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Dental Laboratory Journeyman

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THIS THIRD volume of CDC 4Y052, *Dental Laboratory Journeyman*, consists of four units. Unit 1 describes the procedures to inspect preliminary impressions, identify anatomic landmarks, and fabricate casts. Unit 2 describes the fundamentals of orthodontic appliances. Unit 3 provides information on treatment appliances and articulator principles. Unit 4 covers dental implant principles and dental implant fabrication procedures.

A glossary is included for your use.

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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.

Please read the menu for Unit 1 and begin ➔

Unit 1. Impressions and Casts

POURING IMPRESSIONS and constructing casts may be the simplest aspects of dental laboratory procedures; however, careless inattention to these simple tasks can result in a myriad of problems. A technician who does not realize the importance of these tasks is destined to repeat his or her mistakes—causing unnecessary and avoidable rework, not to mention the wasted time and aggravation of the patient—your customer. In this lesson, we focus our attention on the significance of impressions and casts.

1–1. Impressions

Working with impressions challenges the technician in several areas. Turning a negative reproduction of the mouth into an adequate positive dental cast requires skill, experience, patience, and an ability to visualize. One of the most important skills is judging when the impression is accurate. In this section, we discuss the requirements for impressions and the anatomical features needed to construct a functionally esthetic prosthesis.

401. Identify anatomic landmarks of impressions, casts, and prostheses

Different types of appliances have different anatomical requirements. A complete denture impression needs good reproduction of the ridge, sulcus, and posterior border. A fixed dental prosthesis (FDP) impression, on the other hand, emphasizes tooth preparation reproduction. We will use a complete denture as an example of an impression, cast, and appliance relationship so that we may discuss each anatomical feature.

Identify anatomic landmarks of impressions, casts, and prostheses

Figures 1–1 and 1–2 show both the maxillary landmarks and the mandibular landmarks that we discuss here. The landmarks are identified by callouts (numbers) on the figures. Notice that the landmarks can be grouped into three categories:

1. Those found in both the maxilla and the mandible.
2. Those found only in the maxilla.
3. Those found only in the mandible.

The landmarks common to both the maxilla and mandible are the residual ridges, labial frena, and buccal frena. All three landmarks are important in complete denture construction.

Residual ridges are the ridges of bone (alveolus) that form the maxilla and mandible in which the teeth, if present, are embedded. If the teeth are gone, the mouth is edentulous and the ridges, in general, resemble those shown in figures 1–1 and 1–2. The exact shape of the ridge depends upon such factors as the patient’s age, oral health, and bone structure.

The labial and buccal frena are comprised of the folds of soft tissue that are slightly mobile. If we do not construct appliances that allow for this movement, the frena will become sore and will detract from the patient’s quality of life.

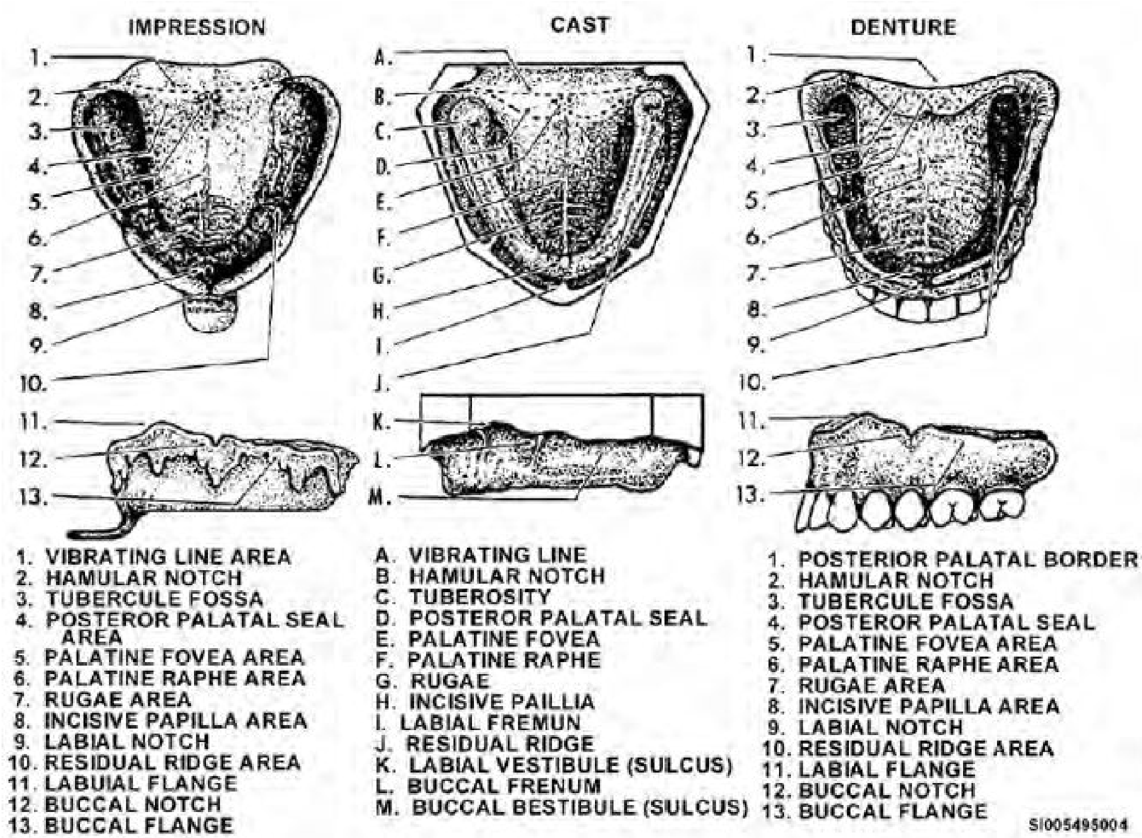


Figure 1–1. Maxillary landmarks.

