL materials	SCLs are made of flexible polymers (plastics) and have significant water content. Most SCLs are from 38–72 percent water. Many different combinations of material and water content are available, and the CL fitter must consider the individual patient's needs when choosing a particular lens.

SCL materials

Lens material and water content affects the following:

O_2 permeability.

Lens tendency to attract protein deposits.

SCL parameters.

SCL prescription.

O_2 permeability

Just like RGP CLs, the density of the SCL material affects its O_2 permeability. Less dense materials have higher O_2 permeability. Water content plays a large role in material density. Higher water content results in lower material density and higher O_2 permeability.

Lens tendency to attract protein deposits

SCLs are available in both hydrophilic and hydrophobic materials. Hydrophilic materials typically resist proteins better than hydrophobic materials. However, hydrophobic materials are more comfortable, especially for patients with dry eye. When considering a specific material, lenses with higher water content are generally more prone to deposits than lenses with lower water content. Again, the CL fitter must consider the individual patient needs when choosing an appropriate lens.

SCL parameters

SCLs do not have as many parameters as RGP CLs. Normally, only the following four parameters are considered as SCL parameters:

1. Material—the actual polymer used to make the lens. Most CL fitters simply indicate the brand name of a specific lens. Several brand name lenses are made of the same material.
2. PWR—the dioptric PWR of the CL.
3. DIA—the overall DIA of a CL. The DIA is also referred to as the *OAD* and is always specified in mm.
4. BC—the back surface curve of a CL. The BC is always given in mm (radius of DIA) rather than diopters. The BC is determined by the front curvature of the patient's central cornea.

SCL prescription

A CL fitter must specify all four of the parameters discussed previously. The CL Rx is normally given an expiration date of one year. The written Rx looks similar to this:

OD: Acuvue Oasys 14.0 / 8.8 / –4.00

OS: Acuvue Oasys 14.0 / 8.8 / –3.75

In this example, the specific brand name of the lenses prescribed is Acuvue Oasys. The DIA of the lenses is 14.0 mm for both eyes, and the BCs are 8.8 mm for both eyes. The PWR of the right lens is –4.00D and the PWR of the left lens is –3.75D.

The following table lists and describes the types and replacement types of SCLs.

Types of SCLs	
Type	**Description**
DW	The FDA has approved DW SCLs for DW only. The wearer is expected to remove his or her lenses nightly for cleaning and to give the eyes a "rest" from CL wear.
EW	EW SCLs have been determined by the FDA to be safe when worn on a continuous schedule. Most EWSCLs are approved for seven days and six nights of wear, but several lens are approved for up to 30 days of continuous wear.
Flexible Wear (FW)	FW SCLs are designed to be worn on a DW basis but have been determined by the FDA to be safe to wear overnight occasionally.
Replacement Type	
Conventional SCL	Conventional lenses are designed to be used for 12–18 months before being replaced. These lenses require the most diligent care. However, all SCLs eventually accumulate permanent protein no matter how well maintained. Protein deposits decrease the lens's O_2 permeability and affect both vision and comfort. The older the lens is the less healthy it is to wear due to protein deposits.
Replacement Type	
Frequent Replacement (Planned Replacement)	Frequent replacement lenses are replaced monthly, quarterly, or semi-annually. Because of protein buildup over time, replacing the lenses more frequently is healthier for the eye.
Disposable SCL	Disposable lenses are just that, lenses that are thrown away and replaced after a specified period of time. They may be prescribed to be worn on an EW basis, in which case, they are replaced at least weekly. If prescribed to be worn on a DW basis, they are replaced at least every two weeks and as frequently as daily. Disposables are the most popular lenses because they require minimal care and are the healthiest CLs for the eye.
Correction Type	
Spherical	A spherical lens has the same BC in all meridians. Spherical lens are used to correct simple myopia and simple hyperopia. They can also be used for patients who have small amounts (<1.00D) of astigmatism. The lens "masks" some of the astigmatism by gently molding the cornea from a football shape into a basketball shape, but the patient's vision is not likely to be as clear as it is with his or her spectacles.
Toric	A toric lens is an SCL with one BC, but two different refracting PWRs oriented 90° away from each other. A toric lens is used to correct the vision of patients who have larger amounts (>1.00D) of corneal astigmatism. A toric lens may be either a cylinder or a spherocylinder lens.
Bifocal	Bifocal SCLs are available in both concentric PWR rings and aspheric designs (fig. 4–3).
Color Type	
Clear	A colorless, clear lens.
Tinted	Lenses are available with tints serving specific purposes.
Visibility Tint	Some lenses have a very light blue or aqua visibility tint. This tint does not affect the color of the patient's eye but makes the lens easier to see if it's dropped on a white surface like a sink.
Enhancing Tint	This tint makes the patient's eyes appear a deeper shade of their original color, without actually changing the eye color. A blue enhancing lens makes a blue eye appear a deeper blue; a green enhancing lens makes a green eye appear a deeper green, etc.

Types of SCLs	
Type	**Description**
Color Type	
Opaque	An opaque tint is a tint completely masking the patient's natural eye color. Opaques are most popular with dark-eyed individuals desiring blue or green eyes. The CLs used for special effects in movies and often at Halloween time (zombie, cat eye, 8-ball, etc.) are opaque lenses.
X-chrom Lens	The X-chrom lens is a red CL worn on the nondominant eye of color-deficient people. The lens helps some patients to better interpret colors or contrasts.

NOTE: Spherical, toric, bifocal, and tinted lenses are all available as both DW and EW SCLs.

All lenses can be described using one of the terms from each of the type categories: wear, replacement, correction, and color. The optometrist prescribing the lenses is responsible for specifying the exact wear schedule as well as the replacement schedule.

There are hundreds of lenses available to today's doctor for prescribing. A useful resource is a quarterly publication named *"Tyler's Quarterly."* It lists all the CLs, both SCLs and RGP CLs, approved by the FDA and available for prescribing in the United States.

Verifying CL parameters

CLs, like spectacles, must be verified before dispensing to ensure they meet the specifications requested. Since CLs come in direct contact with the highly sensitive cornea, verification of CLs, in some respects, may be even more important than verification of spectacles.

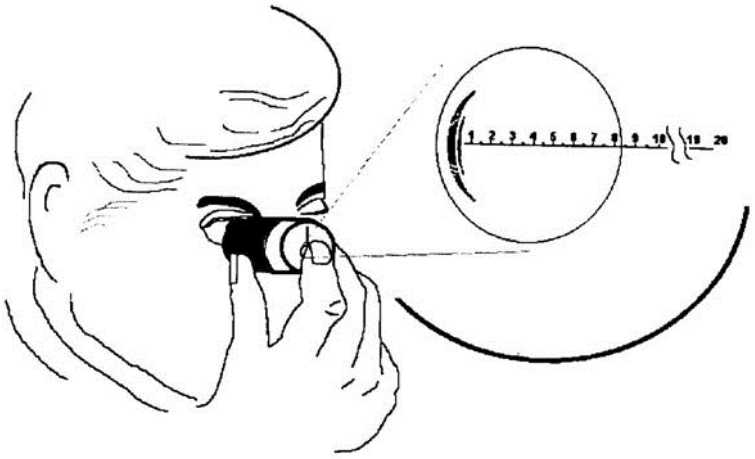
RGP CL verification

Verification of RGP CLs usually consists of the parameter checks listed in the table below, along with the equipment used to perform the check.

RGP CL Parameter Checks	
Parameter Checked	**Equipment Used**
BC	Radiuscope (fig. 4–4) or "con-ta-check" (an attachment to the keratometer).
PWR	Lensometer.
DIA or OAD	Magnifying loupe (fig. 4–4) or reticle.
OZ	Magnifying loupe (fig. 4–4) or reticle.
CT	Thickness gauge (fig. 4–4) or Geneva lens clock.
Edge	Slit lamp.

Soft lens verification

Verification of soft lenses consists simply of double-checking the parameters listed on the shipping vial with those requested, as well as inspecting the lens on the patient's eye before dispensing. Because of their elasticity, verification beyond checking the vial and placing the lens on the patient's eye is difficult with current instrumentation. However, due to the soft lenses' susceptibility to contamination and tearing, quality control by the manufacturer is strictly enforced.



Magnifying loupe (reticle)

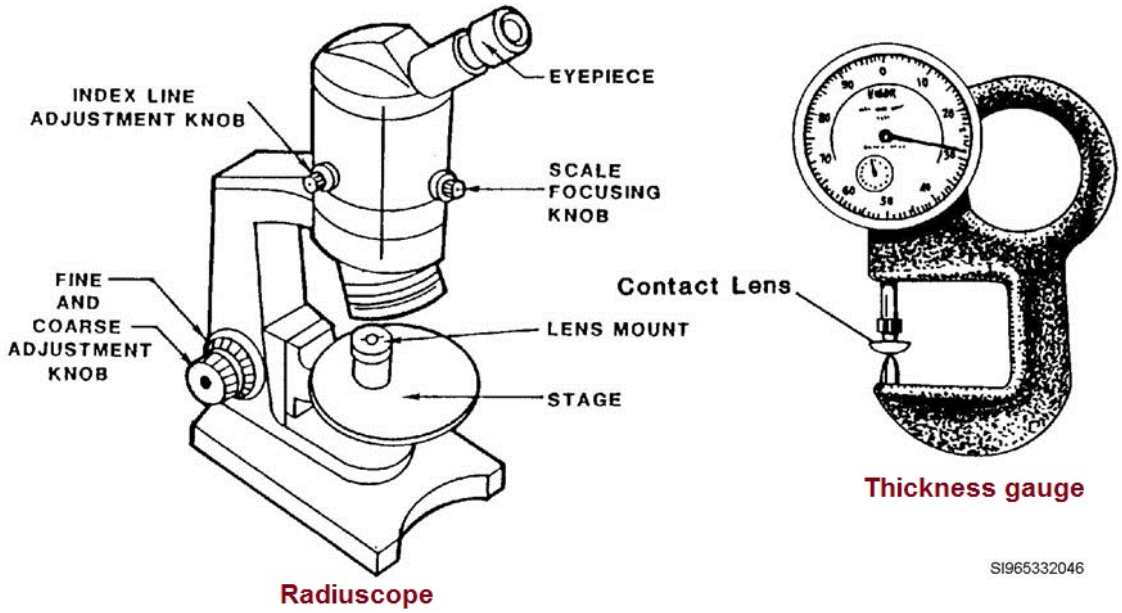


Figure 4–4. Magnifying loupe (reticle), radiuscope, and thickness gauge.

627. Inserting and removing contact lenses

It's essential that good hygiene be emphasized before a patient inserts or removes a CL. Certain rules of hygiene must constantly be observed to preclude the possibility of an infection or disease. The patient's hands must be thoroughly washed before handling, inserting, or removing CLs. The soap used should be free of cold cream, deodorant, or medication. An antibacterial soap is the best choice. A lint-free towel should be used to dry hands to ensure lint does not get on the hands and transfer to the lenses. Additionally, fingernails should be kept clean and neat. If the patient is inserting or removing CLs over a sink, have the patient plug the sink.

Inserting an RGP CL

If the patient wears RGP CLs in both eyes, instruct him or her to always start with the right lens. This will help to ensure the patient does not confuse the right and left lenses. The CL case is clearly

marked for right- and left-lens storage. The best way to prevent a mix-up is to remove the second lens from the contact case only *after* the first lens has been inserted.

After a lens has been cleaned and a wetting agent applied, the convex surface of the lens is placed on the index finger of the dominant hand. With the other hand, the patient grasps the upper eyelid by the margin to prevent blinking. With the third finger of the dominant hand, the patient holds the lower eyelid down while advancing the CL toward the cornea. Using the third finger as a pivot, the patient then places the lens directly on the cornea. Control of the lids should be maintained for 3–4 seconds. The last step is to have the patient look downward and slowly release the lower eyelid, and then slowly release the upper eyelid and blink.

Centering the lens

Occasionally, a lens may slide off the cornea onto the sclera or be inadvertently placed onto the sclera during insertion. (Remember the lens cannot slip behind the eye. The conjunctiva prevents this from occurring.)

First, locate the lens. Have the patient look in the direction of the lens. If this does not work, then have the patient slide the lens onto the cornea by gently pushing or nudging the upper or lower eyelids with the fingers. There is usually enough tearing to permit the lens to be easily steered onto the cornea in this fashion.

Removing an RGP CL

RGP CLs can be removed in one of the two following ways:

1. One-finger method.
2. Two-handed method.

One-finger method

The lens must be on the center of the cornea before attempting removal; again, the patient should start with the right eye. Have the patient look into a mirror and open his or her eyes as wide as possible, causing a startled appearance. The patient then places the index finger or second finger at the temporal canthus, pulls the canthus back toward the ear, while keeping the eyes wide open, and then blinks the eye hard and quick (fig. 4–5). The lens should be ejected by the eyelid margins. If the lens is not ejected, have the patient blink again. The other hand is used to catch the ejected lens.

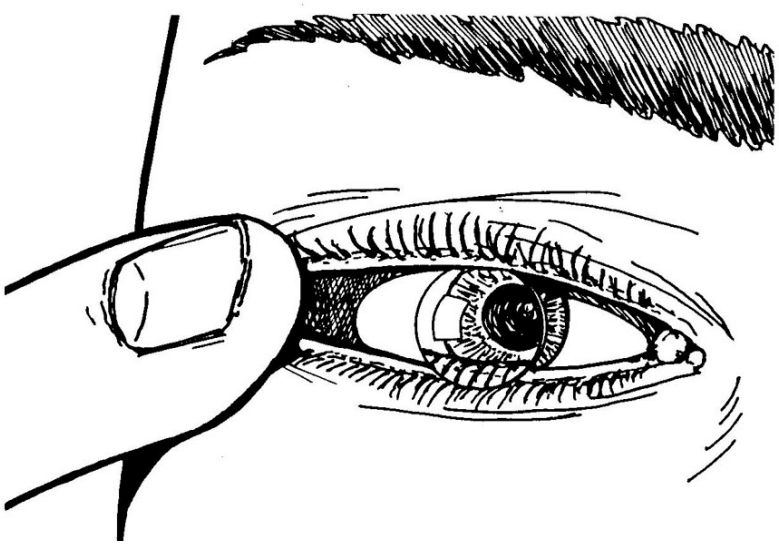


Figure 4–5. One-finger method of RGP CL removal.

Two-handed method

Some patients are unable to remove the lens using the one-finger method. Patients with small eyes or loose eyelids may do better by using two fingers to remove the lens. Patients first place one finger on the lower eyelid and pull the eyelid margin temporally. This places the margin tight against the globe at the lower limbus. Then, with one finger of the other hand, pull the margin of the upper eyelid temporally to place the margin tight against the globe. Then flip the lens out with a scissors motion of the two fingers (fig. 4–6).

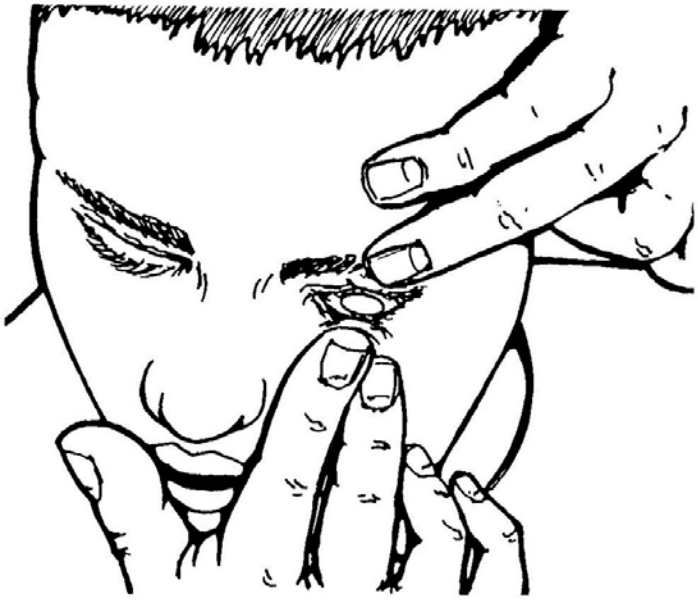


Figure 4–6. Two-handed method of RGP CL removal.

Inserting an SCL

After the lenses have been cleaned, disinfected, and rinsed, they can be inserted onto the eye as follows:

1. Have the patient wash his or her hands; if over a sink, plug the sink, remove the right lens from the case, and inspect the lens for debris.
2. Make sure the lens is not inside out. There are two methods for doing this: the taco test (fig. 4–7) and the bowl test (fig. 4–8).

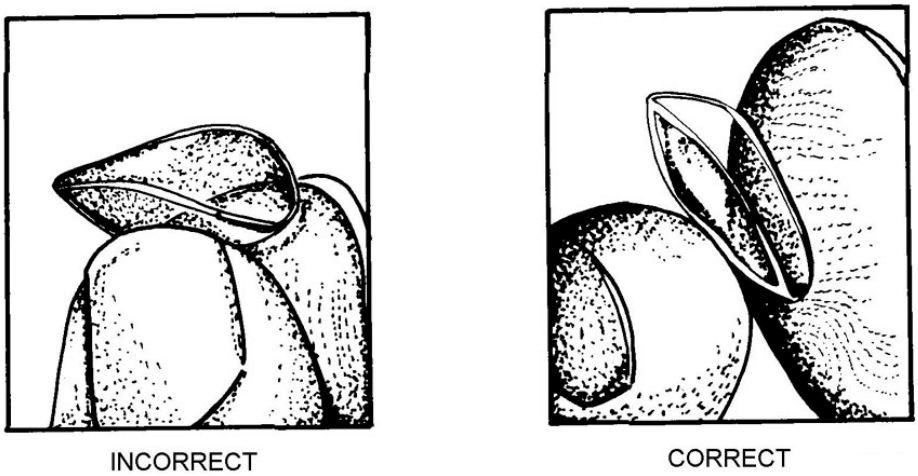


Figure 4–7. Taco test for an SCL.