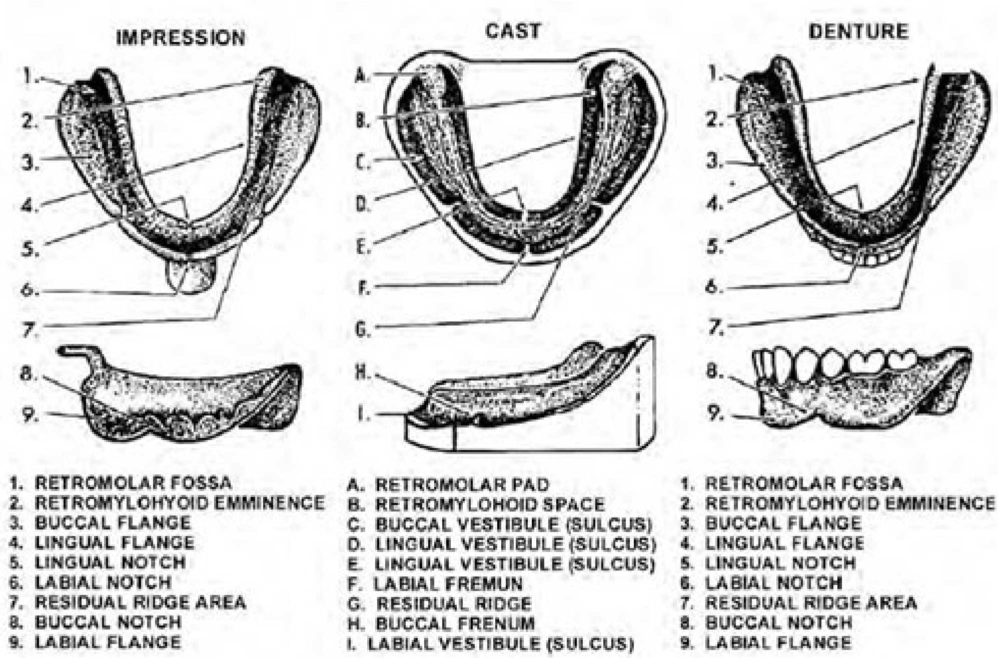


Figure 1–2. Mandibular landmarks.

Labial frena are two small folds of mucous membrane located at the median line of both the maxilla and mandible. Each extends from the inner surface of the lip to the alveolar mucosa and limits, to some extent, the movement of the lip. The attachment of the frena to the alveolar mucosa is variable. This is especially true of the upper frenum, whose attachment to the alveolar mucosa may extend as far down as the gingival border of the teeth. Both the upper and lower labial frena are evident in impressions, making indentations called labial notches.
The labial frenum activity is mostly vertical, so the labial notch of a denture should be narrow, as shown in figure 1–3. The mandibular frenum is usually shorter and wider than the maxillary labial frenum.

Buccal frena are found on the right and left sides of the maxilla and mandible in the buccal region, usually near the premolar teeth (figs. 1–1 and 1–2). Like the labial frena, the buccal frena are small folds of mucous membrane that attach the cheeks to the alveolar ridges. Buccal frena make indentations called buccal notches in the impressions. This tissue moves both horizontally and vertically (e.g., when the patient grins or puckers). This requires a wider clearance on the contour of a denture flange to avoid tissue irritation, as shown in figure 1–3.

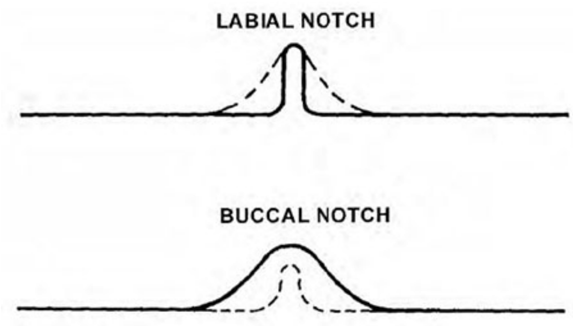


Figure 1–3. Labial and buccal notches.

Maxillary landmarks

Failure to understand the position and function of maxillary landmarks, as shown in figure 1–1, can result in an appliance that has poor retention and causes tissue damage and pain to the patient.

The labial vestibule extends between the right and left buccal frenums or between the area of the right and left first bicuspids, as seen in figure 1–1. If the anterior ridge is in fair to good condition, the denture border is usually 2-millimeters (mm) thick or less. A thicker border would protrude the lip. The buccal vestibule extends from the first bicuspid to the hamular notch. Typical width of the buccal border is usually about 2–3 mm, expanding to 3–5 mm as it approaches the distal region.

The hamular notch, located distal to the tuberosity, is a displaceable area about 2 mm wide, as shown in figure 1–1. This is an important area because it identifies the distal end of the denture that supplies the necessary soft tissue for the peripheral seal.

The incisive papilla is located at the midline posterior to the central incisors. It is a covering of soft tissue that protects nerves and blood vessels passing through the incisive foramen. Excessive pressure on the incisive papilla can cause discomfort for the patient. In this case, the dentist may have this area relieved.

Rugae are irregularly shaped ridges of connective tissue covered with mucous membrane, found in the anterior third of the hard palate. Some dentists believe that the rugae play a part in speech and, therefore, may prescribe their reproduction in the appliance. Others believe rugae to be of no use at all. When the rugae are reproduced in the denture resin, it is somewhat harder for the patient to keep this area of the denture clean. For this reason, dentists do not routinely prescribe artificial rugae.

The median raphe is a slightly raised area of tissue that extends along the midline of the palate. It may be quite dense and nonresilient, or it may be barely discernible. If it is prominent, the dentist may prescribe relief to prevent the appliance from rocking.

The shape of the hard palate in cross-section is flat, rounded, U-shaped, or V-shaped (fig. 1–4). The shape of each palate presents unique challenges to denture base stability. A denture that forms to a flat, palatal shape resists vertical displacement but not horizontal (H) forces. The rounded and U-shaped palates resist both vertical and horizontal forces.
The V-shaped palate is the most problematic because any vertical or horizontal movement tends to break the seal between the denture base and the tissue.

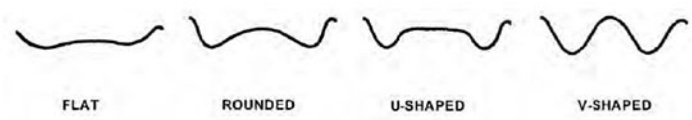


Figure 1–4. Forms of the hard palate.

The shape of the soft palate determines the shape of the terminal end of the posterior border and the placement of the posterior palatal seal. The House classification has three basic variations that occur in the soft palate:

- Class I has more than 5 mm of movable tissue and is ideal for retention.
- Class II has 1–5 mm of movable tissue; good retention is usually possible.
- Class III has less than 1 mm of movable tissue; retention is usually poor.

Each classification has a postpalatal seal design suited for its anatomical shape. The dentist determines the postpalatal design.

Fovea palatine are small pits or indentations found on each side of the midline, usually on the distal end of the hard palate. They are often used as landmarks in locating the area for the posterior palatal seal. Unfortunately, fovea are not a reliable reference. The dentist is responsible for and should determine where the junction of the hard and soft palate occurs.

The hamular notch is found posterior to the tuberosity and is formed by the maxilla and part of the sphenoid bone. It serves as a landmark to determine the extension of the posterior border of the upper denture. Since the notch is filled with soft tissue, which can be displaced, it is used as a seal area for the posterior border of the maxillary denture.

These soft tissue areas are critical to the design and function of a postpalatal seal. Please note the recommended widths and depths of the average postpalatal seal shown in figure 1–5.

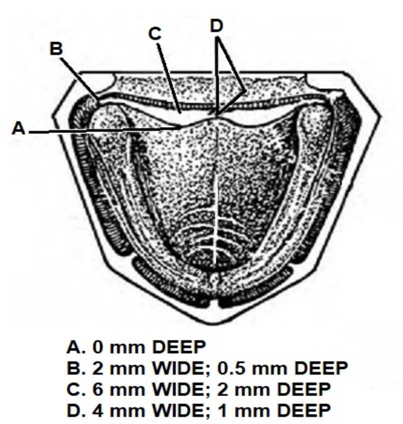


Figure 1–5. Postpalatal seal dimensions.

Mandibular landmarks

Typically, mandibular dentures present the most difficulty for patient and dentist alike. Understanding the position and function of mandibular landmarks is important to creating a functional denture that pleases the patient.

The lingual frenum is a fibrous band of tissue that attaches the tongue to the floor of the mouth. It must be allowed unrestricted movement around and through the denture border to avoid pain or displacement of the denture.

The retromolar pad is a small pear-shaped bulge of mucous membrane and muscle attachments (this is why it stays constant) that lies distal to the third molar. The retromolar pad is included in almost all complete denture techniques as a seal area for the posterior border of the lower denture. It also supports the saddle of removable dental prosthesis (RDP).

The primary areas of support are the posterior alveolar ridge and buccal shelf; however, if the ridge is poor, the buccal shelf must carry most of the support. This is why the vestibule must be accurately represented in the impression and cast. The anterior alveolar ridge is a secondary area of support because it tends to resorb underload.

The width and length of the buccal vestibule are dependent upon the buccal shelf and the activity of the buccinator muscle. Typically, the border that fills this area should be about 2 mm thick and—like all denture borders—smooth and rounded.

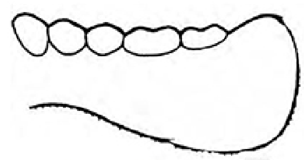


Figure 1–6. Mandibular lingual flange curvature.

The lingual vestibule is the area where the lingual flange "fits." Achieving an adequate seal requires that the denture flanges adapt to the anterior, middle, and distal lingual vestibules. The typically "S-shaped" curve, seen in figure 1–6, is common to most mandibular dentures. Denture base design problems usually occur in the distal lingual vestibule.

The distolingual vestibule is referred to as the lateral throat form or retromylohyoid fossa. The denture flange can have three general lengths, categorized into three classes, as seen in figure 1–7. A Class I lateral throat form will accommodate a fairly long and wide flange. A Class II lateral throat form is about half as long and narrow as a Class I. Class I and II throat forms are the most common. A Class III throat form has a minimum length and thickness.

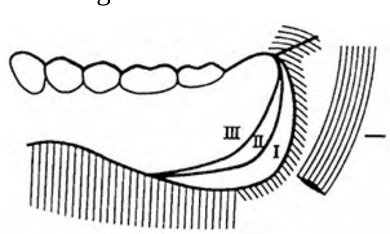


Figure 1–7. Classification of lateral throat form.

The mental foramen is situated between the roots of the first and second bicuspids about halfway between the upper and lower borders of the body of the mandible. The foramen is not a significant feature in denture base construction unless the ridge is extremely resorbed. In these cases, it may be necessary to relieve the denture over this area to avoid excessive pressure with its resulting pain. The dentist must make this decision.

Requirements

Impressions form the foundation for all prosthesis fabrication. The accuracy of the cast used to fabricate any prosthesis will determine the accuracy of the final product. All impressions must be able to reproduce specific anatomical features, but the requirements for impressions for fixed dental prostheses will differ from those for removable prostheses. We will discuss each of these individually, beginning with the fixed impression.

Fixed prostheses impressions

The materials used for fixed impressions have improved significantly over the years. We place great demands on the performance characteristics of the material, mostly due to the presence of severe undercuts in the dentulous mouth. The requirements of an accurate impression for a fixed restoration are discussed in the following table:

Fixed Impression Requirements	
Requirement	**Description**
Dimensional stability	Describes the property of an impression to maintain its shape after a period of time. It is a tremendous asset to be able to make accurate fixed casts days and weeks after the patient was originally impressed.
Elasticity	The elastic qualities of modern final impression materials allow the material to stretch as it is being removed from severe undercuts. This facilitates easy separation of the impression from the patient's arch and from the poured cast.
Durability	The ability of an impression to exist for a long time without deterioration. Crown and fixed dental prostheses fabrication routinely requires multiple pours from one impression. As a result, the material is exposed to wet and dry environments, changes in temperature, as well as plenty of physical abuse.
Dimensional accuracy	This is critical for all types of impressions, but none more so than for fixed. Accurate fit is essential for marginal integrity, retention, and support of crowns and fixed partial dentures.
Ability to reproduce intricate detail	The typical tooth preparation for a crown includes very fine margins and sometimes narrow, vertical grooves. These features must be reproduced precisely to ensure success of the restoration.

Removable prostheses impressions

A successful, removable impression will capture and cover as much of the supporting alveolar ridge area as possible and yet not distort any soft tissue areas. It must properly represent the hard and soft tissues of the mouth to create a removable prosthesis that preserves the alveolar ridge. Preservation of the alveolar ridge is dependent upon the following:

- Support.
- Retention.
- Stability.

Support

The primary areas of support are at right angles to the occlusal forces and usually do not resorb easily. The maxillary areas include the posterior ridges and flat areas of the palate. The mandibular areas include the buccal shelf, posterior ridges, and the retromolar pad (pear-shaped pad). Though the retromolar pad is sometimes soft and can be a poor support area, coverage is necessary so that the retromylohyoid flange is complete and the buccal shelf is covered.

Secondary areas of support, on an edentulous ridge, are at greater than right angles or parallel to the occlusal forces. These areas are the anterior ridge and all ridge slopes of the maxillae and mandible.

Retention

Soft tissue undercuts must be handled carefully because soft tissue is easily displaced. The most significant soft tissue undercut, in the mandibular denture, is the retromylohyoid flange.