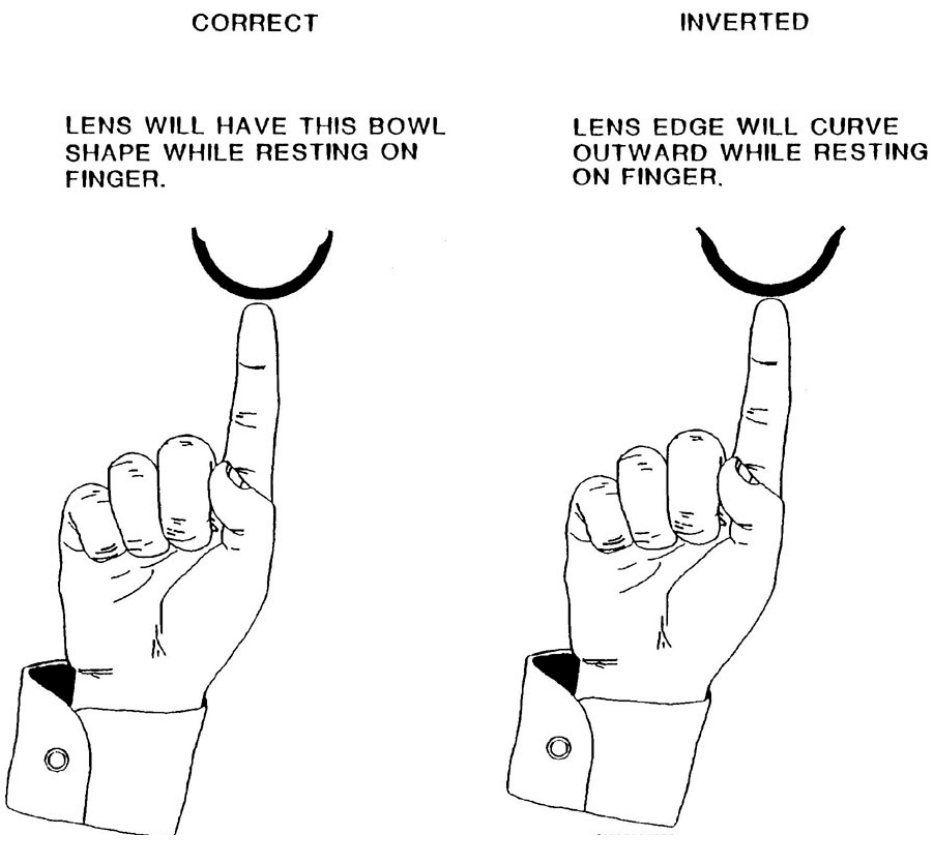


Figure 4–8. Bowl test for an SCL.

3. Have the patient place the moistened lens on the index finger of the dominant hand with the convex side toward the finger.
4. Have the patient pull the lower eyelid down with the middle finger of that hand. Reach over his or her head with the other hand and grasp the upper eyelid (fig. 4–9). This step is similar to the two-handed method used for RGP CLs.

Figure 4–9. Grasping upper lid.

5. Have patient look up.
6. While looking up, the patient places the lens on the lower sclera (fig. 4–10).

Figure 4–10. Placing SCL on lower sclera.

7. The patient then removes the index finger and looks down, lets go of the lower eyelid, waits a second, and then releases the upper eyelid.
8. The lens should center itself. If it does not, have the patient close the eye and massage the eyelid to center the lens (fig. 4–11).

Figure 4–11. Centering SCL.

9. Have patient repeat steps 1–8 for the left eye.

Removing an SCL

Follow these steps for removing an SCL:

1. Have the patient wash his or her hands and, if over a sink, plug the sink.
2. Have the patient hold the right lower eyelid down with the middle finger of the dominant hand (fig. 4–12).

Figure 4–12. Grasping lower lid.

3. Have the patient make sure the lens is on center.
4. Have the patient then reach over his or her head with the other hand and grasp the upper eyelid.

5. Have the patient lightly place the tip of the index finger on the center of the lens surface with the dominant hand.
6. Have the patient look up and at the same time slide the lens down onto the lower sclera, while keeping the index finger on the lens (fig. 4–13).

Figure 4–13. Sliding SCL off cornea.

7. The patient then gently pinches the lens between the thumb and index finger and pulls the lens away from the sclera (fig. 4–14).

Figure 4–14. Removing SCL.

8. Have the patient place the right lens in the case compartment marked “right.”
9. Have the patient repeat steps 1–8 for the left eye.

628. Instructing patients on contact lens wear and care

To teach patients CL care, you must first have a good understanding of the solutions used with both soft and RGP CLs.

Solutions

Various solutions are available for CL care. The table below lists and gives the use of each type of solution.

CL Solutions and Use	
Solution	**Use**
Cleaning	Cleans both SCL and RGP CLs.
Rinsing	Rinses off SCL or RGP CLs. It can be normal saline, a storing, or a disinfecting solution.
Disinfecting	Kills bacteria and viruses. Used on both RGP CLs and SCLs.
Soaking and Storing	Stores the SCL and RGP CLs. It can be a disinfecting solution.
Neutralizing	Used in conjunction with certain SCL hydrogen peroxide disinfecting solutions to neutralize the hydrogen peroxide.

CL Solutions and Use	
Solution	**Use**
Conditioning and Storing	Specialized storing solution for an RGP CL, aiding in the wetting of the RGP CL.
Enzyming	Used on a weekly basis to remove stubborn deposits or protein buildup on an SCL or RGP CL.
Wetting	A specialized solution for RGP CLs. It aids in making the lens hydrophilic (loves water). It's used on an RGP CL before inserting it into an eye.
Lubricating	Used with an SCL and an RGP CL to rewet the lens while still in the patient's eye.

Caring for RGP CLs

Most patients you examine will wear either SCLs or RGP CLs, but you might see a few hard CL wearers. Just remember, handle hard lens similarly to RGP CLs.

As you did when giving instructions for insertion and removal of CLs, stress to your patients the importance of good hygiene.

Cleaning solution

Clean RGP CLs with an RGP CL cleaning solution. Place a drop of the cleaning solution on the concave surface of the lens and rub the solution onto both lens surfaces with the thumb and index finger for a few seconds.

Another cleaning method is to place an RGP CL in the palm of your hand. Next, add three drops of cleaning solution. Using your index finger and the palm of your hand, vigorously scrub both sides of the lens. Daily cleaning of the lens is necessary to remove any deposits, protein buildup, cosmetics, or other debris the lens may have acquired during the day.

Rinsing solution

After cleaning, the lenses must be rinsed to remove the cleaning solution. This is done by using a rinsing solution, which is normally a preserved saline. Cleaning and rinsing should be done each day because dirty lenses can produce discomfort and interfere with proper wetting of the lens.

Soaking/storing solution

After rinsing the lenses thoroughly, place them in a soaking/storing solution overnight. These solutions contain antimicrobial agents to disinfect the lens. Some soaking solutions have a conditioner in the solution, which reconditions the surface of the lens, allowing it to wet properly.

Wetting solution

In the morning, patients remove the lenses from the case, and apply a wetting solution. The patient applies the wetting solution by placing a lens in the palm of his or her hand and putting two drops of wetting solution on the lens. Patients should make sure both sides of the lens are covered with the wetting solution.

Multipurpose solution

Solutions are available in a combination of cleaning, wetting, and soaking solutions.

Enzyming solution

An enzyming solution is used weekly. It consists of either a solution or a pill mixed with saline. The main purpose for using an enzyming solution is to disintegrate the stubborn built-on protein that has not come off with daily cleaning. Each enzyming solution is different. Some take 15 minutes to work, while others take hours. Read the instructions enclosed with the enzyme solution before using it.

Lubricating solution

The last solution used with RGP CLs is the lubricating solution. The patient uses this rewetting solution while he or she is still wearing the CL. A drop of this solution is placed in the eye by having the patient tilt his or her head back and gently placing one drop in the lower conjunctival sac.

Caring for SCLs

Just as with RGP CLs, SCLs need to be cared for properly. Because SCLs tend to absorb bacteria and other unwanted substances, it's imperative they be cleaned and disinfected daily, unless, of course, they are EW or disposable. As with RGP CLs, use only SCL-approved solutions on SCLs. RGP CL solutions should never be used on SCLs, because it can ruin the lens.

Additionally, never use fluorescein on a patient while he or she is still wearing SCLs. Fluorescein permanently turns the lenses yellow. Ensure the SCL patient does not reinsert his or her lenses for at least one hour after the use of fluorescein.

Normally, at the end of the day, an SCL wearer needs to take the lenses out, clean, disinfect, and store them overnight. Be very careful when cleaning SCLs. Unlike an RGP CL, an SCL is very fragile and can be torn easily by the patient's fingernail (fig. 4–15).

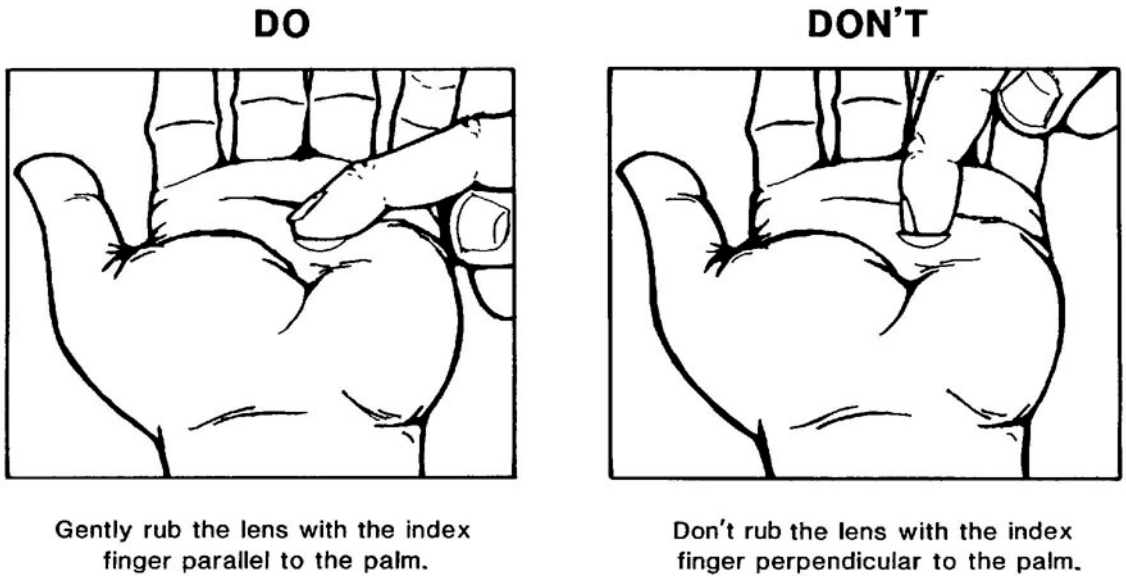


Figure 4–15. "How-to" of SCL handling.

Instruct patients to trim back the fingernail of the index finger of their dominant hand (usually the right) and not to use the end of the index finger but to use the "pad" of their index figure as shown in figure 4–15.

Cleaning solution

For cleaning, have the patient place the contact in the palm of his or her left hand. Place three drops of an approved SCL cleaning solution on the lens. Instruct the patient, with the palm side of the right index finger, to scrub the surface of the CL in a back-and-forth motion. Warn the patient if the SCL ever gets near the fingernail, to stop immediately and move the lens away from the fingernail. Remind the patient to keep his or her index finger parallel to the palm of the other hand (fig. 4–15). Clean one side of the lens for 30 seconds. Then, have the patient flip the lens over and clean the other side of the lens using the same technique.

Rinsing solution

Once the lens is clean, it's then time to rinse off the soap using an approved SCL rinsing solution. This rinsing solution can be a saline solution or a disinfecting solution. Instruct the patient to read the label on the bottle to tell whether he or she is using the correct solution or not.

Chemical disinfection

To chemically disinfect a CL, a strong chemical disinfectant must be used to kill off any bacteria. There are two types of chemical disinfection systems used. The first type uses hydrogen peroxide; the second type uses a nonhydrogen peroxide disinfectant. The hydrogen peroxide system is an excellent disinfectant. Not only does it kill off most bacteria, it also disables the HIV and acquired immunodeficiency syndrome (AIDS).

Aircrew members on the Aircrew Soft Contact Lens Program (ASCLP) must use a hydrogen-peroxide based care system. Ciba AOSEPT® (fig. 4–16) or Clear Care™ are the care systems most clinics recommend for ASCLP participants.

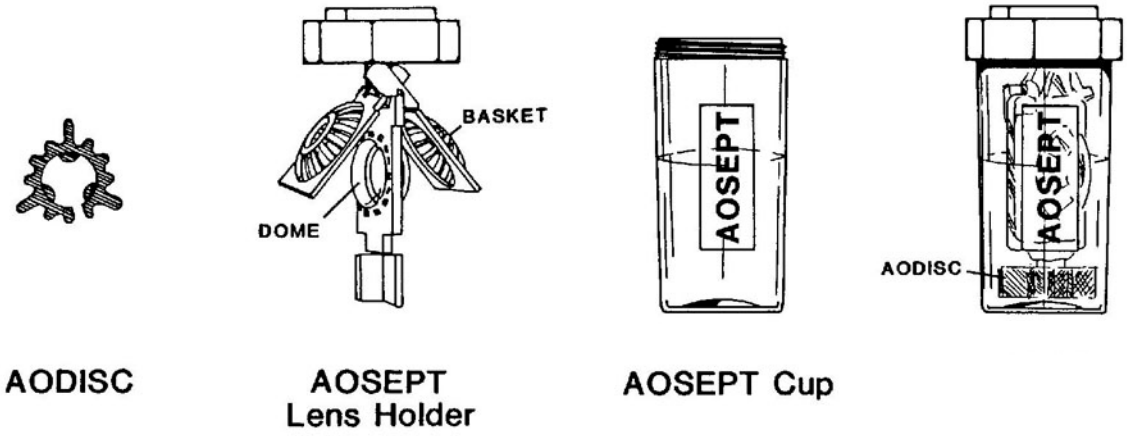


Figure 4–16. AOSEPT® lens holder and cup.

Because it's an easy to use, highly effective solution, many AF eye doctors recommend it to all their SCL wearers. Other ASCLP-approved disinfecting systems include PeroxiClear and Oxysept UltraCare. For this lesson, we'll give instructions for the AOSEPT® system.

NOTE: Solutions containing hydrogen peroxide are extremely irritating to the eye and will cause a chemical burn. Once the hydrogen peroxide has been broken down into water and O_2, it's safe for the solution to make contact with the eye.

In the bottom of the AOSEPT® system case is a platinum disc. The platinum disc slowly neutralizes the hydrogen peroxide. Other systems do not use a platinum disc and must use a neutralizing solution in its place. Just as with other disinfection systems, the right lens is placed in the right basket, and the left lens goes in the left basket. Pour the AOSEPT® hydrogen peroxide solution into the case until it reaches the "full" line, then close the case. Do not be surprised when you hear a fizzing noise; this is normal and to be expected. If you do not hear the fizzing noise, then either the platinum disc is too old to neutralize the solution, or the neutralization/disinfection is complete (this takes a minimum of six hours). Once disinfection is complete, the lenses can be reinserted into the eyes. The table below and figure 4–17 provide further guidance.

AOSEPT® Cleaning and Disinfecting Procedures	
Step	**Instructions**
1	Wash and rinse hands thoroughly and pat dry with a clean, lint-free towel.
2	Remove lenses and place them into the appropriately marked dome basket holder (fig. 4–17[A]).

AOSEPT® Cleaning and Disinfecting Procedures	
Step	**Instructions**
3	Thoroughly rinse the lenses with AOSEPT® for five seconds through the basket holder (fig. 4–17[B]).
4	Fill the lens case to the fill line with AOSEPT® and place the lens holder in the case. Tighten the cap and store lenses overnight or at least for six hours. **NOTE:** Do not shake the case! (fig. 4–17[C]).
5	After soaking lenses for six hours, lenses are ready to wear. No final rinse is necessary, but if you wish, rinse with a sterile saline. NEVER rinse with AOSEPT® prior to insertion!

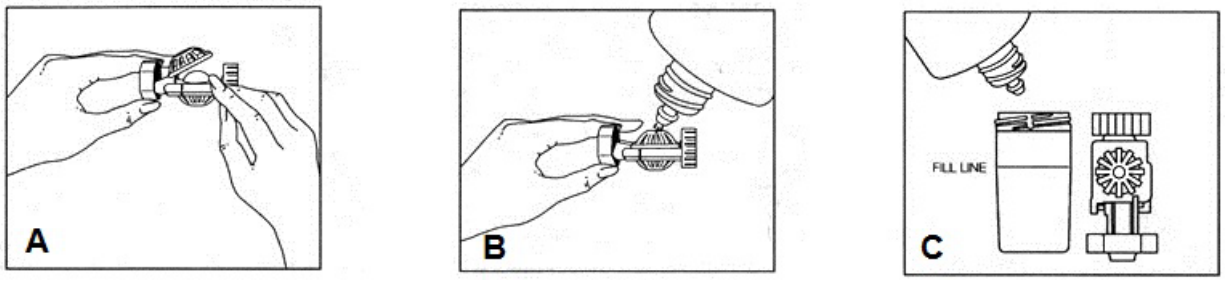


Figure 4–17. How to use the AOSEPT® solution.

With the nonhydrogen peroxide chemical disinfection system, the CLs are stored in the case using only the chemical disinfection solution. The case is filled three-fourths of the way. The right lens is placed in the case, then the left lens. Because this is a disinfecting solution, the lenses need only be stored in this solution for a minimum of four hours in order to be disinfected.

Lubricating solution

Lubricating an SCL is accomplished in the same manner as an RGP CL. Lubrication of the DW lenses is on an as-needed basis. EW and disposable lenses should be lubricated upon awakening and prior to sleeping.

Enzyming solution

Enzyming SCLs is slightly different from enzyming RGP CLs. Enzyming weekly can make the lenses last longer. With the AOSEPT® system, you can enzyme while you disinfect. This saves a step compared to the other systems. This combination step is the best method for enzyming lenses. It has been proven that while enzyming in the hydrogen peroxide solution, the lenses become cleaner than with any other method. After enzyming an SCL, it must be disinfected. Since the lenses are being disinfected as they are being enzymed, you do not have to disinfect the lenses as a separate step with the AOSEPT® system. Two different types of SCL enzymatic cleaners are solutions and pills.

Enzymatic solutions

The first type of enzymatic cleaner we'll discuss is a premade solution. The enzymatic agent is already dissolved into the solution. The solution is placed in a special container holding the lenses. The lenses stay in the solution for the manufacturer's recommended time.

Enzymatic pills

The second type of enzymatic cleaner comes in pill form. The pill must be mixed with saline or a disinfecting solution. When the pill is placed in a solution, it bubbles and fizzes. It's recommended to leave the CL in the enzyme solution overnight.

SCL precautions

Because SCLs can absorb substances, some of which are potentially harmful to the eyes or the lenses themselves, there are certain necessary precautions that should be taken. In the table below are the SCL DOs and DON'Ts; study them carefully.

SCL DOs
1. Use only approved SCL solutions. 2. Use the approved solutions only for what they are designed (i.e., do not use a cleaning solution as a lubricant). 3. Remove SCLs before swimming. 4. Remove SCLs in the presence of noxious and irritating vapors. Remove SCLs if you have to don a gas mask. 5. Keep nonpreserved saline refrigerated. 6. Disinfect the lenses after enzyming. 7. Remove the lenses if there is any redness, discomfort, or blurred vision. 8. Read the instructions if you are not sure!
SCL DON'Ts
1. Use fluorescein with an SCL. (**NOTE:** If fluorescein is used, the patient should not put the lenses back into his or her eyes for at least one hour.) 2. Instill medications or other ophthalmic solutions in the eyes while wearing CLs (both SCLs and RGP CLs). 3. Wear contaminated lenses. 4. Switch brands. Some brands are not compatible with other brands and can ruin the lenses. Always stay with the original brand your doctor prescribed.