The *peripheral seal* is the positive contact of the entire perimeter of the denture base. This seal includes the postpalatal seal and the labial, lingual, and buccal vestibules. A flange that does not fill the vestibule will have an inadequate peripheral seal that directly affects the retention of the denture. The peripheral seal is considered the *most* important and *effective* factor of retention.

Stability

Stability, as defined for dentures, is the adequacy of the prosthesis to resist horizontal movements. Resistance to the movements is directly related to proper fit and to the retention factors mentioned above. Dentures are prone to horizontal movements because of the forces generated when a person speaks or eats. The stability of a denture is directly related to its retention, the more retention present, the more stable the denture.

Common problems with alginate impression

Alginate impressions are used for diagnostic casts as well as for complete and removable partial denture final impressions. Alginate impressions are used so much, it warrants discussion of specific problem areas associated with them.

Impressions may be distorted or missing vital portions. The impression material may have pulled away from the tray; be too thin or slumped; or have voids, tears, bubbles, or distortions (fig. 1–8).

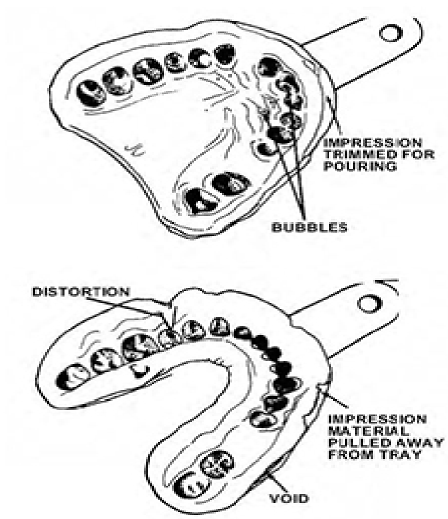


Figure 1–8. Common problems with alginate impressions.

Alginate impression material may pull away from the tray while removing the impression from the mouth. Close inspection combined with gentle touching of sulcus sections can reveal loose spots. Remember that alginate, due to its tendencies to gain or lose water, is easily distorted and an impression will separate from the tray if not stored in a humid environment. For this reason, alginate impressions must *not* have prolonged exposure to air and must be poured within 10–12 minutes.

Alginate slump in a stock impression tray usually occurs in the palatal area of an impression. This slumping (fig. 1–9) is typical of patients with a high-palatal vault and is caused by overly thick, unsupported alginate. Remember that alginate should be a uniform thickness—3 mm. If the alginate is excessively thick and unsupported, it will collapse. When this occurs, it causes the entire impression to “pull” towards the slumped area (the midline). The end result is an impression that is narrower than the patient’s actual intraoral dimensions.

When prostheses, usually a partial or Hawley retainer, are constructed on a distorted cast, they will *not* fit the patient. Avoid this problem by either building up the palatal area of the stock impression tray with beading wax or by constructing a custom impression tray.

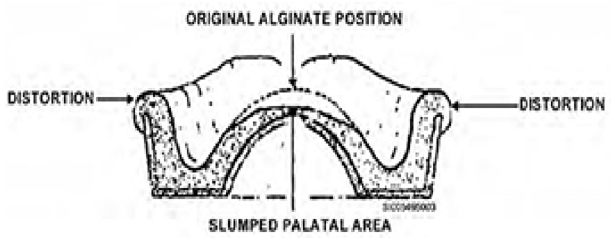


Figure 1–9. Alginate slumping by lack of support.

Impression voids and bubbles are caused by mistakes similar to those made in the lab while pouring impressions. Voids are created, usually in the sulcus, by moving the impression vertically while it is setting. An improper mixing technique or a high-surface tension on the teeth can cause bubbles. V-shaped distortions leading outward from a tooth into the sulcus are caused by the material beginning to set before insertion in the mouth. Tears are usually found at the posterior border of the tray due to a lack of support. During impression pouring, this tear can create a void by allowing air to enter the liquid stone. The following table describes some common problems encountered when pouring alginate impressions:

Common Problems With Alginate Impressions		
Problem	**Probable Cause**	**Solution**
Voids in impression.	Voids in impression material during making of impression.	Obtain another impression.
Impression separated from the tray.	Too much time in open air between impression and pouring.	Pour alginate impressions immediately or store in a humid environment for no longer than 12 minutes.
Impression pulled away from the tray.	Lack of tray adhesive or improper removal or handling technique.	Retake final impressions.
Cast surface chalky and soft.	Cast *not separated* from cast within 1 hour after pouring. Incorrect water-powder ratio.	Separate cast from impression within 1 hour. Weigh stone and mix with recommended amount of water.
Voids on surface of cast.	Mechanical spatulator not used. Flowing stone trapped air during pouring.	Mix stone in mechanical spatulator under reduced atmospheric pressure. Pour slowly to minimize voids.
Cast base too thin or too thick.	Cast improperly trimmed. First-pour stone not checked for thickness, and retentive nodules not reduced prior to pouring of base.	Check cast frequently when trimming. Check nodules for proper height.
Critical areas of cast trimmed away.	Inattention to trimming procedures.	Check cast frequently when trimming.
Cast broken easily.	Improper powder-water ratio.	Use recommended powder-water ratio.
Slurry sludge stuck on cast, making surface rough.	Cast not dipped into clear slurry water during trimming.	Soak or wet cast in clear slurry water when trimming on cast trimmer.

Self-Test Questions

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

401. Identify anatomic landmarks of impressions, casts, and prostheses

1. When identifying anatomic landmarks, which landmarks are common to both the maxilla and mandible?

2. What two small folds of mucous membrane are located at the median line of both the maxilla and mandible?

3. Why is the hamular notch important to the peripheral seal?

4. When considering denture base stability associated with the hard palate, what are the four forms of the hard palate?

5. Which of the three soft palate classes of the House classification scheme is ideal for retention and why?

6. When fabricating the mandibular denture base, what landmark almost *always* serves as a seal for the posterior border?

7. What are the requirements for an impression for a fixed restoration?

8. Match the description in column A with the term in column B. Some column B items may be used more than once or not at all.

Column A	*Column B*
____ (1) This area of support is at right angles to the occlusal forces.	a. Retention.
____ (2) The peripheral seal is the most important factor.	b. Stability.
____ (3) The adequacy to resist horizontal movements.	c. Primary.
____ (4) This area of support is at greater than right angles or parallel to the occlusal forces.	d. Secondary.

9. What is the probable cause and what is the solution for an alginate impression that separates from the tray?

10. Why are stock tray alginate impressions of patients with a high-palatal vault prone to distortion?

11. What causes voids on the surface of a diagnostic cast?

1–2. Construct Casts

Casts are the foundation upon which all prostheses are built. Typically, prosthesis fabrication occurs near the end of a patient's treatment plan. By the time you see a final impression, the patient has spent many hours in the dental treatment room. The casts of impressions you receive in the lab from the dentist could be the culmination of weeks or months of work. Given this significant investment, you must handle the final impression with the utmost care. Cast construction is the next critical step in duplicating the anatomical features captured in an impression. Perform each step in cast construction carefully or all the work that follows will be wasted.

402. Diagnostic casts

This lesson describes diagnostic casts. Diagnostic casts are critical to treatment planning.

Diagnostic casts

Let us examine how best to produce accurate, bubble-free, diagnostic casts. Here are some do's and don'ts to remember when pouring impressions.

Remember When Pouring Impressions	
Do	**Don't**
• Always follow infection control guidelines when pouring and trimming a cast. • Pour alginate impressions within 10–12 minutes after removal from the mouth. • Remove the mucous film and debris from the surface of the impression with a gentle stream of body-temperature water. • Follow the manufacturer's directions when preparing a mix of gypsum product. • Use a proper separator, such as Super-Sep, when pouring one gypsum material against another. • Use a vibrating table to make a thick, gypsum mix flow into all of the crevices of the impression. • Pour a small amount of the gypsum product into a corner of the impression, and let it slowly advance to the other side.	• Over vibrate. The vibrator is set too high if the impression "jumps" in your hand, if the mix moves so fast it skips over surface detail, or if vibration wave patterns develop on the surface of the mix that can cause entrapment of air. • Expose the poured impression to vibration while bench setting. • Allow the poured alginate or rubber-base impression to set more than 1 hour prior to separating.

Remember When Pouring Impressions	
Do	**Don't**
• After covering the entire surface of the impression, progressively larger amounts of the mix may safely be added.	

Two-step method of pouring a diagnostic cast

In a two-step method, the anatomic portion is poured first; then the base is added as a second step. To help prevent distortion caused by pressure from its own weight, a poured impression may be suspended by the handle from a tray holder (fig. 1–10). The two-step pouring procedure is as shown in the following table:

Two-Step Pouring Procedure	
Step	**Action**
1	Fill the anatomical portion of the impression as described above to include full border coverage.
2	To guarantee a union between the two pours, leave nodules and roughened peaks on the surface of the first pour.
3	After the final set, wet the first pour with saturated calcium sulfate dihydrate solution (SDS) to prevent slurry debris from permanently sticking to the cast; then allow the water to be absorbed, and invert the first pour into a newly mixed mound of the same material.
4	While it is still soft, shape the mound to the desired size and thickness. This second step forms a base.
5	Build up a base thickness of about 18 mm (¼ inch).
6	Overbuild the base to compensate for trimming reductions.
7	Separate the cast as previously directed.

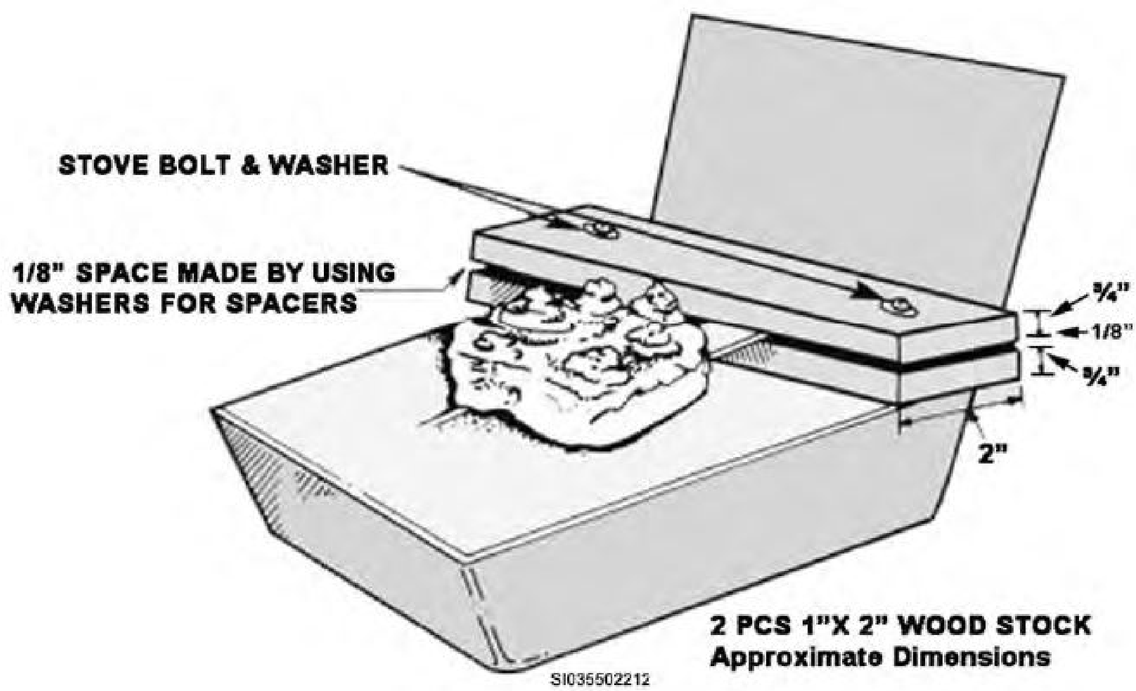


Figure 1–10. Tray holder for two-step pouring method.

NOTE: In a mandibular impression, the second pour tends to creep up over the lingual flanges and lock the tray into the hardened mix. A tray is difficult to remove under these conditions, and the cast may be ruined in the process. To prevent this problem, invert the first pour onto the second mix of material without letting the tray become buried. While the material is still soft, flatten and shape the tongue area of a mandibular impression, so the area is relatively smooth and is about 1 mm above (occlusal to) the lingual sulcus.

One-step method of pouring a diagnostic cast

The one-step method of pouring diagnostic casts is quicker but has its limitations. Impressions must never be poured then inverted into a mound of gypsum material to form the entire cast in one step. The material tends to settle toward the base while it is setting, leaving the softer material toward the anatomic areas of the cast, producing a marginally adequate cast. The gypsum mix also has a tendency to fall away from important impression borders. In addition, it is difficult to control the thickness of the base and the orientation of the anatomic portion to the base. An impression may be filled with a mix of gypsum product with enough material stacked up for a base right on top (sometimes called the “upright method”). This technique is more successful with maxillary than with mandibular impressions.