Care and cleaning of specific types of CLs

There are a few differences between the care and cleaning of DW, EW, and disposable contacts.

DW

A DW patient wears the lenses only during waking hours. On a daily basis, the patient gets up in the morning, takes the lenses out of the case, rinses them off (uses a wetting solution if the patient is an RGP CL wearer), and inserts the lenses into the eyes.

As the day goes on, the patient may use lubricating drops to rewet the lenses. At the end of the day, the patient removes, cleans, rinses, and stores the lenses. The lenses should be stored in a disinfecting solution (soaking solution for RGP CLs). This goes on each day until the enzyming day (usually on the weekend). On that day, after cleaning the lenses, patients must enzyme the lenses and then disinfect them. The next morning, the patient repeats the regular, daily routine.

EW

For EW lenses, the regimen is different. Because these lenses are worn for a maximum of seven days straight, they are not disinfected or cleaned daily. After wearing the lenses for seven days, remove, clean, enzyme, and disinfect them just like DW lenses. Leave the EW lenses out overnight. The next day, the lenses can be worn.

Disposable wear

For disposable lenses, the care is much different depending on if they are *EW* disposables or *DW* disposables. EW disposable lenses are inserted, then removed and thrown out seven days later. There is no cleaning, disinfecting, or enzyming. DW disposable lenses are treated as DW lenses, but they are not enzymed and are disposed of after approximately 14 days of use.

A recent addition is the daily disposable lens, which is thrown away and replaced daily.

The following table lists how often you should clean, disinfect, enzyme, and lubricate various lens.

Lens Cleaning, Disinfecting, Enzyming, and Lubricating Schedule				
Lens Type	**Cleaned**	**Disinfected**	**Enzymed**	**Lubricated**
DW	Daily	Daily	Weekly	As needed
EW	Weekly	Weekly	Weekly	Upon awakening and before sleeping

Lens Cleaning, Disinfecting, Enzyming, and Lubricating Schedule				
Lens Type	**Cleaned**	**Disinfected**	**Enzymed**	**Lubricated**
Disposable EW SCL	None	None	None	Upon awakening and before sleeping
Disposable DW SCL	Daily	Daily	None	As needed
Disposable Daily	None	None	None	As needed
FW	Daily	Daily if in DW Mode	Weekly	As needed

You may be the only one who ever gives the patient instruction on how to care for his or her lenses. A good portion of CL-related complications can be linked back to a pattern of improper care. Make sure your patients understand how to care for their lenses and why each step is important. Patients who understand the consequences of neglecting lens care are usually much more compliant.

Deployments and CL wear

When instructing patients on CL wear and care, you may find it helpful to educate active duty (AD) personnel (nonaircrew) that they are not allowed to deploy with CLs unless they have written authorization by the deployed unit commander.

If given approval, these members must receive predeployment education on the safe wear and maintenance of CLs in the area of responsibility (AOR) environment. Additionally, members are still expected to deploy with two pairs of spectacles, a gas mask and/or ballistic eyewear insert (if applicable), and a full complement of CL maintenance items (i.e., storage and cleaning solutions), enough to last for the duration of their deployment.

629. Maintaining the contact lens inventory

Once a lens has been used on a patient, it needs to be cleaned, disinfected, enzymed, and then stored properly until its next use. As stated earlier, the first step, as always, is to clean your hands. Then use approved SCL cleaning solution (daily cleanser) on the lens. Next, rinse off the cleaning solution with an SCL rinsing solution (usually saline solution) followed by disinfection and enzyming. This is usually done chemically with a hydrogen peroxide system (AOSEPT®) and the Ultrazyme® tablets, used according to instructions. Once you have completed all of these steps, store the CL.

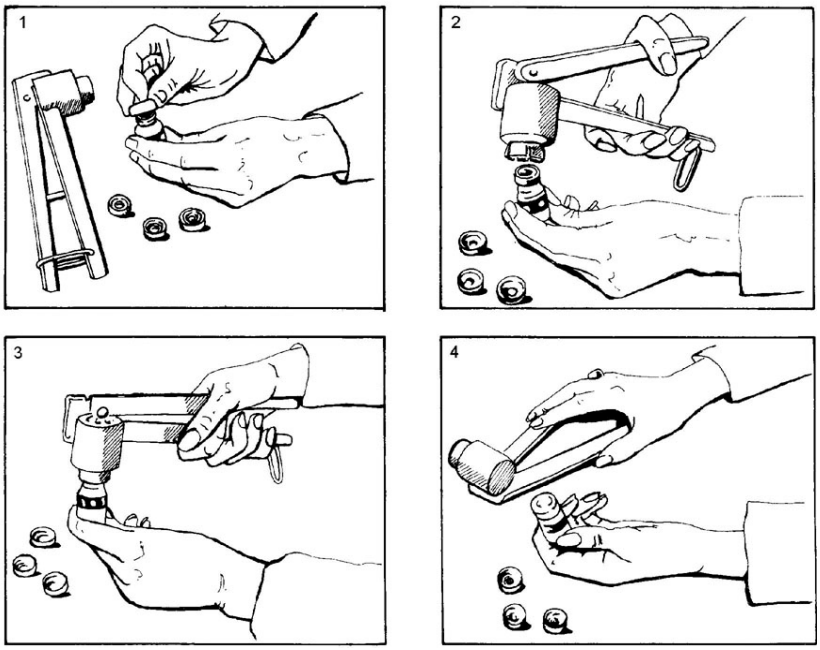


Figure 4–18. CL vial crimper in use.

If your clinic maintains diagnostic fitting lenses, they are stored in the vial they came in (the vial with the CL information printed on it). It's recommended the lens be stored in Opti-Free®, a disinfectant storage solution made by Alcon. Fill the vial and place the rubber stopper in the top. A metal cap (called a vial cap) is placed over the rubber stopper and crimped in place with CL vial crimpers (fig. 4–18).

After the vials have been sealed, it's a good practice to mark them in some manner to let you know how long they have been stored. If the lens has not been used again to fit a patient within 90 days, it's best to dump the old Opti-Free® from the vial and replace it with fresh Opti-Free®. In case your clinic maintains an RGP CL fitting set, the cleaning, disinfecting, and storage procedures are not much different. Use only approved RGP CL solutions with these lenses. Like you did when handling any other types of lenses, first clean your hands. Next, clean the RGP CLs with a cleaning solution, then rinse them. RGP CLs can also be stored dry. When an RGP CL is to be used on a new patient, rinse the lens, and then cover it with a wetting solution before insertion.

630. Elective and medical contact lens programs

Elective CL-related services are not covered by TRICARE and do not have to be offered at an MTF. Elective means the patient chooses to wear CLs. Nonelective CL services would include service to those who require CLs to see well (i.e., patients who have corneal disorders and whose vision can only be corrected with a CL) and those requiring CL wear in the performance of their duties (some aircrew personnel).

Elective CL programs

Most optometry clinics offer some elective CL services—the scope is dependent on the resources available and the impact on beneficiaries' access for routine eye care (which is a TRICARE benefit).

The availability of elective CL programs can depend on manning (how many doctors/technicians are assigned to a clinic), as well as the demand for services. If a clinic is low-manned, the staff has to prioritize what the clinic can offer. Because the wear of CLs is typically elective in nature, it's typically one of the first programs cut or altered to save time, allowing the clinic to see more patients. Sometimes the program is scrapped completely—the clinic will not perform CL fits or updates for anyone. Sometimes it's scaled back—the clinic will only perform CL updates for those patients already wearing contacts and having no complications. Sometimes the program is available to all patients, sometimes only to AD members, and narrower still, sometimes it's only available to AD members on the ASCLP.

Under the elective CL program, patients are both physically and financially responsible for obtaining their lenses and solutions. The optometry clinic provides professional fitting and follow-up service as well as a written CL Rx.

Medical CL programs

Medical CL services are available at most optometry clinics and take priority over elective CL services. TRICARE only covers contacts to treat certain conditions. Examples of lenses that qualify as medical CL services include the following:

- Corneal or scleral lenses for treatment of keratoconus.
- Corneal or scleral lenses to reduce corneal irregularities other than astigmatism.
- Scleral lenses to retain moisture when normal tearing is not present or is inadequate.
- Intraocular lenses or CLs for loss of human lens function resulting from intraocular surgery, ocular injury, or congenital absence.

Ordering CLs

The procedures to order CLs for those members that fall under the medical CL program vary depending on your medical logistics' requirements.

Regardless of the slight variations in what different medical logistics sections might require to place an order, they will always need the following information from your clinic:

- Your ophthalmic clinic's medical supply account number.
- The patient's first and last name and contact information.
- The CL Rx information:
    - Brand.
    - PWR.
    - BC.
    - DIA.
- The name of the CLs company/supplier and their address and phone number.

The ophthalmic clinic has to pay for lenses ordered under the medical CL program. This is why, in addition to the Rx, you must provide your clinic's account number to medical logisitics.

ASCLP

For members on the ASCLP, there is not necessarily a medical *need* to wear contacts. Unless the aircrew member has a medical condition warranting the *need* to wear contacts, their lenses are not purchased by the ophthalmic clinic. However, under the ASCLP, the member's unit can opt to purchase contacts for their personnel. If this is the case, the member's unit is responsible for placing those orders themselves. Routine CL wear that is not medically indicated should not be ordered through the ophthalmic clinic or through medical logistics.

Free diagnostic fitting lenses and CL solution

Many companies offer free diagnostic fitting (trial) lenses and CL solution. This is a win-win situation for you and their company. You get free supplies, while the company gets a patient successfully using their lenses and/or CL solution. When the patient is given a Rx, it's for their specific brand of contacts and they have gained a new customer. To minimize the chance of an allergic reaction, doctors typically recommend to their patients not to switch CL solution, so patients may also stick with the brand of solution they are given.

More than likely, your clinic already has accounts with each of these companies. If not, it would behoove you to contact these companies and establish accounts. Doing so allows you to place orders quickly and efficiently online. When setting up an account, let the company know you work in a military ophthalmic clinic. Often, they have a representative trained and dedicated to assisting military facilities and are already knowledgeable of our unique restraints. You can never commit military funds to pay for items without properly routing a request through medical logistics. Unfortunately, with these "free" products, the company still expects the ordering clinic to pay for shipping and handling. This complicates the ordering process for a military ophthalmic technician hoping to obtain free items. However, if you inform the company representative of this military restriction, often the representative is able to set up the account to automatically waive the shipping fee. This allows your clinic to quickly and easily place orders online and take advantage of what are now actually free products.

Some of the companies to contact include the following:

- CooperVision at http://coopervision.com/.
- Bausch & Lomb at http://www.bausch.com/.
- Vistakon at http://www.acuvueprofessional.com/.
- Alcon at http://www.alcon.com/eye-care-products/.
- AMO at http://www.abbottmedicaloptics.com/products/corneal.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

626. Contact lens characteristics

1. What are the two general categories of CLs?

2. List the advantages and disadvantages of RGP CLs.

3. What does O_2 permeability refer to in regards to RGP CLs?

4. What do hydrophilic materials allow for?

5. List the advantages and disadvantages of SCLs.

6. SCLs are made up of what percentage of water?

7. Which SCLs are better at resisting protein buildup?

8. What are the four Rx parameters normally considered when prescribing SCLs?

9. What is the purpose of visibility tints on an SCL?

10. What is the purpose of an X-chrom lens?

627. Inserting and removing contact lenses

1. What two simple things can patients do to keep from confusing the right and left CLs?

2. Why is it not possible for an RGP CL to slip behind the eye?

3. What are the two methods for removal of an RGP CL?

4. What are the two methods for ensuring that an SCL is not inside out?

5. Before removing an SCL, where should it be on the eye?

628. Instructing patients on contact lens wear and care

1. List the types of solutions used in CL care and indicate whether they are used on RGP CLs, SCLs, or both.

2. What is the main purpose of an enzyming solution?

3. If fluorescein is installed while the patient is still wearing SCLs, what, if anything, will happen to the CLs?

4. What are the two types of chemical disinfectants used with SCL?

5. Why is the hydrogen peroxide system an excellent disinfectant?

6. List three dos and three don’ts associated with SCL handling or wear.

629. Maintaining the contact lens inventory

1. What four things must you do to a lens after it has been used on one patient and before it is used on another patient?

2. What is the recommended disinfectant storage solution for lens fitting sets?

3. When maintaining CL sets, how many days can you store the lenses between uses before replacing the disinfectant storage solution?

4. After an RGP CL has been rinsed, and before inserting it on a new patient, what solution should be used on it?

630. Elective and medical contact lens programs

1. TRICARE does not cover which CL service?

2. Who is responsible for obtaining the patient’s lenses under the elective CL service program?

3. Which types of CLs would qualify under the medical CL program?

4. What information do you need to provide to medical logistics to order CL?

5. If a member is on the ASCLP and his or her unit opts to purchase contacts for its personnel, what organization is responsible for placing the order?

4–2. Aerospace Optometry

You interact with members on flying status on a daily basis. With this in mind, it would be beneficial to understand some of the general aircrew terminology. Once we create that foundation, we'll further discuss the specifics of the ASCLP—the member's responsibilities and the oversight of the program.

631. Aircrew terminology

Different categories and acronyms, as well as different medical classes for flying, describe aviation personnel. The category an aircrew member belongs to is defined by his or her duties in accomplishing the flying mission. With this in mind, let us look at some of the different classes of flyers.

Rated aircrew

Rated aircrew includes all USAF officers who hold a current USAF aeronautical rating. This category includes pilots, navigators, weapons systems officers, electronic warfare officers, 12SX Special Operations Combat Systems Officers, and flight surgeons (FS).

Nonrated aircrew

Nonrated aircrew includes both USAF officers and enlisted members who are routinely required to be onboard the aircraft to accomplish the primary mission. This category includes loadmasters, flight engineers, aerial gunners and bombers, pararescue personnel, and flight nurses.

Operational support flyer (aviation-related special duty)

Operational support flyers (also referred to as aviation-related special duty) include individuals required to perform specific, essential in-flight duties authorized crewmembers (rated/nonrated) cannot perform. These individuals may fly frequently and regularly, but they are not routinely required to be onboard the aircraft to accomplish the primary mission. This category includes all ground-based aircraft controllers, such as air traffic controllers and combat controllers.

Aviation-related acronyms

The table below lists aviation-related acronyms and their description.

Aircrew Acronyms	
Acronym	**Description**
FSO	Flight surgeons office, also known as flight medicine. The FSO is ultimately responsible for the healthcare of aircrew personnel. Paper aircrew medical records are designated with the word "FLY" on the outside of the cover. Electronic aircrew medical records have a black plane icon in the upper right-hand corner of the screen. Paper records are maintained in flight medicine rather than the main record section of the hospital/clinic. If seen for a medical appointment by an outside agency (any clinic, military or civilian), aircrew members should notify flight medicine so that the FS can review the medical entry for that appointment. Based upon the medical record entry, the FS makes a determination of whether the individual is medically qualified to continue his or her flying duties.
DNIF	Duties Not Including Flying Anytime an aircrew member has a medical condition or is on medication that could compromise his or her performance on duty, he or she is placed on DNIF status until the condition is resolved. Aircrew members are often placed on DNIF when they do not meet visual standards for flying. Because the mission of the optometry clinic is to support the AF flying mission, it is imperative that the visual care for aircrews is a high priority to minimize DNIF time.
DNIC	Duties Not Including Controlling
DNIJ	Duties Not Including Jumping
DNIA	Duties Not to Include Alert
RPA	Remotely Piloted Aircraft
SUAS	Small Unmanned Aircraft Systems
SOD	Special Operational Duty

Medical flying classes

An aircrew member's flying class dictates the following:

- The tests required during a flight physical.
- How many pairs and which types of spectacles are authorized.
- If a member wears contacts, the requirement to be on the ASCLP or not.
- The type of testing that is required if the member requires any vision waivers.

Flying Class I

Flying Class (FC) I qualifies members for selection into military flight screening (MFS), and once MFS is passed, commencement of undergraduate flight training (UFT). These aircrew members are students who, upon graduation, become rated aircrew and are then classified as FC II.

FC IA qualifies members for selection and commencement of Undergraduate Navigator Training (UNT) and initial medical qualification for 12SX Special Operations Combat Systems Officer.

FC II

FC II qualifies members for the following:

- Selection into URT and FS training.
- Rated officers for continued flying duties (pilots, RPA pilots, navigators/electronic warfare officers, 12SX Special Operations Combat Systems Officer, and FSs).

FC II qualifies rated officers for duty in certain restricted aircraft categories:

- FC IIA—low-G aircraft (i.e., tanker, transport, bomber, T–43, T–1).
- FC IIB—nonejection-seat aircraft.
- FC IIC—aviation duty as specified on the member's Department of Defense (DD) Form 2992, Medical Recommendation For Flying Or Special Operational Duty, or equivalent (i.e., restricted to multiplace aircraft).
- FC IIU—duty as URT and RPA pilot duties only.

FC III

FC III qualifies members for aviation as indicated in the Air Force Officer Classification Directory (AFOCD), and the Air Force Enlisted Classification Directory (AFECD). Nonrated aircrew personnel and operational support flyers fall into this category.

SOD

A SOD exam qualifies members for duties in which aviation is not their primary function; they must meet aviation standards if so indicated in the AFOCD or AFECD.

Aircrew visual requirements

All aircrew members, rated, nonrated, and operational support personnel, are required to have 20/20 VA in each eye; both in the DVA and NVA, at all times. If an aircrew member wears CLs, he or she must have a DVA of 20/20 and an NVA of 20/20 in each eye while wearing his or her contacts. For members on the ASCLP, documentation must show that their vision is also 20/20 wearing their spectacles immediately after the removal of their CLs.

Failure to meet the visual requirements results in DNIF/C/J/A status until the vision is corrected. This usually means placing a priority order for new spectacles. In the event their vision cannot be corrected, the FS may elect to permanently remove the individual from flight status.

As stated earlier, the FS makes the determination of whether the individual is medically qualified to continue his or her flying duties. The ophthalmic clinic performs the required or requested tests and advises the FS whether the individual meets visual and eye health standards required for continued flight duty.

Aircrew spectacle authorizations

Aircrew members who are on active flight status are authorized two pairs of flight frames with clear lenses and two pairs with tinted lens. When ordering spectacles for aircrew members, always ask if they fly with night vision goggles (NVG). If they do, it's imperative their glasses be ordered with polycarbonate lenses for safety purposes.

Personnel on inactive flight status are authorized one pair of clear flight frames per year. Pilot trainees are also authorized flight frames, but the glasses are not provided until the trainee is ready to report to the flying phase of their training. Pilot trainees are authorized one clear and one tinted pair of flight frames.