Some dentists request a “high-mount” pour of the diagnostic cast. In this method, the impression is poured, similar to the upright method, making sure the first pour is at least 15 mm thick in the dentulous areas and 10 mm thick over edentulous areas. Large retention nodules are placed, but no attempt is made to develop a base. After final set and separation of the cast, the retention nodules are flattened slightly. This method is usually used when the dentist will be using the casts to make a diagnostic mounting and does not need to remove the casts from the mountings.

Although the one-step method is an option, it is best to depend on the two-step method. In the end, it will save time by ensuring the best cast quality.

Separating diagnostic casts

Separate a cast from an impression after the heat generated by the final setting reaction dissipates completely (about 45 minutes after pouring). If a cast is not separated from an alginate impression before the alginate shows signs of dehydration, the cast will probably show unacceptable surface damage. Do not allow a poured cast to stand in an alginate impression for more than one hour.

Trimming diagnostic casts

Do not trim a cast for at least two hours after it has reached the final set. Rinse the cast in a container of saturated calcium SDS before and during the trimming procedure. Never trim a dry cast on a wet model trimmer because the slushy debris coming off the trimming wheel falls on the dry surface and becomes permanently attached to the cast surface.

NOTE: Use only SDS for soaking or rinsing casts.

Make sure the cast includes all of the denture-support areas and features that define denture borders. Keep the cast free of nodules or voids. When trimming a cast, follow the guidelines shown in figure 1–11. Fully represent the sulci areas in the cast but not more than 3 mm deep. The sulci are routinely protected by a peripheral “land” area or ledge extending 4 mm outward.

Make sure the cast extends 5 mm beyond the hamular notch areas of the maxillary arch and 5 mm beyond the retromolar pads of the mandibular arch. A cast should be about 15 mm (5⁄8 inch) thick at its thinnest area (usually the palatal vault of the upper and the tongue-space region of the lower).

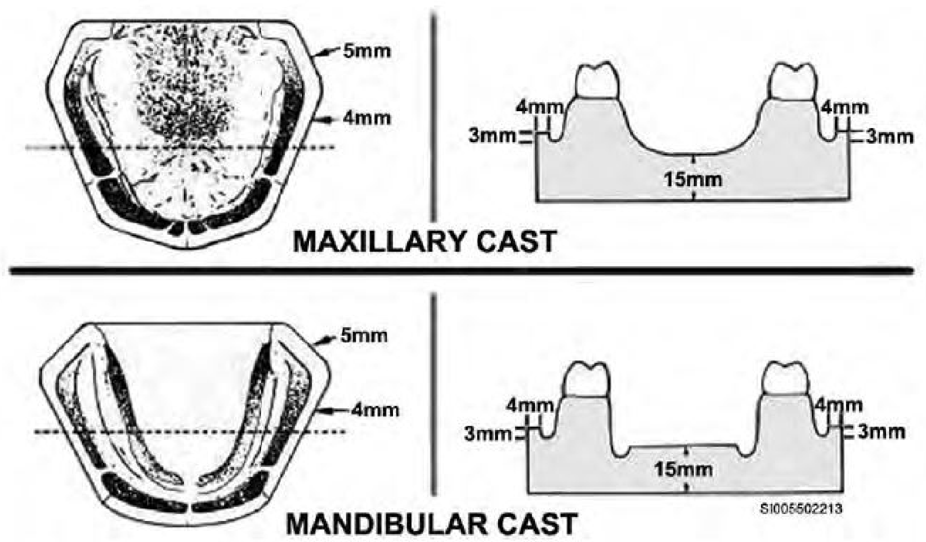


Figure 1–11. Trimming maxillary and mandibular casts.

403. Construct casts for full arch impressions

Master casts for FDP must be extremely accurate. They receive extra emphasis since additional production steps are needed. These steps increase the risk of error. There are two basic working cast-and-die systems: (1) a solid cast and an individual die and (2) a working cast with a removable die. We begin with a discussion of the solid cast and individual dies. Parts of the following material are adapted from *Fundamentals of Fixed Prosthodontics* by Herbert T. Shillingburg, Jr., Doctor of Dental Surgery (DDS).; Sumiya Hobo, DDS, Master of Science in Dentistry (MSD).; and Lowell D. Whitsett, DDS; Quintessence Publishing Co.; and the *Ney Crown and Bridge Manual* by J.M. Ney Co., Bloomfield, Connecticut.

Solid casts

The solid cast is made from a second pour of the full arch or arch segment of the final impression. This method provides a fixed and immovable relationship between abutments, improving the accuracy of the fit and of the proximal contacts. Solid casts can be used to refine metal proximal contacts, refine labial and lingual contours, and provide an accurate relationship between retainers of a FDP. Multiple pours can only be done with rubber-base materials, since the hydrocolloid impressions are distorted after the first pour. Prepare and pour the impression as usual. Once separated, trim the cast or die for ease of handling.

Dies

Dies may be removable, part of a solid cast, or individual dies. Removable dies enable you to remove and reposition a die in a working cast. The individual die is a second pour that can be used to verify fit of a restoration.

Bulk-trimming dies

Bulk trim the die with a cast trimmer, bur, or arbor band. The root part of the die should be a little larger than the preparation, with a slight taper downward on the sides of the handle. Figure 1–12 shows a properly trimmed die handle of a hand die; however, the die is *not complete*. First, it must be trimmed below the margin to aid in waxing the axial contours. Figure 1–13 shows how a deeply ditched die influences overcontouring. A properly trimmed die allows you to refine the margins as well as help wax the individual portion of the pattern.

Figure 1–12. Properly trimmed die handle.

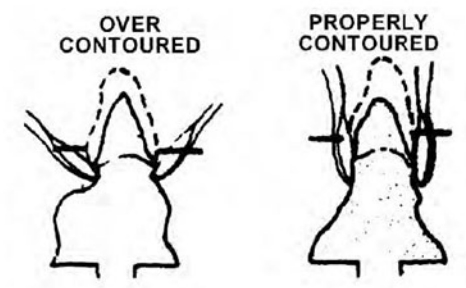


Figure 1–13. How contour is influenced by die trimming.

Trim dies in a well-lighted area, and use magnification for sharp, clear vision.

NOTE: Wear safety goggles and use proper ventilation when performing this procedure.

Do the initial bulk trimming with a pear-shaped acrylic bur (fig. 1–14). You want to expose about 4 mm of stone below the margin, without creating a deep recess. The die contours should resemble the root part of a natural tooth.

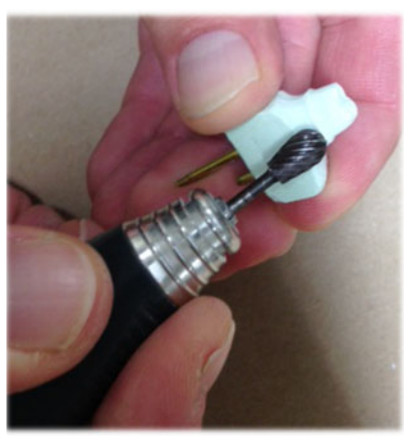


Figure 1–14. Bulk-trimming with a pear shape bur.

Final-trimming dies

Final trimming is a very critical and precise procedure. Ideally, the dentist should complete this step. It is important, however, that you be able to do this when necessary. Do the final trimming with a sharp beaver blade, as shown in figure 1–15. At the mesial and distal surfaces, make your cuts straight down because the proximal contours of the pattern are fairly straight. On the facial and lingual areas, strive for about 0.5 mm of undercut. This will serve as a guide to the "not greater than 0.5 mm" rule for height of contour.

Figure 1–15. Trimming the margin.

To make sure that the margins are highly visible, mark them with a red pencil. Figure 1–16 shows how to lightly outline the margins of the die. Now that the margins are clearly visible, be extremely cautious that they are not worn or rounded by handling. (Applying die hardener to the margins protects them from abrasion and does not open the margin.) Do *not* use a graphite pencil to mark margins because the graphite could create pits in the casting.

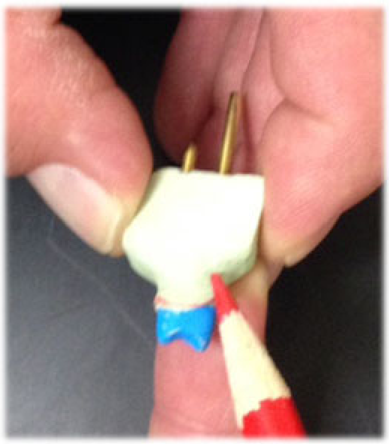


Figure 1–16. Marking the margin.

One last procedure in die preparation is to apply a die spacer to create a space for the cement. The cement in a precision casting exerts pressure on the casting (hydraulic effect) that can prevent it from completely seating. The die spacer allows room for the cement for the casting to seat completely (fig. 1–17). The die spacer must *not* cover the margins. The manufacturer recommends the exact thickness and distance from the margin. The thickness depends on the material and number of coats applied.

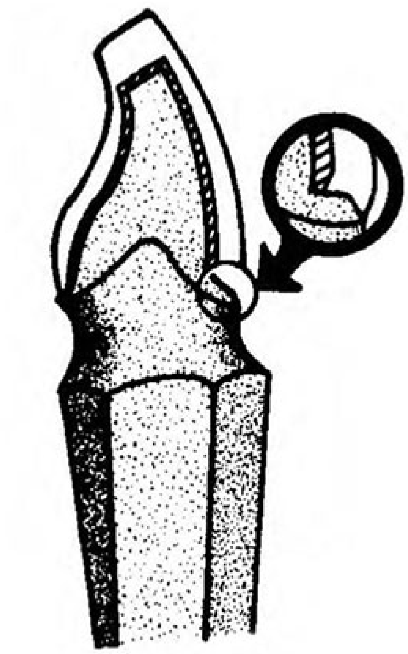


Figure 1–17. Applying the die spacer.

Working cast with a removable die

A working cast constructed with removable dies has the same requirement for strength and accuracy as an individual die. This capability to repeatedly remove and replace a die to its original position is possible using a dowel pin system. Now, we will discuss the Pindex System.

Pindex System

In the Pindex System, holes are drilled in the stone arch after it is poured and allowed to set. Then, pins are cemented in the holes, and a metal or plastic sleeve is placed over each pin. The cast completion procedures are similar to the other removable die techniques. This technique can be useful when it is more advantageous to pin the die after the first pour.

Hydrocolloid impressions are sometimes difficult to pin and pour. In addition, the epoxy resin dies are easily made with this technique. The Pindex System make sure that all pins are parallel, which helps when constructing FDP. Each die constructed uses the two-pin concept to prevent die rotation.

A 50-gram mix of die stone should be enough for the first pour. Prepare the mix and pour the impression as you would ordinarily. There should be about 10 mm of stone above the margins of the preparation to give it strength. Once the die stone reaches final set (45 minutes), carefully separate the arch from the impression. Flatten the base surface with the model trimmer (fig. 1–18). Place the cast on a flat surface and check for rocking. The cast must not rock. If the cast rocks, it will probably break during the drilling of the pin holes. Let the arch dry before drilling. Final casts should be sanded before pindexing.

CAUTION: Accelerating the drying time by heating weakens the cast.

This Pindex System uses a machine to drill a hole into the bottom of a stone arch. Dowel pins are then cemented in place. After cementing the pins, trim excess cement from the pins.

Figure 1–18. Trimming the cast base.

The drilling machine has a light indicator showing where the holes are drilled in the base. Simply align the light beam over the desired location, and press down on the platform, drilling a hole as shown in figure 1–19. After all the holes are drilled, remove the dust with a blast of air.

NOTE: Wear safety goggles when performing this procedure.

Figure 1–19. Drilling pin holes.

There are three basic types of Pindex pins: (1) dual (pin and sleeve combination) (fig. 1–20), (2) long, and (3) short. The following chart describes what role each pin plays when pindexing:

Pindex pin types	
Pin Type	**Description**
Dual (with plastic sleeve)	Used for anteriors because of arch size. This pin may be used without the sleeve if space is limited; however, repeated removal and replacement without a sleeve can wear away the stone (fig. 1–20).
Long (with the white plastic sleeve)	Used as a dowel pin for posterior teeth.
Short (with the gray sleeve)	Used in conjunction with the long pins for indexing posterior dies.

Figure 1–20. Types of Pindex pins.

If a dual pin is used, make a small groove across the hole with a separating disc to allow for the ridge of metal on the pin. Select the proper pin for each location, and cement it in place with cyanoacrylate glue. After the glue is dry, place the corresponding plastic or metal sleeve over the metal pin. Regular brass dowel pins can be used for retained areas instead of a Pindex pin. Apply a die separator to the base of all the dies you intend to remove from the base. Base the pindexed model as described in the manual dowel pin method. Regardless of the system or technique used, the possibility for error always exists. A few of the more common problem areas you may encounter are identified, along with the probable cause and solution, in the following table:

Common Pindexing Problems		
Problem	**Probable Cause**	**Solution**
Voids or air bubbles on surface of cast.	Die stone not properly vacuum mixed. Die stone poured into impression too rapidly.	Vacuum mix for at least 15 seconds; make sure mix is creating the minimum necessary vacuum. Add mixed stone in small increments at one border of the impression until preparation is filled. Use a rod or spatula to flow stone into small areas, prior to pouring remaining.
Unable to remove dies after making saw cuts.	Saw cuts not parallel. Adjacent teeth restricting removal of die.	Keep saw cuts parallel to each other and perpendicular to the base. Pin and saw out the adjacent teeth; edentulous areas may also be pinned.
Removable die will not seat completely.	Debris (stone and wax) in pinhole or contacting base of die.	Inspect all areas closely before seating die; clean debris using air pressure or steam cleaner.