While we tend to think of the flight frame as being for flyers only, other personnel are authorized their wear. The following is a fairly complete list of nonflying status personnel who are authorized to get flight frames:

- AF Air Traffic Controllers (one clear and one tinted pair).
- Navy parachute riggers who are required to perform parachute testing (one tinted pair).
- Deployable members of the US Navy Navigation Aids Support Unit (one clear and one tinted pair).
- Nonflying physiological training personnel required to perform chamber duties (one clear pair).
- Navy aviators, Navy flight line, and Navy flight deck personnel (authorized the gold Air Force flight (AFF) frames).
- Nonflying team members of the Navy's Blue Angels and the AF Thunderbirds (one clear and one tinted pair).
- High altitude/low opening (HALO) and high-altitude airdrop mission support personnel (two clear pairs and two tinted pairs).
- Missile propellant transfer personnel required to wear rocket fuel handler clothing while performing missile fuel transfer and inspection duties (two pairs clear with comfort cables).

632. Aircrew soft contact lens program

As you're aware, we have mentioned the ASCLP numerous times in this volume of your CDCs. This is because the ASCLP is an overlapping program that requires proper documentation in the patient's medical record and the Aerospace Information Management System (ASIMS). The ASCLP also shares training and ordering procedures with the general CL program and involves co-management with the flight medicine clinic.

The lesson that follows provides information to help you better explain the ASCLP. More information and the most recent updates regarding the ASCLP can be found in AFI 48–123, *Medical Examinations and Standards*, and the *USAF Aircrew Contact Lens Policy* found through the Optometry/Ophthalmic Technicians Knowledge Exchange site at: https://kx2.afms.mil/kj/kx2/AFContactLensProgram/Pages/home.aspx.

Eligibility

FC I/IA/II/IIU/III personnel must be under flight medicine management if they use CLs while performing aircrew duties.

All FC I/IA members who elect to wear contacts must adhere to all ASCLP requirements, regardless of whether they wear their contacts on or off duty.

For FC II and IIU members, program requirements must be met if they wear their contacts eight hours prior to or while performing aircrew duties. If these members only wear their contacts when off duty and at least eight hours before reporting for duty, they are not required to follow ASCLP requirements but are highly encouraged to do so.

FC III individuals are only required to adhere to ASCLP requirements if they use CLs for in-flight duties. As with the FCII and IIA members, they are still highly encouraged to do so.

Approved CLs and waivers

Only CLs and solutions on the approved ASCLP list are authorized. This list can be found at the website previously mentioned. A waiver is required for any aircrew member who is required to wear a CL or use a solution that is not on the approved list.

Since only lenses on the approved ASCLP list can be worn, this makes bifocal, EW, and monovision CLs off-limits. However, for FC II/IIU/III members, these lenses can be electively worn while off-duty.

For aircrew personnel who require correction for an astigmatism of 2.00 diopters or greater, a waiver must be obtained before they can wear CLs while on duty.

Risks associated with CL wear

To decrease the potential of undue risk, SCLs are used to correct the vision of nondiseased eyes and are best when worn on a daily basis only. CLs must never be worn during sleep, or for more than 24 consecutive hours, unless operationally required. At the end of each wearing period, the aircrew member must remove, clean, and properly disinfect the CLs. The risks of SCLs when worn in this manner are minimal. If worn on flights exceeding four hours, eye irritation becomes much more likely (due to dry air). If this occurs, CL use must be discontinued for the remainder of the flight, and the member should promptly report to an optometrist for an evaluation.

In larger studies, some patients have reported the following temporary conditions related to CL wear (these conditions may briefly ground an aviator):

Discharge.
Discomfort.
Blurred vision.
Distorted vision.
Minor infections.
Sensitivity to light.
Redness (fig. 4–19).
Watering of the eyes.
Abrasion of the cornea.
GPC (fig. 4–20).

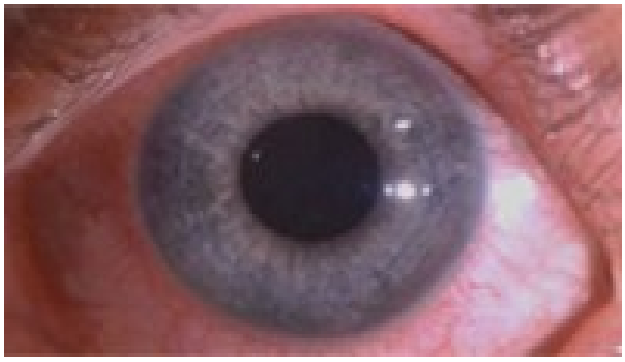


Figure 4–19. CL-induced acute red eye.

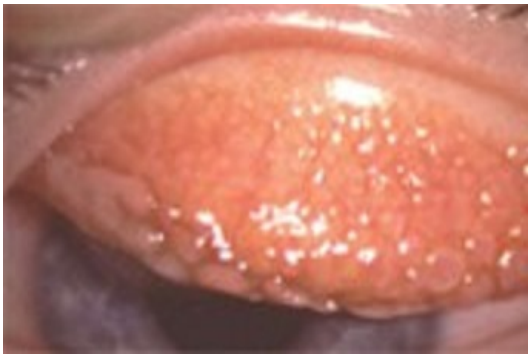


Figure 4–20. GPC (allergic response to CL deposits).

In rare instances, the following conditions have been reported and may lead to permanent medical disqualification from flying:

Loss of an eye.

Severe eye infections.

Permanent corneal scarring (opacification).

Moderate to severe decreased VA (temporary and permanent).

Growth of blood vessels into the cornea (neovascularization) (fig. 4–21).

Ulceration and/or perforation of the cornea that may require surgery (fig. 4–22).

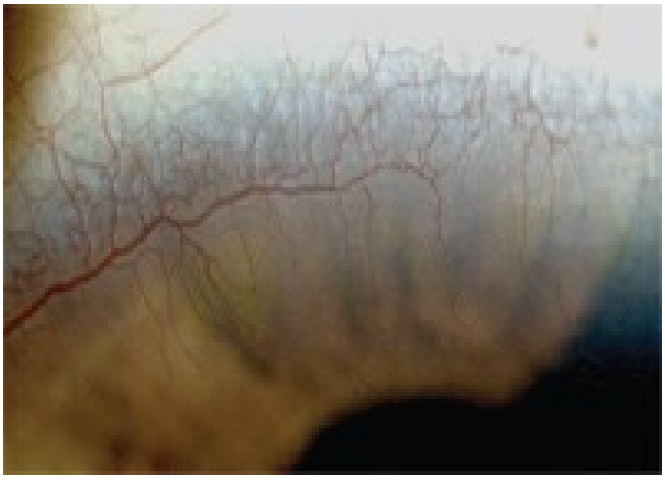


Figure 4–21. CL-induced corneal neovascularization.

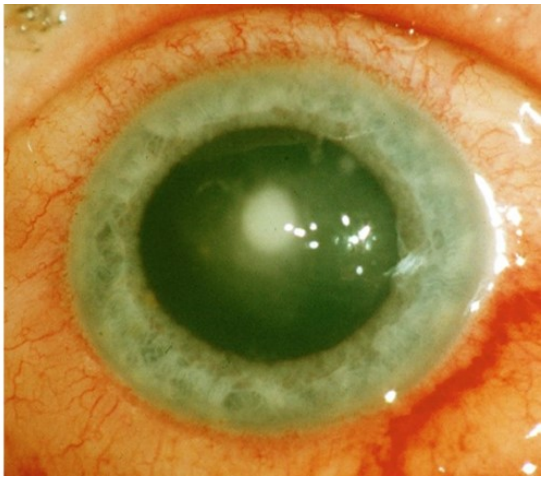


Figure 4–22. CL-induced corneal ulcer.

If the aircrew member reports any of the problems listed above, he or she must contact the FS and optometrist immediately.

Ensure proper CL care

Aircrew members are fit with lenses on the AF list of approved CLs. After a successful fit, you or the optometrist will teach the member about lens care. Make sure the member knows to use *only* those lens care products on the list of AF-approved products for aircrew. The patient must also be shown how to insert and remove his or her lenses, as well as the procedures for cleaning, storing, wetting, and disinfecting. Make sure the member demonstrates proficiency in the cleaning, insertion, and removal of CLs before he or she leaves the clinic. If the member cannot, hold his or her contacts and have him or her come back another day.

Remind the aircrew member that he or she must carry a backup pair of glasses and have them immediately accessible when flying with CLs.

Program details

The ASCLP process starts when an FS approves an aircrew member for enrollment into the program. Next, an optometrist performs a CL fitting. The member then has mandatory follow-up appointments. Throughout all this, the member's progress and adherence to the program are documented and tracked.

SCL database

All identified flyers qualified to participate in the ASCLP are tracked in a database in the ASIMS. Qualified flyers wishing to participate in the ASCLP begin by requesting enrollment into the program from an FS.

Enrollment

After reading, understanding, and signing the aircrew instructions for enrollment into the ASCLP, the member is evaluated by an FS. If the individual meets the requirements for the program, the FS signs the request letter, and the flyer reports to optometry to schedule an appointment for an examination. With an electronic health record, the signing and routing of paperwork is completed and entered digitally.

Trial lens fit

Once examined, successfully fit with a trial lens, and completed a follow-up exam, the optometrist signs the request letter. Again, with an electronic health record, the signing is completed digitally. The flyer returns to flight medicine and is entered into the ASCLP database (ASIMS) for follow-up.

Follow-up

For new CL wearers, the follow-ups are one week, one month, and twelve months with an optometrist, not the FS. Between the initial fit and the one-week follow-up, flyers must not wear their CLs in flight within eight hours prior to performing flight duties.

For flyers already on the ASCLP and are having no CL wear complications, only annual visits are required.

Flight and deployment requirements

Aviators using CLs must carry a CL case with solution and prescription spectacles in flight.

When deployed, aircrew members who wear nondisposable CLs are required to carry one factory-sealed replacement pair of contacts. For those members who wear disposable or frequent replacement CLs, they must have a three-month supply of factory-sealed replacement lenses. In both cases, the replacement CLs must match the patient's current CL Rx. In addition, members are expected to have at least a month's supply of CL solution. Finally, deploying members are also required to have two pair of clear and two pair of sunglasses flight frames with their current Rx.

Beyond the one-month supply required by the deployed aircrew member, aircrew flight equipment (AFE) has the responsibility to maintain ASCLP-approved CL solution for the remainder of the deployment.

633. Managing the aircrew soft contact lens program

The ASCLP is a program that overlaps the realms of both flight medicine and optometry clinics. Although it's true that AFI 48–123 and the *USAF Aircrew Contact Lens Policy* states that it's flight medicine's responsibility for the administration of the program, you'll often find that the optometry clinic takes on a large portion of the actual administration of the ASCLP. You'll find that the division of responsibility depends on each base, each clinic, and what works best to accomplish the mission.

At some bases, flight medicine will update ASIMS when a member is newly enrolled, each time a member accomplishes a mandatory follow-up appointment, or when an incident form is required due to a CL complication. At some bases, optometry takes on this role. Additionally, sometimes the flight medicine staff tracks when members are due and notifies these members to schedule an appointment. Sometimes the optometry staff accomplishes these tasks. The division of these roles is often flexible and something your clinic and the flight medicine clinic can work out between themselves.

Below we'll discuss how AFI 48–123 and the *USAF Aircrew Contact Lens Policy* divides the responsibilities for managing the program.

Aircrew member

For the aircrew member to participate in the ASCLP, the following steps must be taken. The aircrew member:

- Receives a briefing from local FS prior to initial ASCLP CL fit.
- Reports CL use and complications, if any, to local FS.

- Receives and becomes familiar with mandatory instructions for CL use.
- Maintains a current CL Rx.
- Follows general flight rules, which states that aircrew who wear corrective spectacles or CLs must carry a spare set of clear Rx spectacles on his or her person while performing flight duties.
- Ensures his or her primary and backup spectacles are a current Rx and adequate to meet applicable flight vision standards.
- Maintains at least one set of unused and current replacement CLs.
- If buying his or her own CL supplies, ensures he or she complies with the ASCLP-approved list or have a current waiver authorizing otherwise.

Flying squadrons

The flying squadrons are responsible for the following:

- If operationally justified, approve CL purchases and supplies unit funds.
- The squadron life support section has the responsibility to maintain appropriate SCL solutions for deployment if the squadron elects to purchase CLs.

Flight medicine

Flight medicine has the following responsibilities:

Administers the ASCLP.

Briefs aircrew and ensures they are familiar with the rules of the ASCLP.

Documents and manages CL use by all eligible aircrew members as defined by AFI 48–123 and *USAF Aircrew Contact Lens Policy*.

Ensures all CL-related incidents and DNIF days are reported to the USAF School of Aerospace Medicine/Department of Aerospace Medicine, Clinical Sciences Division, Aerospace Medicine Branch (USAFSAM/FECO) within 72 hours.

Optometry

The optometry clinic performs the following actions to help ensure the success of the ASCLP:

- Examines, fits, and prescribes CLs for eligible AD aircrew members, including Air Reserve Component (ARC) (includes the Air Force Reserve and Air National Guard) members who are authorized to wear CLs in-flight and who have access to an MTF optometry clinic.
- Reports all aircrew CL-related incidents and complications to flight medicine and to USAFSAM/FECO (within 72 hours) using the "*USAF Aircrew Contact Lens Incident Report*" form in ASIMS.

  NOTE: The incident form and USAFSAM/FECO contact information can be found at: https://kx.afms.mil/kj/kx2/AFContactLensProgram/Pages/home.aspx.
- Obtains the current ASCLP-approved CL and solution list.
- Trains aircrew in the emergency removal of CLs.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

631. Aircrew terminology

1. Define the term "rated aircrew."

2. Define the term "non-rated aircrew."

3. Which department is responsible for the healthcare of aircrew personnel?

4. Under what conditions would an aircrew member be placed in DNIF status?

5. What does FC I qualify a member for?

6. List the rated officers that make up FC II.

7. Operational support flyers fall into which FC category?

8. For members on the ASCLP, what must their vision be immediately after the removal of their CLs?

632. Aircrew soft contact lens program

1. Who must be under flight medicine management if they use CLs while performing aircrew duties?

2. At the end of each wearing period, what must aircrew members do with their CLs?

3. What can cause eye irritation to become more likely for an aircrew member wearing CLs in flights lasting more than four hours?

4. List the conditions that may lead to temporarily grounding of an aviator due to CL wear.

5. What must an aircrew member carry with him or her when flying and wearing CLs?

6. Who approves an aircrew member for enrollment into the ASCLP?

7. How often must a flyer be seen who is already on the ASCLP and has no CL wear complications?

633. Managing the aircrew soft contact lens program

1. According to AFI and policy, who is responsible for the administration of the ASCLP?

2. Who is responsible for maintaining at least one set of unused and current replacement CLs?

3. Who briefs the aircrew and ensures they are familiar with the rules of the ASCLP?

4. Who is responsible to train the aircrew in the emergency removal of CLs?

4–3. Corneal Refractive Surgery

Over the last 20 years, refractive surgery has made tremendous strides in effectiveness and safety. Surgically altering an otherwise healthy eye was considered highly controversial because of safety and possible long-term side effects. Now, refractive surgery is an option for correcting common eye problems, such as nearsightedness, farsightedness, and astigmatism. Refractive surgery has become an acceptable, effective, and relatively safe procedure.

634. USAF corneal refractive surgery program

Refractive surgery for AD members provides an opportunity to significantly enhance mission performance in the many military environments where the use of glasses or CLs is either impractical or compromises the ability to safely perform these missions. The readiness benefits from eliminating or reducing the dependency on glasses are enormous.

Serious complications associated with the procedures are extremely rare. Infections are the most worrisome complications. Fortunately, infections can usually be eliminated with antibiotic medications. Other possible problems include delayed surface healing, corneal haze or scarring, over- or under correction, and the development of astigmatism. Some individuals can have a poor or excessive healing response. Most complications remain treatable with medications or further surgery.

With all the hype and advertisement over refractive surgery, a quick-fix mindset has evolved. People need to keep in mind that this is real eye surgery. Laser refractive surgery has complications associated with it. Like any surgery, something can go wrong. Make sure your patients understand the decision to have eye surgery done is important and should not be a hasty decision.

Currently, only PRK and LASIK are the types of CRS authorized for AD members. Informational booklets on these types of surgeries, policy, application procedures, and reference material can be found at https://kx2.afms.mil/kj/kx1/AFRefractiveSurgery/Pages/home.aspx.

PRK

PRK uses an excimer laser (fig. 4–23) instead of a knife to reshape the cornea.

Figure 4–23. Excimer laser.

PRK literally disintegrates (photoablates) the corneal stroma after the epithelium is removed, thereby reshaping the curve of the cornea (fig. 4–24).

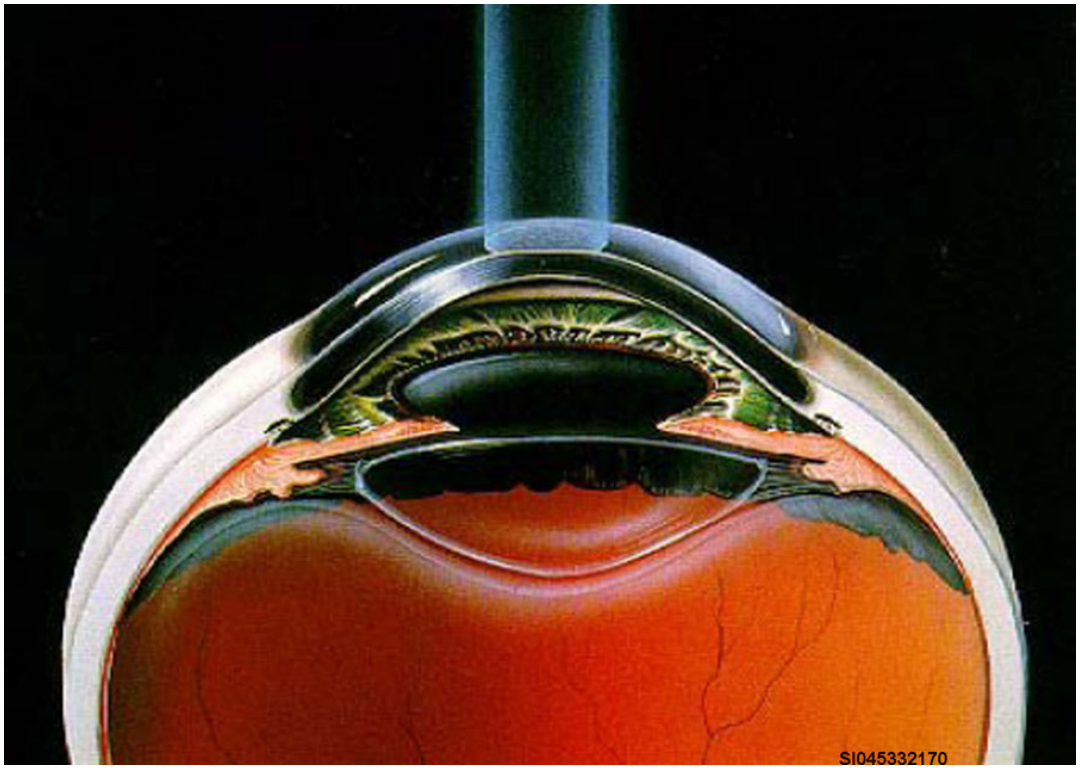


Figure 4–24. PRK.

This quick process is computer assisted and gives very predictable results. The corneal epithelium does grow back, but there is a period (three months or more) where there is a risk of fluctuating vision, infection, and scarring. The patient must use antibiotic and anti-inflammatory drops until healing is complete.

For correction of nearsightedness, the laser flattens the front of the cornea by removing small amounts of tissue. To correct for farsightedness, the laser is used to steepen the front of the cornea by removing small amounts of tissue from a ring-shaped area around the center of the cornea. To correct for astigmatism, the laser removes small amounts of tissue from the corneal surface corresponding to the cornea's astigmatic shape.

LASIK

LASIK is a type of refractive surgery where an instrument, called a keratome, cuts a central corneal flap (fig. 4–25). The flap is then laid back and the laser surgery is performed. The flap is then repositioned on the cornea.

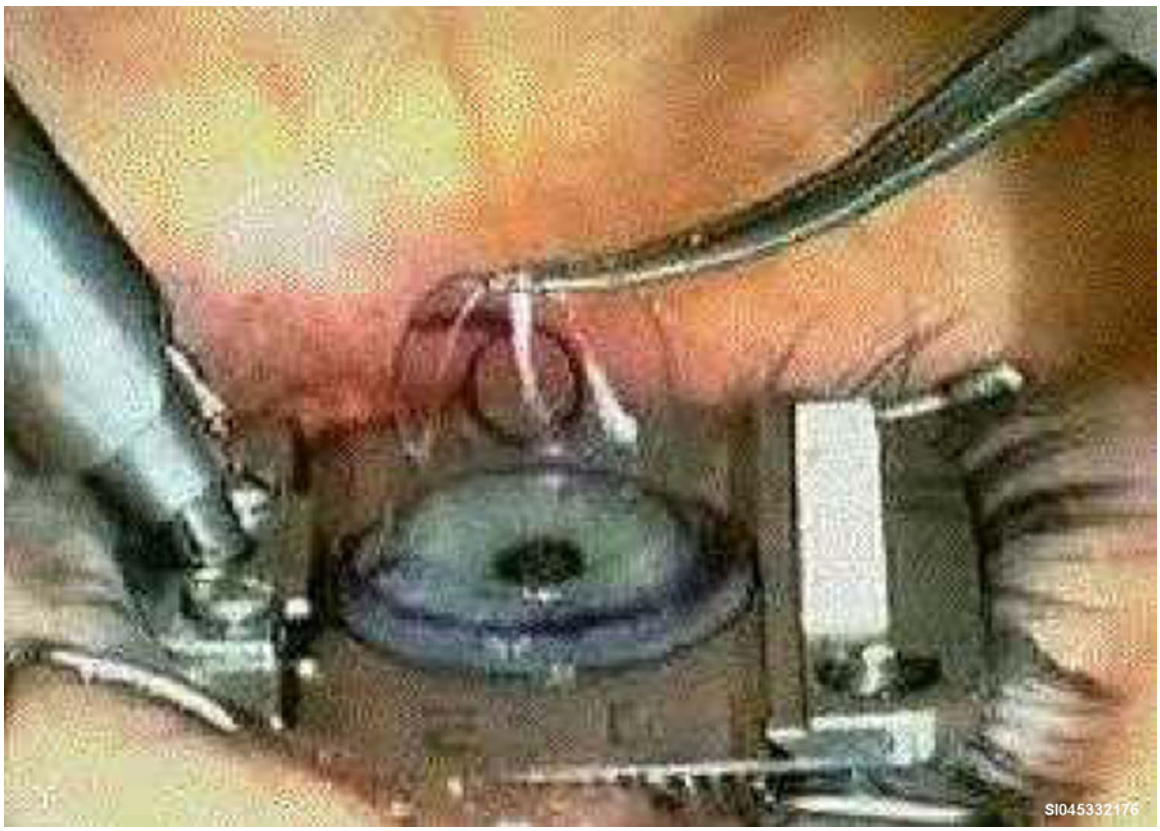


Figure 4–25. LASIK.

The advantage to this procedure over PRK is that photoabalation occurs in the stroma without disrupting the epithelium. This facilitates healing and gives a more predictable result. The drawback to LASIK is that the corneal flap may become displaced. There is also little room for error with this procedure.

Eligibility

AF personnel fall into one of the following three groups for CRS management requirements:

1. AASD.
2. Warfighters.
3. AASD applicants (which falls under AASD for program requirements).

Certain guidelines must be met for an applicant to be considered for either the AASD or the Warfighter program.

The table below defines the clinical guidelines that make an applicant eligible for CRS and, in some cases, whether the member would be better suited to have PRK or LASIK surgery.

USAF CRS Eligibility Clinical Guidelines	
Age	21 years or older.
Standard Refractive Limits	Myopia: –1.00D to –8.00D spherical equivalent (SE) (PRK). –1.00D to –12.00D SE (LASIK). Hyperopia: +1.00D to +4.00D SE. Cylinder: no more than 4.00D. ****For AASD:** Most minus meridian not to exceed – 8.00D. Most plus meridian not to exceed +3.00D. Astigmatism not to exceed 3.00D.
VISX Wavefront Refractive Limits	Myopia: –0.50D to –11.00D SE and cylinder no greater than 3.00D. Hyperopia: +0.50D to +3.00D SE and cylinder no greater than 2.00D. Mixed Astigmatism: 1.00D to 5.00D of cylinder where magnitude of cylinder is greater than magnitude of spherical error and of opposite sign.
PRK versus LASIK	****Procedure authorized may not be the procedure requested by the patient.** The AASD and Warfighter Program Managers, working in conjunction with the Refractive Surgery (RS) Centers and surgeons, will be the final authority on approved procedure. -less than -3.00D: PRK highly encouraged. -3.00D to -6.00D: PRK or LASIK (based on occupation and hobbies). -6.00 or greater: encourage LASIK. **NOTE:** Some surgeons will offer other surface procedures, such as LASEK or epi-LASIK for moderate to high myopes).
Pupils	Colvard or Ruler: up to and including 9.0 mm.
Pachymetry	PRK: $\geq$ 475 µm; no thinner than 375 µm residual. LASIK: $\geq$ 500 µm; 300 µm in the bed; assume 160 µm flap thickness. Sph Eq: 16 µm per diopter = tissue removed.
Keratometry	(TRANSPOSE TO PLUS CYLINDER PRIOR TO CALCULATING). Post-op keratometry's (K) of 35.00 D and above is acceptable. (Steep K – MR Sphere = post-op K). No CRS for K's <40D or > 48D. I-S <1.26 (AASD) <1.40 (warfighter).

USAF CRS Eligibility Clinical Guidelines	
Refractive Stabilization	No more a 0.50D shift in sphere or cylinder or more than 15° axis change over the past year.
Disqualifying Systemic Conditions	Autoimmune Diseases. Immunodeficiency Diseases (AIDS/HIV on meds). Pregnancy—must be six months postpartum. Breastfeeding—nursing discontinued for six months. Diabetes. (Keloid formers are OK).
Disqualifying Ocular Conditions	History of Herpetic Eye Disease. Keratoconus or Form-fruste keratoconus. Pellucid Marginal Degeneration. Ocular Rosacea. Severe Dry Eye Disease. Glaucoma (Pigment Dispersion Syndrome is not disqualifying if patient is not on medications and shows no signs of glaucoma). Visual Axis Corneal Scars.
Disqualifying Medications	Imitrex: needs to be off for six months. Accutane: needs to be of six months. Amiodarone (antiarrhythmic med). Tuberculosis Meds (INH): needs to be off for one month. Prednisone. Any immunosuppressive drug.
Occupational Considerations	AASD personnel may be treated at any DOD CRS Center with the following exception: • All hyperopic AASD evaluated at Aeromedical Consultation Service (ACS) prior to treatment at Wright-Patterson AFB. • Special Forces: PRK recommended. • Security Police: PRK recommended.

Application Process

There is no requirement for any service member to obtain CRS. Therefore, CRS is not a TRICARE covered benefit. As such, it's imperative that members make educated, informed decisions before obtaining this elective surgery since anyone unable to meet vision standards following CRS may be disqualified from continued military service.

AASD and Warfighters applying for civilian treatment

ARC personnel who are not eligible to receive surgery or care at a DOD CRS center or MTF may elect to have CRS through a civilian center at their own expense.

AD personnel and ARC AASD members may also elect to have CRS performed at a civilian center at their own expense. However, these members *must* receive permission *prior* to doing so. Both AASD and Warfighters must route a Commander's Authorization Form (fig. 4–26) through their supervisor, unit mobility officer, squadron commander, health benefits advisor, and the MTF commander. A

health benefits counseling appointment is required to ensure members are aware they are seeking an elective surgery that may affect their military benefits and status.

USAF Corneal Refractive Surgery (USAF-CRS) Program

Commander's Authorization Form
Obtaining Refractive Surgery from a Civilian Source

Printed Name/Grade:	John Smith
Signature	*John Smith*

The above member requests permission to obtain refractive surgery to correct their vision from a civilian provider. **AFI 44-102, para 6.2, dated 20 January 2012 authorizes this elective treatment.** Complete program details are available online at https://kx.afms.mil/kj/kx1/AFRefractiveSurgery/Pages/home.aspx.

IAW *AFI 44-102, para 6.2.*, Air Force personnel must have 6 months of active duty (AD) retainability (time until separation, retirement or loss of AD status) from date of surgery.

Military members are authorized civilian CRS treatment/follow-up at his/her own expense within the guidelines set in AFI 41-210, TRICARE Operations and *Patient Administration Functions*, para 6.52.1.

Active Duty personnel must be counseled by their military Medical Treatment Facility (MTF) prior to the surgery (AFI 41-210, Para. 2.52.2.). This is to ensure the Active Duty member understands that elective procedures obtained at their own expense could adversely affect their military disability benefits in the event of an undesirable outcome.

Active Duty personnel must have written approval of the member's squadron commander and the Medical Treatment Facility (MTF) commander prior to any non-refundable deposits (surgery, airline tickets, etc) being made (AFI 44-102, Para 6.2).

Active Duty personnel must take regular leave for the procedure (AFI 36-3003, Table 2, rule 8).

The MTF (Optometry/PCM) will initiate a Duty Limiting Condition Report, AF Form 469, (not world-wide qualified [WWQ]) when the patient returns from CRS procedure. Member will **NOT** deploy or PCS while on steroid eye drops after any CRS. **The individual will be off mobility status and not eligible to PCS for up to four months** while on steroid eye drops. Recovery from surgery will impact the individual's activities. Expect some limitations on routine duties for up to one month depending on vision standards applicable to individuals' AFSC. The wear of sunglasses outdoors for the first year is required to prevent complications.

IAW *AFI 48-123, para 6.20.5.*, the **Commander's Authorization is valid for 6 months from date of signature.** Individuals will be required to re-accomplish the authorization letter if surgery is scheduled for more than 6 months from the date it is signed.

Member's Job Title: **Electrical Systems Journeyman** AFSC: Duty **3E051** Primary **3E051**

AASD ONLY: Aviations Service Code (ASC) **N/A** Date of current separation, retirement or loss of AD status: **17 May 2020**

To best of your knowledge, is the member scheduled to deploy, TDY or PCS during the next 6 months? ☐ YES ☒ NO

Endorsement of this form indicates your concurrence with the member's absence and/or duty limitations following elective surgery. If you have any questions regarding this notification, please contact the MTF or Optometry Clinic.

Supervisor	Printed Name/Grade Stamp, if applicable	John Smith's Supervisor	Date
	Signature	*John Smith's Supervisor*	Phone
Unit Mobility Officer	Printed Name/Grade Stamp, if applicable	John Smith's Unit Mobility Officer	Date
	Signature	*John Smith's Unit Mobility Officer*	Phone
Squadron Commander	Printed Name/Grade stamp recommended	John Smith's Squadron Commander	Date
	Signature	*John Smith's Squadron Commander*	Phone
Health Benefits Advisor	Printed Name/Grade Stamp, if applicable	MTF Health Benefits Advisor	Date
	Signature	*MTF Health Benefits Advisor*	Phone
Medical Treatment Facility Commander	Printed Name/Grade Stamp recommended	MTF Commander	Date
	Signature	*MTF Commander*	Phone

Commander's Authorization Form for Civilian Corneal Refractive Surgery, 28 May 2014

Figure 4–26. Commander's Authorization Form for obtaining surgery from a civilian source.

Additionally, all members seeking permission to have CRS through a civilian center must also route a USAF Refractive Surgery Application for approval (fig. 4–27).

USAF REFRACTIVE SURGERY APPLICATION - Civilian Treatment

This form and other USAF-CRS Tools are available on AF Knowledge Exchange — USAF-CRS (Public Access)

Application Date: 17 Jun 2017

APPLICANT INFORMATION

Last Name: Smith	First Name: John	Middle Initial: M			
SSN (last 4): 1234	DOB: 27 May 1990	Age: 27			
Grade/ Rank: O3/Capt	Primary AFSC: 11AX	Sex: (Male) Female			
Duty Status: (AD) AGR AFRes ANG Other	MAJCOM: AMC				
Total # months of remaining AD retainability (eligible for elective surgery benefits): 23 months					
*NOTE: AF personnel MUST HAVE 6 months retainability **AFTER** the Date of Surgery.*					
Unit/Squadron & Office Symbol: 123 AS/DO	Phone (DSN): 123-1234				
Street: 123 Street Dr.					
Base / State Zip + 4: Base AFB, State 12345-1234					
Duty E-mail: john.smith.217@us.af.mil					

AASD PERSONNEL ONLY

Actively Flying? [X] Yes [ ] No	Current Aircraft Assignment: Cargo		
Crew/Duty Position: Pilot	Aviation Service Code (ASC): 11AX		
Total # of Military Flying Hours: 227	Total # of Flying Hours in Last 6 Month: 15		

FLIGHT SURGEON CONTACT INFORMATION

Unit/Squadron & Office Symbol: 231 AMDS	Phone (DSN): 123-4321		
Street: 432 Road Dr.			
Base / State Zip + 4: Base AFB, State 12345-1234			
Flight Surgeon's Name/Rank: Dr. Flight Surgeon/Maj			
Flight Surgeon's Duty Email: flight.surgeon@us.af.mil			
Flight Surgeon's Signature: *Flight Surgeon*			

REFRACTIVE SURGEON CONTACT INFORMATION

Refractive Surgery Center: Civilian Surgery Center's Name					
Street: 321 Drive Rd.	City / State Zip + 4: City, State 12345-1234				
Refractive Surgeon's Name: Dr. Civilian Doc	Phone: (123) 456-7891	FAX: (123) 456-1987			

MANDATORY QUESTIONS (APPLICANT MUST INITIAL)

Initials	
JS	I understand that **I am responsible for reading and am required to comply** with the policy and guidelines of the USAF Refractive Surgery (USAF-RS) Program available on the AF Knowledge Exchange (DotMil) https://kx.afms.mil/kj/kx1/AFRefractiveSurgery/Pages/home.aspx or Public Access http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=20427
JS	I understand **I am NOT authorized to schedule or undergo refractive surgery** until I have received "Permission to Proceed" from the appropriate USAF-CRS Program Manager. If granted "Permission to Proceed", the final treatment decision is not guaranteed, but will be made by the surgeon.
JS	I understand that if my commander endorses this request for refractive surgery, the authorization is only valid for a period of 6 months from the date of the commander's signature. I understand I must obtain a new commander's authorization if I am unable to complete refractive surgery within the 6 months period. I understand I must present an original, signed, and valid commander's authorization to the treatment center before I will be treated.
JS	I must inform my flight surgeon, primary care provider, and eye care provider of surgery, follow-up care, and any complications. I must accomplish all follow-up examinations as required by policy or I may be restricted from duty or be DNIF until in compliance.
JS	I understand that during my evaluation at a RS center, I may be disqualified as a CRS candidate and will not be treated. The final decision will be made by my surgeon.
JS	If I am disqualified as a CRS candidate, I am not eligible for reimbursement of expenses incurred for travel to/from the RS center, including, but not limited to travel, meals, and lodging.
JS	I understand that I may require or continue to require reading and/or distance prescription correction for best vision after surgery. I understand that CRS will create a permanent change in my vision and even with an optimal outcome may change over time.
JS	I understand my vision may take time to fully recover following CRS Surgery and there is a risk of not meeting relevant vision standards after CRS. Therefore, I may be disqualified from certain careers, duties, or even continued military service.
JS	Furthermore, I understand there is a chance I cannot be fit with contact lenses after CRS.

Applicant's Signature: *John Smith*

Mail/E-Mail application and all supporting documents to:

Aviation Program Manager
USAFSAM/FECO WRIGHT-PATTERSON AFB, OH
E-Mail: USAFSAM.AP.Mgr@us.af.mil
Voice: (937) 938-2684 / 2677 DSN 798-2684 / 2677

Warfighter Program Manager
JOINT WARFIGHTER REFRACTIVE SURGERY CENTER
2201 BERQUIST DRIVE, STE 1
Attn: 59 SSS / SG02ER (WF Pkts)
LACKLAND AFB, TX 78236-9908
E-Mail: 59MDW.SGCEP@us.af.mil
FAX: (210) 292-2813 / DSN 554-2813
Voice: (210) 292-2237 / DSN 554-2313

USAF: Civilian Refractive Surgery Application (Page 1 of 2), 31 March 2014

USAF-CRS PROGRAM MANAGER REVIEW USE ONLY
APM (AASD) WPM (Warfighter)

Disposition Date: 6 Jul 2017
Permission to Proceed? [X] Yes [ ] No

Reviewing Officer's Name/Rank: Reviewing Officer/Capt

Reviewing Officer's Signature: *Reviewing Officer*

Figure 4–27. USAF refractive surgery application—civilian treatment.

AASD members will need to route this form through their local FS. Both AASD members and Warfighters need to have an initial examination performed by their civilian provider as part of their application.

Once complete, the member submits his or her USAF Refractive Surgery Application to the appropriate program manager for permission to proceed. Program manager email/mailing addresses can be found at the CRS website mentioned earlier. All of these documents *must* be accomplished and permission to proceed granted *prior* to the member having CRS.

If granted permission to proceed, personnel can then obtain CRS through the civilian center they indicated on their application. After surgery, the member must coordinate all required postoperative follow-ups with his or her civilian provider. The member will have to report to optometry and/or a primary care manager (PCM) or FS (whichever is appropriate) to manage his or her return-to-duty status.

AASD members applying for DOD treatment

Similar to the steps when applying for civilian treatment, AASD members applying for CRS through an MTF must complete and route a Commander's Authorization form through the proper channels (fig. 4–28).

This form is a little different in that the member's commander will need to designate whether the member is priority I, II, or III.

- Priority I—personnel assigned to USAF AASD career fields. Not included are permanently disqualified Airmen and/or former aviators who have cross-trained from aviation career duties.
- Priority II—personnel whose routine military duties require wear of NVG, eye protection, or respiratory protection. This does not include nuclear, biological, and chemical (NBC) masks worn only for deployments or exercises.
- Priority III—personnel who do not meet the above criteria in their current military duties.

Because members are applying for CRS through an MTF, they are not required to meet with and obtain signatures from the health benefits advisor or MTF commander.

Also similar to the civilian application process, AASD members will need to complete a USAF Refractive Surgery Application. This again needs to be signed by an FS. However, this time members have their local optometry clinic complete the initial examination as part of their application.

Once complete, the AASD member submits his or her application to the AASD program manager for permission to proceed. Personnel are not authorized to have surgery at a military CRS center until permission to proceed authorization has been granted.

Members must have at least six months remaining on AD status following their CRS surgery. Additionally, AASD personnel must be on unit-funded or permissive temporary duty (TDY) status for their CRS treatment. Leave status is not authorized.

Warfighters applying for DOD treatment

Warfighters will follow the same process as AASD members applying for DOD treatment. A Commander's Authorization Form, in which their squadron commander designates which priority they fall under (fig. 4–28), and a USAF Refractive Surgery Application is required. Warfighters do not need to route their USAF Refractive Surgery Application for FS's signature.

Because they are applying for CRS at an MTF, members will have their local optometry clinic complete the initial examination as part of their application.

Once complete, the Warfighter submits his or her application to the warfighter program manager for permission to proceed. Personnel are not authorized to have surgery at a military CRS center until permission to proceed authorization has been granted.

Mirroring the AASD requirement when applying for CRS at a military center, Warfighters must also have at least six months remaining on AD status following surgery. Also, personnel must be on unit-funded or permissive TDY status for their CRS treatment. Leave status is not authorized.

USAF Corneal Refractive Surgery (USAF-CRS) Program

Commander's Authorization

Applicant's Printed Name/Grade:	John Smith/O3
Applicant's Signature	*John Smith*

The above member requests permission to obtain refractive surgery to correct their vision at a DoD Refractive Surgery Center. **AFI 48-123, para 6.20.5 dated 05 November 2013 authorizes this elective treatment** and is available online at USAF-CRS Website. The policy letter outlines program guidance, issues to consider before authorizing an individual to enter the program and procedures to be followed. **It should be reviewed prior to completion of this authorization. All signatures acknowledge an understanding of the policy and concurrence of the applicant member's request.**

IAW *USAF-CRS Policy*, access to DoD laser centers is prioritized by the member's **Squadron Commander**. The categories are as follows:

Priority I: Personnel assigned to USAF Aviation and Aviation-Related Special Duty (AASD) career fields. Not included are permanently disqualified aircrew and/or former aviators who have cross-trained from aviation career duties.

Priority II: Personnel whose **routine** military duties require wear of Night Vision Goggles (NVG), eye protection or respiratory protection. This **does not** include Nuclear, Biological and Chemical (NBC) masks worn only for deployment/exercises.

Priority III: Personnel who do not meet the above criteria in their current military duties.

IAW *USAF-CRS Policy, para 4.3*, Air Force personnel must have 6 months of active duty (AD) retainability (time until separation, retirement or loss of AD status) from date of surgery.

Participation in this program requires a considerable investment of time by the individual, resulting in an impact upon mission requirements.

Typical Time Requirements	Initial evaluation (local MTF) – ½ day
	Surgery – 1 week (pre-surgery evaluation, treatment, and initial recovery
	Post-operative evaluations (local MTF) – 5 visits up to ½ day each in the first year

Recovery from surgery will impact the member's activities. The wear of sunglasses outdoors for the first year is authorized and strongly recommended to prevent complications. Depending upon individual healing and applicable AFSC vision standards, the individual **WILL NOT be World-Wide Qualified (WWQ) while on steroid eye drops (minimum of one month, typically 3-4 months)**. PCS during the post-operative period is strongly discouraged in order to maintain continuity of care. The member will be non-deployable during this timeframe, and a Duty Limiting Condition (DLC) report will be issued. Duties may be assigned relative to the member's recovery. For aircrew, non-deployable Return-to-Flight Status (RTFS) is typically within the first 1-2 months, with return to WWQ status typically within the first 4 months. Flight Surgeons (FS) will manage the appropriate grounding actions and DLC for AASD personnel. Primary Care Managers (PCM) in conjunction with local optometry clinics will manage the DLC for Warfighter personnel.

The member must bring this letter to the initial corneal refractive surgery evaluation in order for the evaluation to proceed. IAW *USAF-CRS Policy, para 4.2*, the **Commander's Authorization is only valid 6 months from the date of signature.** Individuals will be required to re-accomplish the authorization letter if surgery is scheduled beyond 6 months from the date it is signed.

Member's Job Title: Pilot AFSC: Primary/Duty: _____ AASD ONLY: ASC: 11AX

Date of separation, retirement or loss of AD status (**Do not** put "indefinite"): 17 May 2019

To best of your knowledge, is the member scheduled to deploy or PCS during the next 6 months? ☐ Yes ☒ No

This member is eligible as (check appropriate): **Priority** ☒ I ☐ II ☐ III

Supervisor	Printed Name/Grade Stamp, if applicable	Supervisor	Date
	Signature	*Supervisor*	Phone
Unit Mobility Officer	Printed Name/Grade Stamp, if applicable	Unit Mobility Officer	Date
	Signature	*Unit Mobility Officer*	Phone
Squadron Commander	Printed Name/Grade Stamp recommended	Squadron Commander	Date
	Signature	*Squadron Commander*	Phone

USAF-CRS Commander's Authorization Form, 02 Jun 14

Figure 4-28. Commander's Authorization Form showing priority categories.

635. Managing the USAF refractive surgery program

Each of the three groups mentioned previously (AASD applicants, AASD members, and Warfighters) has specific management requirements.

AASD applicant

An AASD applicant is someone who has previously had CRS (through a civilian or military center) and is now applying for an AASD position. An AASD applicant is managed, after training selection, IAW his or her anticipated AFSC or ASC and, if applicable, will have to meet AASD CRS requirements.

To ensure the member's vision has stabilized postsurgery, the applicant must be at least six months postoperative for his or her initial flight physical prior to waiver disposition.

When an AASD applicant pursues CRS, the FS must enter all pre- and post-CRS documentation into the Physical Examination and Processing Program (PEPP) of the Aeromedical Information Management Waiver Tracking System (AIMWTS). If not already in their military medical record, applicants who had CRS through a civilian center will have to obtain records of their pre- and post-CRS and provide it to the FS.

AASD members

AASD members must make all post-CRS evaluations and submit all required documentation or face a possibly prolonged DNIF period. Before flight medicine submits a waiver to request a member be returned to flight status, the AASD member must meet the requirements in the table below.

CRS Waiver Requirements to Return-to-Flight Status	
Examination	Requirement.
Best corrected VA	20/20 or better each eye.
PV® 5 percent low-contrast chart	20/50 or better each eye.
Slit lamp exam	LASIK—no striae or flap complications. PRK—no more than trace corneal haze.
Refractive error	Stable, no more than 0.50 diopter shift in manifest sphere or cylinder refractive PWR between two readings at least two weeks apart.
IOP	Normal—≤ 21 mm Hg.
Fundus exam	No new or previously unrecognized retinal pathology.
OVT depth perception	Line D, E, or F. If fails and previously waived for depth perception using AO Vectograph then waived limits of that test. See defective depth perception/stereopsis waiver guide.

The majority of these tests are performed in optometry. At some MTFs, flight medicine administers the depth perception test on the OVT. Optometry accomplishes specific tests at specific postoperative timeframes. The table below indicates which test is required to be performed at which postoperative follow-up.

AASD Refractive Surgery Follow-up Requirements					
	1 MONTH	**2 MONTH (PRK only)**	**3 MONTH**	**6 MONTH**	**12 MONTH**
Medications	X	X	X	X	X
History	X		X	X	X
Symptoms	X	X	X	X	X
Uncorrected VA (regular VA and HC/low-contrast PV®)	X		X	X	X
Applanation tonometry/IOP	X	X	X	X	X

AASD Refractive Surgery Follow-up Requirements					
	1 MONTH	2 MONTH (PRK only)	3 MONTH	6 MONTH	12 MONTH
OVT depth perception	When required for a return-to-flight waiver only.				
Manifest Rx	X		X	X	X
Best corrected VA (regular VA and HC/low-contrast PV®)	X		X	X	X
Cycloplegic refraction Rx	When required for a return-to-flight waiver only.				
Slit lamp exam	X		X	X	X
DFE	When required for a return-to-flight waiver only.				
Any significant postoperative events	X		X	X	X

Following LASIK, there is a minimum one-month DNIF period. An initial waiver can be requested once the AASD member meets the CRS waiver requirements listed above.

There is no minimum DNIF timeframe following PRK. Generally, it takes about 2–3 months for enough corneal healing to occur for AASD members to meet CRS waiver requirements and an initial waiver can be requested.

AASD members are not to deploy or complete a permanent change of station (PCS) while on steroid eye drops following any CRS procedure. Members are not worldwide-qualified (WWQ) until the steroid eye drops are discontinued and at least one month has passed since the date of their surgery.

Warfighters

When a Warfighter returns from having CRS, the member's PCM should update his or her duty limitation code (DLC) in ASIMS. Optometry will work in conjunction with the PCM to ensure this happens.

Just like AASD members following CRS, Warfighters are not to deploy or complete a PCS while on steroid eye drops following any CRS procedure. Warfighters are also not WWQ until steroid eye drops are discontinued and at least one month has passed since the date of their surgery. Update ASIMS to reflect this status.

The table below indicates which postoperative tests are required to be performed at which follow-up.

Warfighter Refractive Surgery Follow-up Requirements					
	1 MONTH	2 MONTH (PRK only)	3 MONTH	6 MONTH	12 MONTH
Medications	X	X	X	X	X
History	X		X	X	X
Symptoms	X	X	X	X	X
Uncorrected VA	X		X	X	X
IOP	X	X	X	X	X
Manifest Rx	X		X	X	X
Best corrected VA	X		X	X	X
Slit lamp exam	X		X	X	X
DFE					X

The eye care provider's management responsibilities

To sustain a successful CRS program and ensure all pre- and postoperational requirements are met, the AF requires that its eye care providers accomplish the following:

- Maintain a working understanding of the USAF CRS program.
- Serve as a point of contact for Warfighter personnel during the application, treatment, and postoperative management of CRS.
- Monitor all CRS postoperative personnel:
    - For members who had surgery at a military center, by administratively co-managing with the DOD CRS Center.
    - For members who had surgery at a civilian center, by administratively monitoring the agreement with the civilian center.
- Attend the USAF CRS and Operational Optometry Workshop.
    - If unable to attend, complete the online CRS training before beginning CRS care.
- Coordinate and accomplish clinical screening, referral and application, and post-CRS evaluations IAW appropriate program requirements.
    - Use only approved forms.
    - Sign and date the co-managed care agreement when a member's CRS is scheduled.
- For Warfighters:
    - Initiate and manage appropriate AF Form 469, Duty Limiting Condition Report, (which indicates the member's DLC following CRS) in conjunction with the member's PCM.
    - Ensure the member's post-CRS vision meets vision requirements based on the AFOCD or AFECD.
    - Notify the Warfighter program manager and CRS consultant of any CRS complications or incidents.
- For AASD members:
    - Ensure the member's post-CRS vision meets AASD vision requirements.
    - Advise the FS on appropriate DNIF actions.
    - Report to the FS and the AASD program manager any aircrew members who require grounding for unexpected CRS-related events.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

634. USAF corneal refractive surgery program

1. Refractive surgery is an option for correcting which common eye problems?

2. Which refractive surgery consists of removing the epithelium and photoablating the stroma with the excimer laser?

3. Which instrument is used to cut a central corneal flap in refractive surgery?

4. What is the *minimum* age requirement for CRS eligibility?

5. For Warfighters, what is the maximum standard refractive limit for cylinder correction allowable for the AF CRS program?

6. To be considered refractively stable, and therefore eligible for CRS, there can be no more than how much of a shift in sphere or cylinder in the past year?

7. When an AASD or Warfighter is routing the Commander's Authorization Form to request permission to have CRS at a civilian center, what are the two additional signatures needed?

8. An AASD member routing the USAF Refractive Surgery Application is required to get what additional signature?

9. How much time must a member have remaining on AD status following surgery from a military center?

10. Should a member be on leave status when obtaining CRS through a military center?

635. Managing the USAF refractive surgery program

1. Where does the FS enter all pre- and post-CRS documentation when an applicant to AASD is pursuing CRS?

2. Postoperatively, for an AASD member's refractive error to be considered stable, what conditions must it meet?

3. During which of the follow-ups is an AASD member required to have the cycloplegic refraction Rx accomplished?

4. What is the *minimum* DNIF period following LASIK?

5. Is a member WWQ if on steroid eye drops following CRS?

6. What must an eye care provider do if he or she is unable to attend the USAF CRS and Operational Optometry Workshop?

4–4. Night Vision Goggles

Most NVG systems are helmet-mounted and look like binoculars. To make objects and landscape visible at night, NVGs usually use two image-intensifier tubes to amplify or intensify low levels of reflected and emitted ambient light. The NVG intensified image resembles a black and white television image, except it's in shades of green.

636. Night vision devices

Aviator's night vision imaging systems (ANVIS), commonly called night vision devices (NVD) or NVGs, have become an integral part of flight operations (fig. 4–29).

Figure 4–29. NVGs.

While NVGs do not turn night into day, they do "open up" the night considerably (fig. 4–30).

Figure 4–30. NVG image.

Using NVGs, the aircrew can perform daytime tactics at night because of the increased situational awareness the NVGs provide. However, if the NVGs are incorrectly maintained, adjusted, or fitted they can cause frustration, headaches, and ultimately decreased flight safety.

AN/AVS–9 is the formal military designation for the NVS used in today's aircraft. They are commonly called ANVIS as introduced earlier. The setup consists of a pair of light-intensifier tubes and optics that attach to a mount fixed to the outside of the helmet (fig. 4–31).

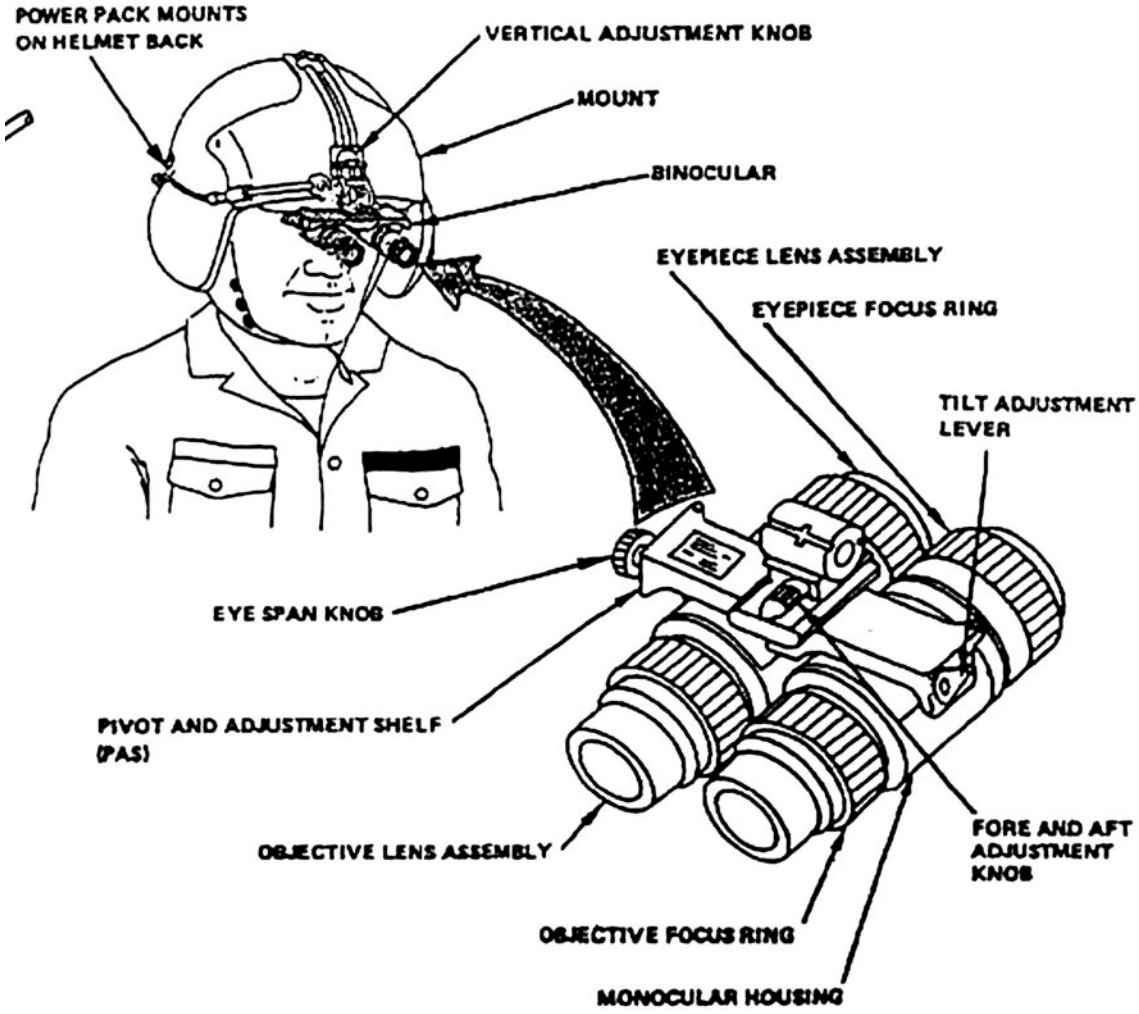


Figure 4–31. Night vision goggle system.

Using this mount, the NVG assembly can swing up and out of the field of view. The mount must be custom fit to each helmet, and pilots must perform a focusing routine with the NVGs before each flight. The entire package adds about one and one-half pounds to the front of the helmet.

Theory of operation

NVGs work by capturing and amplifying the electromagnetic radiation that exists outside our normal range of vision. Conventional NVGs require some available light to function, since they are using light amplification to intensify images. The signature green hue of NVGs is due to a change in the contrast. The image intensifier turns the image green before the image is transferred to the user's eyes. Humans can see the color green better than any other color on the visible spectrum. The green color helps the human eye distinguish objects and make out distances in dim situations.

NVGs allow aircrew members to fly over all types of terrain, performing covert operations at night. Generally, these covert operations are performed at low level where the threat of obstacles (like trees and power lines) exists. To ensure the safety of the aircrew, their NVGs must be maintained and adjusted properly. In these missions, the NVGs work by collecting the available ambient light from the night sky (stars, moon, and man-made). The image is then intensified and presented to the user through a series of optical lenses.

Polycarbonate lens and NVGs

For aircrew members who require spectacle correction, it's important to order their flight frames with polycarbonate lenses. Because the NVGs are in such close contact with the frames, ensure you order the most impact-resistant material available. Polycarbonate lenses are extremely resistant to breakage.

When ordering flight frames for an aviator, ask if he or she is required to use NVGs. If so, order his or her clear flight frames with polycarbonate lenses. This is done regardless of whether or not the member is on the ASCLP and usually wears CLs in-flight. When ordering flight frames for these personnel, request polycarbonate material when entering orders into the Spectacle Request Transmission System (SRTS) or SRTS web application. It may already be obvious, but polycarbonate lenses for NVG use are only fabricated with clear lenses, not for the member's tinted flight frames.

637. Night vision goggle adjustment procedures

When fit and adjusted properly, NVGs can dramatically enhance night vision. Conversely, improper adjustment can severely degrade vision. The adjustment process is critical to a member obtaining optimal visual capability. While aircrew members will find that NVGs are not hard to use, they need to understand their design characteristics to get the most out of them.

The following lesson will go over some of the adjustable parts of the ANVIS system. This general knowledge will aid you in better understanding the system and may help you in offering hints or suggestions that improves the visual function of an aircrew member struggling with his or her NVGs.

The ANVIS NVGs consist of the three following components:

1. Mount.
2. Battery pack.
3. Binocular assembly.

The NVG mount

The NVG mount is secured to the helmet and holds the binocular assembly in front of the wearer's eyes. The mount has the following three important features:

1. Low-battery indicator.
2. Vertical adjustment knob—moves the binocular assembly up and down.
3. Lock-release button—allows the rotation of the NVGs from a stowed position to its operating position and helps in removing the binocular assembly from the mount.

The helmet mount has a vertical adjustment knob that moves the NVGs up and down.

The battery pack

The battery pack powers the NVGs. Either alkaline or lithium AA batteries can be used. Important facts about the battery pack include the following:

- Loading batteries—lithium batteries are inserted with the positive side up, while alkaline batteries go in positive side down.
- Switching battery power—the battery pack has a three-position switch. The OFF position is in the middle with UP and DOWN positions for the two-battery compartments. ANVIS NVGs operate on the battery or batteries that correspond to the switch position, which provides an internal spare in the system.

The lock-release lever rotates the NVGs from the stowed-up position to the (operational) down position. NVGs are automatically switched off in the stowed position. Dual contacts on the NVGs make contact with the dual contacts on the pivot and adjustment shelf (PAS), sending current from the batteries to the NVGs.

A low-battery indicator illuminates when there is less than 30 minutes of battery power left. When this indicator illuminates, the user should switch to the other battery compartment by using the toggle switch. Power for the low-battery indicator is drawn from the battery with the highest voltage.

The binocular assembly

The binocular assembly contains the optical elements of the system. This component has several adjustment features. Learning to operate each feature is essential for proper alignment of the device. The following are the adjustable features on the binocular assembly:

- Diopter focus ring—compensates for individual refractive error.
- Tilt adjustment knob—allows the wearer to rotate the binocular assembly.
- Fore and aft adjustment knob—moves the entire binocular assembly toward or away from the eyes.
- Objective focus ring—focuses the NVGs for distance (adjustment range is from 10 inches to infinity).
- Interpupillary distance adjustment knob—allows the wearer to adjust for the distance between the eyes. The eye span knobs allow a total of 51–72 mm total travel.

The binocular assembly consists of two identical monoculars connected by a PAS. Each monocular assembly has the following four main subassemblies:

1. Monocular housing.
2. Image intensifier.
3. Objective lens.
4. Eyepiece lens.

638. Aeromedical responsibilities

Initial night vision training, safety briefing, and proficiency testing is conducted by AFE personnel at the flying squadron before a member flies with NVGs.

The FS is then responsible for providing at least annual NVG safety briefings and for ensuring that aircrew members are familiar with the principles behind night vision. It’s the FS’s job to educate wearers of the potential problems and limitations of NVG wear and to aid members in reaching optimal visual performance.

The safety briefings given by the FS should include a review of the physiology of unaided night vision, the potential for visual illusions at night, NVG capabilities, NVG limitations, and human factor issues. These briefings are required at least annually but should be given more frequently if operational issues arise or high-incident rates occur.

The FS acts as a consultant to his or her flying squadron in setting up NVG test lanes. These lanes provide an area for night vision education, NVG training and testing, and preflight checks. This allows the flyers to have an area in which they can simulate night vision conditions, make necessary adjustments to their NVDs, and eventually demonstrate NVG proficiency.

The FS is responsible for teaching members how to properly fit, adjust, and focus their NVGs. As stated earlier, proficiency can be demonstrated in an NVG test lane. The actual testing does not need to be accomplished by the FS personally but can be evaluated by other trained crewmembers or AFE personnel. The FS should occasionally confirm the calibration of the NVG test lane, the accuracy of the preflight testing procedures, and the performance of squadron personnel.

Flight medicine staff should perform a record review to ensure aircrew members who require NVGs have passed their most recent VA screening with 20/20 vision at near and far. Any members not able to do so should be referred to the ophthalmic clinic for evaluation.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

636. Night vision devices

1. What symptoms may occur if NVGs are not maintained, adjusted, or fitted correctly?

2. When using NVGs, what must pilots do before each flight?

3. What do conventional NVGs require to function?

4. What does the green color help the human eye do?

5. What material should be requested for the clear flight frames of aviators who are required to use NVGs?

637. Night vision goggle adjustment procedures

1. What three components make up the ANVIS NVGs?

2. What does the lock-release button on the NVG mount allow for?

3. When does the low-battery indicator illuminate?

4. What does the diopter focus ring do?

638. Aeromedical responsibilities

1. What should the FS’s NVG safety briefings include?

2. How often should the FS conduct NVG safety briefings?

3. What is the vision requirement for members required to wear NVGs? If a member does not meet that requirement, what should occur?

Answers to Self-Test Questions

626

1. RGPs and SCLs.
2. Advantages: O_2 transmissibility. Clear, crisp vision. Durability and deposit resistance. Easy maintenance. Relatively inexpensive. Disadvantages: Require “custom” fitting. Initially uncomfortable. Spectacle blur. Not compatible with playing many sports.
3. The ability of gases (air) to permeate (travel through) the lens material. RGP CLs lenses allow O_2 to pass right through the lens.
4. Hydrophilic materials allow the patient’s tears to adhere to the lens surface and improve comfort and vision.
5. Advantages: Relatively easy to fit. Quick adjustment period. Not easily dislodged. May be used for cosmetic purposes. Disadvantages: Must be cleaned and sterilized carefully. Less durable—must be replaced more frequently than RGP CLs. Risk of infection is higher with SCLs than RGP CLs.
6. 38–72 percent.
7. Hydrophilic materials typically resist proteins better.
8. Material, PWR, DIA, BC.
9. This tint does not affect the color of the patient’s eye but makes the lens easier to see if it is dropped on a white surface like a sink.
10. The lens helps some patients to better interpret colors or contrasts.

627

1. Always start with the right lens and remove the second lens from the contact case only after the first lens has been inserted.
2. The conjunctiva prevents it.
3. The one-finger and the two-handed.
4. The taco test and the bowl test.
5. On the lower sclera.

628

1. Cleaning—both; rinsing—both; disinfecting—both; soaking/storing—both; neutralizing—SCLs; conditioning/storing—RGP CLs; enzyming—both; wetting—RGP CLs; and lubricating—both.
2. To disintegrate the stubborn built-on protein that has not come off with daily cleaning.
3. The lenses permanently turn yellow.
4. Hydrogen peroxide and nonhydrogen peroxide.
5. Not only does it kill off most bacteria, it also disables the HIV and AIDS virus.
6. Any three dos—use only approved SCL solutions. Use the approved solutions only for what they are designed (i.e., do not use a cleaning solution as a lubricant). Remove SCLs before swimming. Remove SCLs in the presence of noxious and irritating vapors. Remove SCLs if you have to don a gas mask. Keep nonpreserved saline refrigerated. Disinfect the lenses after enzyming. Remove the lenses if there is any redness, discomfort, or blurred vision. Read the instructions if you are not sure! Any three don’ts—use fluorescein with an SCL. (**NOTE:** If fluorescein is used, the patient should not put the lenses back into the eyes for at least one hour.) Instill medications or other ophthalmic solutions in the eyes while wearing CLs (both SCLs and RGP CLs). Wear contaminated lenses. Switch brands. Some brands are not compatible and can ruin the lenses. Always stay with the original brand your doctor prescribed.

629

1. Clean, disinfect, enzyme, and store properly.
2. Opti-Free®.
3. 90 days.
4. A wetting solution.

630

1. Elective CL-related services.
2. Patients are both physically and financially responsible for obtaining their lenses and solutions.
3. Corneal or scleral lenses for treatment of keratoconus; scleral lenses to retain moisture when normal tearing is not present or is inadequate; corneal or scleral lenses to reduce corneal irregularities other than astigmatism; and intraocular lenses or contact lenses for loss of human lens function resulting from intraocular surgery, ocular injury, or congenital absence.
4. Your ophthalmic clinic's medical supply account number; The patient's first and last name and contact information; The name of the CL company/supplier and their address and phone number; and the CL Rx information: brand, PWR, BC, and DIA.
5. The member's unit is responsible for placing those orders themselves.

631

1. It includes all USAF officers who hold a current USAF aeronautical rating. This category includes pilots, navigators, weapons systems officers, electronic warfare officers, 12SX Special Operations Combat Systems Officers, and FSs.
2. It includes both USAF officers and enlisted members who are routinely required to be onboard the aircraft to accomplish the primary mission. This category includes loadmasters, flight engineers, aerial gunners and bombers, pararescue personnel, and flight nurses.
3. FSO.
4. Anytime an aircrew member has a medical condition or is on medication that could compromise his or her performance on duty.
5. Selection into MFS, and once MFS is passed, commencement of UFT.
6. Pilots, RPA pilots, navigators/electronic warfare officers, 12SX Special Operations Combat Systems Officers, and FSs.
7. FC III.
8. 20/20.

632

1. FC I/IA/II/IIU/III personnel.
2. Remove, clean, and disinfect the CLs.
3. Dry air.
4. Sensitivity to light, distorted vision, blurred vision, redness, watering of the eyes, discharge, minor infections, abrasion of the cornea, discomfort, and GPC.
5. A backup pair of glasses.
6. FS.
7. Annually.

633

1. Flight medicine.
2. The aircrew member.
3. Flight medicine.
4. Optometry.

634

1. Nearsightedness, farsightedness, and astigmatism.
2. PRK.
3. Keratome.
4. 21 years old.
5. 4.00 diopters.
6. 0.50D shift.
7. The health benefits advisor and the MTF commander signatures.

8. FS’s.
9. Six months.
10. No. Personnel must be on unit-funded or permissive TDY status for their CRS treatment. Leave status is not authorized.

635

1. Into the PEPP of the AIMWTS.
2. There can be no more than 0.50 diopter shift in manifest sphere or cylinder refractive PWR between two readings at least 2 weeks apart.
3. When it is required for a return-to-flight waiver only.
4. One month.
5. No. Members are not WWQ until the steroid eye drops are discontinued and at least one month has passed since the date of their surgery.
6. Complete the online CRS training before beginning CRS care.

636

1. Can cause frustration, headaches, and ultimately decreased flight safety.
2. Perform a focusing routine with the NVGs before each flight.
3. Some available light.
4. Distinguish objects and make out distances in dim situations.
5. Polycarbonate.

637

1. The mount, battery pack, and binocular assembly.
2. The rotation of the NVGs from a stowed position to its operating position and helps in removing the binocular assembly from the mount.
3. When there is less than 30 minutes of battery power left.
4. Compensates for individual refractive error.

638

1. A review of the physiology of unaided night vision, the potential for visual illusions at night, NVG capabilities, NVG limitations, and human factor issues.
2. They are required at least annually but should be given more frequently if operational issues arise or high-incident rates occur.
3. 20/20 vision at near and far. Refer member to the ophthalmic clinic for evaluation.

Complete the unit review exercises.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the AFCDA.

70. (626) When cared for properly, how long can rigid gas permeables (RGP) contact lenses (CL) be worn before replacement is needed?
    a. 1 to 3 months.
    b. 2 to 5 months.
    c. 1 to 3 years.
    d. 2 to 5 years.

71. (626) This soft contact lens (SCL) helps patients interpret colors.
    a. Visibility tint.
    b. X-chrom.
    c. Opaque.
    d. Tinted.

72. (627) When inserting a rigid gas permeable (RGP) contact lens (CL), place it directly on the
    a. sclera.
    b. cornea.
    c. canthus.
    d. conjunctiva.

73. (627) When inserting a soft contact lens (SCL), it is placed on the
    a. endothelium.
    b. cornea.
    c. sclera.
    d. iris.

74. (627) To remove a soft contact lens (SCL), the patient should
    a. pull the canthus back with one finger and blink hard.
    b. flip the lens out with a scissors motion of two fingers.
    c. pinch the lens between the thumb and index finger to pull the lens away from the sclera.
    d. pinch the lens between the thumb and index finger to pull the lens away from the cornea.

75. (628) This type of agent is in the rigid gas permeable (RGP) contact lens (CL) soaking or storing solution that disinfects them.
    a. Antienzymatic.
    b. Antimicrobial.
    c. Antibacterial.
    d. Antibiotic.

76. (628) Enzymatic cleaning of contact lenses (CL) removes
    a. bacteria.
    b. proteins.
    c. viruses.
    d. fungus.

77. (628) The platinum disc of the AOSept® disinfecting system neutralizes this.
    a. Potassium chloride.
    b. Hydrogen peroxide.
    c. Hydrochloric acid.
    d. Sodium chloride.

78. (629) It is good practice to mark your fitting lens vials so that you will know
    a. who the last patient was.
    b. which lens is the right lens.
    c. what solutions should be used.
    d. how long each lens has been stored.

79. (630) This organization or person is responsible for purchasing contacts for the medical contact lens (CL) program.
    a. Medical supply section.
    b. Optometry clinic.
    c. Flying squadron.
    d. Patient.

80. (631) Pilots, navigators, and weapons systems officers are considered?
    a. Rated aircrew.
    b. Nonrated aircrew.
    c. Operational support flyer.
    d. Nonoperational support flyer.

81. (631) Loadmasters, flight engineers, aerial gunners and bombers, flight nurses, and pararescue personnel fall into which category?
    a. Rated aircrew.
    b. Nonrated aircrew.
    c. Operational support flyers.
    d. Nonoperational support flyers.

82. (631) This office is ultimately responsible for the healthcare of aircrew personnel.
    a. Forced health management.
    b. Flight surgeons office.
    c. Medical operations.
    d. Medical support.

83. (631) If seen for a medical appointment by an outside agency (military or civilian), which organization should aircrew members notify so the medical entry for that appointment can be reviewed?
    a. Resource management office.
    b. Quality control office.
    c. Optometry clinic.
    d. Flight medicine.

84. (632) Which Flying Class (FC) category/categories are required to adhere to all Aircrew Soft Contact Lens Program (ASCLP) requirements, regardless of whether they wear their contacts on or off duty?
    a. FC I/IA.
    b. FC II/IIU.
    c. FC III.
    d. all FC categories must adhere to the program.

85. (632) Which condition is *not* a risk associated with contact lens (CL) wear?
    a. Redness.
    b. Cataract.
    c. Sensitivity to light.
    d. Abrasion of the cornea.

86. (632) Which must a member participating in the Aircrew Soft Contact Lens Program (ASCLP) have accessible when flying with contacts?
    a. Backup pair of contacts.
    b. Backup pair of glasses.
    c. Rewetting drops.
    d. Enzyme tablets.

87. (633) Which organization is responsible for the administration of the Aircrew Soft Contact Lens Program (ASCLP)?
    a. Optometry.
    b. Family practice.
    c. Flight medicine.
    d. Physical medicine.

88. (633) Whose responsibility is it to maintain a current contact lens (CL) prescription?
    a. Flying squadrons.
    b. Aircrew member.
    c. Flight medicine.
    d. Optometry.

89. (634) Which layer of the cornea is disintegrated during Photorefractive Keratectomy (PRK)?
    a. Stroma.
    b. Epithelium.
    c. Descemet's.
    d. Endothelium.

90. (634) This is the minimum age requirement to be eligible for Corneal Refractive Surgery (CRS).
    a. 16.
    b. 18.
    c. 21.
    d. 24

91. (634) A person whose routine military duties require him or her to wear night vision goggles (NVGs) would fall under which Corneal Refractive Surgery (CRS) *priority* designation?
    a. I.
    b. II.
    c. III.
    d. IV.

92. (635) At least how many weeks apart must the two stable manifest readings be for an Aviation and Aviation Related Special Duty (AASD) member's waiver request?
    a. 2.
    b. 3.
    c. 4.
    d. 5.

93. (635) When is a cycloplegic refraction prescription on an Aviation and Aviation Related Special Duty (AASD) member *required* to be accomplished following Corneal Refractive Surgery (CRS)?
    a. Two-month.
    b. Three-month.
    c. Six-month.
    d. When required for a return to flight waiver.

94. (635) This is the minimum Duties Not Including Flying (DNIF) period following Laser Assisted in-situ Keratomileusis (LASIK) surgery.
    a. Two weeks.
    b. One month.
    c. Six weeks.
    d. Two months.

95. (635) The requirements an eye care provider must accomplish to see Corneal Refractive Surgery (CRS) patients include: maintaining a working understanding of the CRS program, attending the CRS and Operational Optometry Workshop, and
    a. conducting health benefits counseling to members applying for CRS through a civilian center.
    b. granting permission to proceed authorization to members applying for CRS through a civilian center.
    c. initiating and manage appropriate AF Form 469 in conjunction with the member's primary care manager (PCM) for warfighters.
    d. entering all pre- and post-CRS documentation into the Physical Examination and Processing Program (PEPP) of the Aeromedical Information Management Waiver Tracking System (AIMWTS).

96. (636) The image in night vision goggles (NVG) are intensified and presented to the user through a series of
    a. filters.
    b. lenses.
    c. mirrors.
    d. spectacles.

97. (637) The aviator's night vision imaging systems (ANVIS) night vision goggle (NVG) battery indicator illuminates when there is less than how many minutes of power left?
    a. 60.
    b. 45.
    c. 30.
    d. 15.

98. (638) The flight surgeon (FS) is responsible for providing night vision goggle (NVG) safety briefings at least how often?
    a. Monthly.
    b. Quarterly.
    c. Bi-annually.
    d. Annually.

99. (638) The safety briefings given by the flight surgeon (FS) should include a review of the physiology of unaided night vision, the potential for visual illusions at night, night vision goggle (NVG) capabilities, NVG limitations, and
    a. cockpit safety.
    b. human factor issues.
    c. emergency landing protocol.
    d. contact lens (CL) removal procedures for NVG wearers on the Aircrew Soft Contact Lens Program (ASCLP).

100. (638) The testing of an aviator's proficiency with his or her night vision goggles (NVG) can be evaluated by the
    a. flight surgeon (FS) only.
    b. FS or trained ophthalmic personnel.
    c. FS, trained crewmembers, or trained ophthalmic personnel.
    d. FS, trained crewmembers, or aircrew flight equipment personnel.

Glossary

Terms

abduction—The movement of the eye temporally (outward).

accommodation—Increase in optical power by the eye to maintain clear image (focus) as objects are moved closer.

acute—Any condition that flares up suddenly and persists for only a short time.

adduction—The moving of the eye inward (toward the nose).

afferent—Sensory nerve fibers that carry impulses to the brain.

amblyopia—Reduced visual acuity (20/30 or worse), usually in one eye, that is not correctable by refractive means to better than 20/40.

ametropia—Refractive error.

anesthetic—Chemical substance that desensitizes the nerve endings.

anisocoria—Unequal size of pupils, with difference of 1 mm or more.

anisometropia—Unequal refractive error in the two eyes; usually refers to a difference of at least one diopter.

anopsia—Defect or loss of vision from failure to use the visual capacity.

applanation—Method of flattening the cornea. Used for measuring intraocular pressure.

astigmatism—Optical defect in which refractive power is not uniform in all meridians. Light rays entering eye are bent unequally by different meridians, preventing formation of a sharp point focus on the retina. Instead, light rays form two focal lines. This condition can be corrected by a cylinder (toric) eyeglass or contact lens.

autorefractor—Electro-mechanical or computerized instrument used for determining an eye's refractive error.

binocular—Pertaining to both eyes.

cataract—An opacity of the crystalline lens.

choroid—Vascular portion of the eye, between the sclera and the retina, that provides nutrition to the eye.

chronic—Any condition that has persisted for some time.

ciliary nerves—Motor and sensory nerves that innervate the iris, choroid, and ciliary body.

concave—Surface that curves inward.

cones—Specialized visual cells in the retina that are responsible for color vision and sharpness of vision.

congenital—Any disease process or effect that is present from birth.

conjunctiva—Mucous membrane extending from the eyelid margin to the corneal limbus, forming the posterior layer of the eyelids and the anterior layer of the eyeball.

conjunctival sac—Area formed between the lower lid and sclera when lower lid is manually lowered.

convex—Surface that curves outward.

cornea—Transparent anterior portion of the fibrous tunic.

crystalline lens—Transparent, colorless body that is suspended between the aqueous and vitreous. The function of this lens is to bring rays of light to one focal point on the retina.

cycloplegic—Drug that dilates the pupil and paralyzes the ciliary muscles to prevent accommodation.

cycloplegic (wet) refraction—Examination conducted with the use of a cycloplegic drug.

cylinder—Component of lens prescription that converges or diverges light to focus along one axis. Forms a line focus. Has zero power in one meridian and maximum power 090° away.

deviation—Change in direction of a light ray, as when it passes through a prism.

diastolic blood pressure—A reading representing the pressure in the arteries when the ventricles of the heart relax.

diopter—Unit of measure that designates the refractive power of a lens; abbreviated "D."

diplopia—Double vision.

distortion—Defect in a lens that causes a straight line to appear curved.

edema—Swelling caused by a large amount of fluid in a part of the body.

efferent—Motor nerve fibers that carry impulses away from the brain.

esophoria—Latent turning inward of an eye when it is covered.

esotropia—Manifest turning inward of one eye, whether it is covered or not. Fusion is not possible.

exophoria—Latent turning outward of an eye when it is covered.

exotropia—Manifest turning outward of an eye, whether it is covered or not.

extorsion—Top of the eye rotates out (temporally). The inferior oblique causes this to occur as its primary action.

fixate—Act of directing the eye toward the object of regard.

fovea, fovea centralis—The central pit of the macula that produces the sharpest vision. Contains a high concentration of cones.

fundus—Interior, posterior surface of the eyeball; includes the retina, optic disc, macula, and posterior pole.

fusion— Act or process of blending or uniting two images.

glaucoma—Sustained increase in intraocular pressure that causes damage to the eye.

heminanopsia—Non-seeing area in the right or left half of the visual field. Literally means "half blind."

heterophoria—Condition in which a latent tendency of the eyes to deviate is prevented by fusion. Thus, a deviation occurs only when a cover is placed over an eye; when uncovered, the eye straightens.

heterotropia—Misalignment of eyes caused by extraocular muscle imbalance, so that one fovea is not directed at same object as the fovea. Deviation is present even when both eyes are uncovered. See strabismus.

homonymous—Located on the same side.

hyperopia—A refractive error in which the point of focus for rays of light from distant objects falls behind the retina because the eyeball is short or because the refractive power of the lens is weak. Commonly called farsightedness.

illiterate—In the optometry field, this pertains to anyone who cannot discern the English alphabet.

inferior—Located below or directed downward in relation to the eye.

inferior oblique muscle—Extraocular muscle that originates at the anterior medial floor of the orbit and inserts on the posterior temporal sclera.

inferior rectus muscle—Extraocular muscle that originates at the Annulus of Zinn and inserts on the inferior sclera.

infinity—In optical science, a term used to denote a distance so great that the rays of light from it appear parallel.

infrared—Light waves beyond the red portion of the visible spectrum; they are longer wavelengths than can be seen by the human eye.

innervation—Nerve stimulus that contracts a muscle.

interpupillary distance—Distance between the centers of the pupils.

intorsion—Condition in which the top of the eye rotates nasally (toward the nose). Primary action when innervation is made to the superior oblique muscle.

intraocular pressure—Pressure of the intraocular fluid, measured with a tonometer. High pressure *may* indicate glaucoma.

iris—Most anterior part of the uveal tract, which consists of a circular pigmented membrane that is perforated to form the pupil.

iritis—Inflammation of the iris.

isopter—Contour line representing the limits of retinal sensitivity to a specific test target.

keratoconus—Thinning and stretching of the central corneal tissue that produces a bulge or cone shape.

keratometer—Instrument that is used to detect and measure corneal astigmatism.

latent—Condition that is hidden in normal circumstances, but shows up under certain conditions.

lateral—Toward or pertaining to the temporal side of the eye.

lateral canthus—Area where the upper and lower eyelids meet on the temporal side of the eye.

lateral rectus—Extraocular muscle that originates at the annulus of Zinn and inserts on the lateral portion of the sclera.

lensometer—Instrument used for determining the refractive power of spectacles or contact lenses.

lesion—Injury or other change in an organ or tissue of the body that results in impairment or loss of function.

light—Term commonly used for radiant energy that affects our eyes and gives us vision.

limbus—Transitional zone between cornea and sclera.

malingering—Feigning or deliberately giving false test responses to gain desired results.

manifest—Condition that shows up even under normal circumstances.

medial—Toward or pertaining to the nasal side of the eye.

medial rectus—Extraocular muscle that originates at the annulus of Zinn and inserts on the medial portion of the sclera. Primary action is adduction. Innervated by the III CN (oculomotor).

meridian—Imaginary line drawn through or from the optical center or optical axis.

minus lens—Lens that diverges light.

miosis—Condition of having a constricted or very small pupil.

monocular—Pertaining to one eye.

multifocal—Lens with two or more foci due to additional segments.

mydriasis—Condition of having a dilated or large pupil.

mydriatic—Something that dilates the pupil. (Term usually used when referring to drugs).

myopia—A refractive condition of the eye represented by the location of the conjugate focus of the retina at some finite point in front of the eye, when accommodation is said to be relaxed. Commonly called nearsightedness.

nasal—Toward the nose.

nystagmus—Regularly repetitive, usually rapid and involuntary, movement or rotations of the eye.

oblique—Slanted.

occlude—To block or cover an eye.

ocular media—Transparent substances of the eye (e.g., cornea, aqueous humor, crystalline lens, vitreous humor) that light passes through.

ocular motility—Capability of spontaneous or induced movement of the eye.

oculomotor—Third cranial nerve (III CN), which supplies all muscles to the eye, except the lateral rectus and superior oblique.

oculus dexter—Right eye.

oculus sinister—Left eye.

oculus uterque—Both eyes.

ophthalmic—Pertaining to the eye or related functions.

ophthalmologist—Medical doctor who treats eye diseases and performs surgery.

optic disc—That portion of the optic nerve formed by the meeting of all of the retinal nerve fibers. It is insensitive to light (it has no rods or cones) and corresponds to the physiological blind spot.

optic nerve—Collection of all the fibers for one eye that conducts nerve impulses to the optic chiasm and optic tract.

optic tracts—Bundles of nerve fibers that transmit impulses from the optic chiasm to the lateral geniculate body. These tracts contain temporal nerve fibers from one eye and nasal nerve fibers from the other eye.

optometrist—Person who has at least six years of college and is concerned with vision and non-medical visual care. Optometrists use lenses and prisms to correct refractive visual defects; they also diagnose eye diseases and make referrals to ophthalmologists for treatment.

orthophoria—Absence of eye deviation (or tendency toward deviation); no ocular movement is elicited by covering one eye while the other eye views a target. Eyes are aligned correctly and do not deviate.

paresis—Incomplete or partial loss or impairment of a muscle function.

pathology—Study of the nature of diseases or any abnormal variation from a sound or healthy condition.

phoria—See heterophoria.

physiological scotoma—A negative scotoma corresponding to the optic disc.

plus lens—Lens that converges light to a real focus.

positive scotoma—Area of the visual field where the patient does not see anything; the patient is aware of the loss.

primary action—The major action of a muscle.

prism—Wedge-shaped piece of glass or transparent material that has a plane or curved sides, an apex, and a base. Light deviates toward a prism base; but objects seen through a prism appear to move toward the apex.

prognosis—Forecast or prediction of the course of a disease or injury.

ptosis—Falling down or drooping of the upper eyelid below its normal position.

pupil—Opening in the center of the iris.

pupillary reflex—Constriction/dilation of the pupil when exposed to light stimulus.

refraction—Change in direction of light as it passes obliquely from one medium to another of a different density. The bending of light rays.

refractive error—Condition where parallel light rays entering the eye do not focus on the retina.

retina—Light receptive and innermost tunic of the eye (nervous tunic); represents the terminal expansion of the optic nerve.

rods—Specialized cells in the retina that are responsible for discrimination of motion and nightvision.

sclera—White, opaque fibrous tunic of the eyeball.

scotoma—Area that is absent of vision or that has depressed sensitivity. A blind spot. If the scotoma is on the retina, it is considered a positive scotoma because the person will probably notice it. If the cause of the scotoma is behind the retina, it probably will not be noticeable to the person and will be considered a negative.

sensory—Reception of an impulse from a stimulus and transmission of an impulse to the central nervous system.

sphere—Lens with one point focus.

stereopsis—Binocular visual perception of three-dimensional space based on retinal disparity.

strabismus—Condition in which binocular fixation is not present under normal conditions. See heterotropia.

superior—Located above or directed upward in relation to the eye.

suppression—Process of ignoring what one sees.

systolic blood pressure—A reading representing the pressure in the arteries when the ventricles of the heart contract.

temporal—Toward the temple.

tonometer—Instrument for measuring intraocular pressure.

tonometry—Measurement of ocular tension for the purpose of detecting glaucoma.

topical (application)—The delivery system by which a drug is applied directly to the surface of the eye or surrounding skin.

transparent—Pertains to a medium having the property of transmitting light so that objects can be seen through it.

trauma—Any injury, wound, or shock.

trifocal—Lens with three segments, giving three ranges of vision.

tropia—See heterotropia.

uniocular—One-eyed.

visual acuity—Acuteness, distinctness, clearness, or sharpness of vision.

visual field—Area or extent of physical space visible to an eye in a given position.

wavelength—Distance between the crest of one wave and the crest of the next wave. Within the visible spectrum of light, it is directly related to the color of the light.

Abbreviations and Acronyms

AASD	aviation and aviation-related special duty
AC	alternating current
ACS	Aeromedical Consultation Service
AD	active duty
ADV	adenovirus
AF	Air Force
AFE	aircrew flight equipment
AFECD	Air Force Enlisted Classification Directory
AFI	Air Force instruction
AFOCD	Air Force Officer Classification Directory
AFSC	Air Force specialty code
AIDS	acquired immunodeficiency syndrome
AIMWTS	Aeromedical Information Management Waiver Tracking System
ANVIS	aviator’s night vision imaging systems
AO	American Optical
AOR	area of responsibility
APD	afferent pupillary defect
ARC	Air Reserve Component (Air Force Reserve and Air National Guard)
ARM	age-related maculopathy
ARMD	age-related macular degeneration
ASC	aviation service code
ASCLP	Aircrew Soft Contact Lens Program
ASIMS	Aerospace Information Management System
BAT	brightness acuity tester
BC	base curve
BP	blood pressure
BVA	best visual acuity

CA	cancer
CalBox	calibration box
CC	chief complaint
$\overline{cc}$	with correction
CCT	cone contrast test
c/d	cup-to-disc ratio
CDC	Center for Disease Control and Prevention/career development course
CL	contact lens
cm	centimeters
CME	cystoid macular edema
CN	cranial nerve
CRS	corneal refractive surgery
CT	center thickness/cover test
D	diopters
dB	decibel
DD	Department of Defense
DFE	dilated fundus exam
DIA	diameter
DLC	duty limitation code
DM	diabetes mellitus
DNIF/C/J/A	duties not to include flying/controlling/jumping/alert status
DOD	Department of Defense
DVA	distant visual acuity
DVO	distant vision only
DW	daily wear
E/M	evaluation and management
EP	esophoria
EOM	extraocular muscles
ESO	esophoria
EW	extended wear
EXO	exophoria
FB	foreign body
FC	finger count/flying class
FDA	Food and Drug Administration
FDT	frequency-doubling technology
FL	focal length
FOV	field of vision
FS	flight surgeon
FSO	flight surgeon’s office
F/S/U	full, smooth, and unrestricted

ft.	foot/feet
FTFC	full to finger counting
FW	flexible wear
g	gram
GPC	giant papillary conjunctivitis
gt	drop
gtt	drops
HALO	high altitude/low opening
HBP	high blood pressure
HBV	hepatitis B virus
HC	high contrast
HCFA	Health Care Financing Administration
HD	heart disease
Hg	mercury
HIV	human immunodeficiency virus
hr.	hour
HM	hand motion
HTN	hypertension
HUD	heads-up display
IAW	in accordance with
ID	identification
IO	inferior oblique
lOP	intraocular pressure
IPD	interpupillary distance
IR	inferior rectus
LASIK	laser assisted in-situ keratomileusis
LCD	liquid crystal display
LED	light emitting diode
LEE	last eye exam
LET	left esotropia
LH	left hyperopia
LHypo	left hypotropia
LIO	left inferior oblique
LIR	left inferior rectus
LL	light localization
LLR	left lateral rectus
LMR	left medial rectus
LP	light perception
LR	lateral rectus
LSR	left superior rectus

LXT	left exotropia
MFS	military flight screening
MG	Marcus Gunn
mm	millimeter
MR	medial rectus
MTF	military treatment facility
NBC	nuclear, biological, chemical
NCT	noncontact tonometry
NDA	no drug allergies
NIPH	no improvement with pinhole
NKA	no known allergies
NKDA	no known drug allergies
NLP	no light perception
NPC	near point of convergence
NVA	near visual acuity
NVD	night vision devices
NVG	night vision goggles
NVO	near vision only
O_2	oxygen
OAD	overall diameter
OCT	optical coherence tomography
OD	right eye; doctor of optometry
OS	left eye
OVT	optec vision tester
OU	both eyes
OZ	optical zone
PAL	progressive add lens
PAS	pivot and adjustment shelf
PCM	primary care manager
PCS	permanent change of station
PD	pupillary distance
PEPP	Physical Examination and Processing Program
PERRLA	pupils equal, round, react to light, and accommodate
PH	pinhole
PHA	preventative health assessment
PIP	pseudoisochromatic plate
PPE	personal protective equipment
PRK	photorefractive keratectomy
PV	precision vision
PWR	power

RGP	rigid gas permeable (contact lens)
RH	right hyperopia
RIO	right inferior oblique
RLR	right lateral rectus
RMR	right medial rectus
RPA	remotely piloted aircraft
RR	retinal reflex
RSO	right superior oblique
RSR	right superior rectus
Rx	prescription
$\overline{sc}$	without correction
SCL	soft contact lens
SE	spherical equivalent
SF	standard form
SO	superior oblique
SOAP	subjective, objective, assessment, plan/prevention
SOD	special operational duty
sol	solution
SOP	standard operating procedure
SR	superior rectus
SRTS	Spectacle Request and Transmission System
STRAB	strabismus
SUAS	small unmanned aircraft systems
TB	tuberculosis
TDY	temporary duty
TJC	The Joint Commission
UFT	undergraduate flight training
ung	ointment
UNT	undergraduate navigator training
USAFSAM/FECO	USAF School of Aerospace Medicine/Department of Aerospace Medicine, Clinical Sciences Division, Aerospace Medicine Branch
VA	visual acuity
VF	visual field
VTA-ND	Vision Test Apparatus–Near and Distant
VTS–CV	Vision Test Set–Color Vision
WNL	within normal limits
WWQ	worldwide qualified
y/o	year old
°	degrees
µm	micron

Roots

anterior	in front of
a-	not
an-	not
ab-	away from
ad-	toward
anti-	against
automatic	self-governing
bi-	two
bleph-	eyelid
canthus	corner
centi-	100
centr-	center
chroma-	color
contra-	against
di	two
diplo-	double
endo-	inside
epi-	on, outer
es-	into
ex-	out from
extra-	outside
fovea	pit
frontal	forehead
fundus	bottom, deepest
hemi-	half
heteros	different
homalos	normal
homo-	same
hypo-	under, down
inferior	lower
-itis	inflammation
lacrima	tears
lateral	to the side, away from the midline

medial	toward the midline
milli-	1000
oculus, ophthalmos	eye
op-	see
posterior	in back of, toward the rear
pseudo-	false
quad-	quarter
scleros	hard
-script	write
semi-	half
sub-	under
super-	over
superior	above, over, higher
supra-	over
sympathetic	feeling together
tempora-	temple
tri-	three

Student Notes

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69. (625) During the Worth–4 Dot test, if the patient is wearing Anaglyph glasses with the *red lens* over the *right* eye and an *occluder* is placed over the *right* eye, how many dots should the patient report seeing?
    a. 1 white dot.
    b. 2 red dots.
    c. 3 green dots.
    d. 1 red and 1 white dot.