404. Casts for complete dentures

In this lesson, we focus our attention on casts for complete dentures. We begin by discussing the two different systems used for complete denture cast fabrication. The lesson concludes with a discussion of some problem areas and how to resolve them.

Complete denture cast fabrication

In most cases, complete denture impressions are boxed before pouring the master cast. *Boxing* the impression represents a way of confining the flow of the stone to control the shape, thickness, and density of the cast. This is the best method to make sure that all peripheral borders are complete. There are two ways to box an impression. The method selected depends on the kind of impression material the dentist used.

Wax bead, box, and pour system

This method can be used with all final impression materials but is particularly suited for elastic materials such as zinc oxide and eugenol paste or impression plaster.

Beading and boxing the maxillary impression

Procedures for beading and boxing a final impression for a maxillary complete denture are as follows:

Procedures for Beading and Boxing a Maxillary Impression	
Step	**Action**
1	Carefully adapt a strip of utility wax (beading wax) around the impression 3 mm down from the edges of the flanges (fig. 1–21A).
2	Extend the wax strip across the posterior border, about 6 mm behind the vibrating line. Make the beading on one side continuous with the beading on the other. Lute (seal) the wax to the tray with a hot spatula.
3	Build a sidewall around the circumference of the beading to provide an enclosure or “box” into which artificial stone can be poured. Make the sidewall of boxing wax or baseplate wax wide enough to extend 15 mm (⅝ inch) above the highest point on the impression (fig. 1–21B).
4	Water test the assembly for leaks by filling the impression with water. The maxillary final impression is now boxed and ready for pouring.

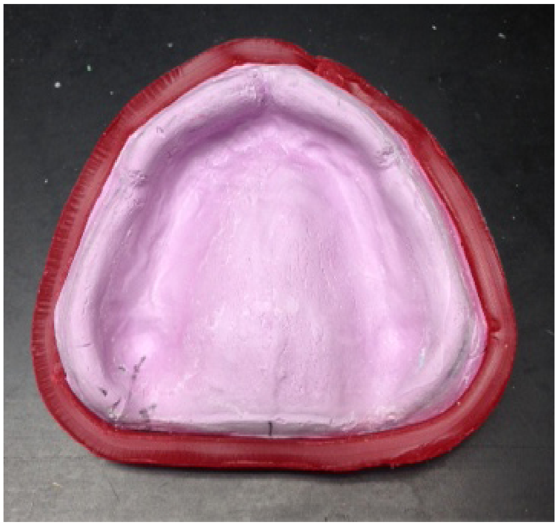


Figure 1–21A. Beading the impression.

Figure 1–21B. Boxing the impression.

Beading and boxing the mandibular impression

Procedures for beading and boxing a final impression for a mandibular complete denture are the same as the maxillary with the *exceptions* shown in the following table:

Procedures for Beading and Boxing a Final Mandibular Complete Denture	
Step	**Action**
1	From the distal third of the buccal flange, across the posterior border of the retromolar fossa, and down to the retromylohyoid eminence on each heel, use two thicknesses of utility wax to provide an adequate land area on the resultant cast.
2	Continue the beading wax around the outline of the lingual area 3 mm from the edges of the lingual flanges. Fill in the lingual area with baseplate wax luted to the beading.
3	After the impression is boxed, test it for leaks and pour the cast.

Plaster-pumice matrix, box, and pour system

The small amount of force used to mold boxing material around a utility wax bead sometimes alters the shape of a final impression made with an elastic impression material. The plaster-pumice matrix, box, and pour system is appropriate for boxing any kind of final impression but is particularly suited when using an *elastic impression material*. The matrix is composed of equal volumes of plaster and coarse pumice. Pumice is incorporated into the plaster to weaken the matrix and make separation of the poured cast easier. It is this matrix that supports the tray and edges of a final impression made with an elastic impression material of rubber-base, silicone, and so forth.

Plaster-pumice method for the maxillary impression

Procedures for creating a plaster-pumice matrix and boxing a final impression for a maxillary complete denture are as shown in the following table:

Plaster-Pumice Method for Maxillary Impression	
Step	**Action**
1	Support the tray about 12 mm (½ inch) off the surface of the table with a small piece of clay. Take the tray with the attached clay and put it aside.
2	Stack a slushy, yet cohesive, mound of the 50/50 plaster-pumice mix on a flat, nonabsorbent surface. Make the patty about 12 mm larger than the diameter of the impression.
3	Place the impression and clay support into the patty *tissue-side* up.
4	Manipulate the matrix mix, so 1.5 mm of flange height is visible all the way around, exposing at least 6 mm of the impression's surface posterior to the vibrating line. Make sure enough of the matrix mix remains around the circumference of the impression to create a ledge at least 8 mm wide.
5	Let the matrix achieve initial set. Hold a razor-sharp blade at right angles to the flanges, and carefully (and uniformly) cut to expose 3 mm of the flanges.
6	After the matrix reaches final set, trim a 6 mm land area around the circumference with a cast trimmer.
7	Paint the land area with two coats of a suitable stone to stone separator such as Super Sep®.
8	Wrap the matrix with boxing wax that stands 15 mm (⅝ inch) above the impression's highest point, and lute the wax to the matrix.
9	Water test the boxed impression for leaks and pour the cast.

Plaster-pumice method for the mandibular impression

Procedures for creating a plaster-pumice matrix and boxing a final impression for a mandibular complete denture are the same as the maxillary with the following *exceptions*:

Plaster-Pumice Method for Mandibular Impression	
Step	**Action**
1	Use two pieces of clay—one on the right and the other on the left in the first molar areas—to hold the tray (especially the heels) 12 mm (½ inch) off the table (fig. 1–22A).
2	Before the matrix reaches its initial set, try to create a smoothly contoured tongue space. Complete the contouring of the tongue space with a sharp knife after the final set (fig. 1–22B).
3	Make a 6 mm wide land area. Extend it from the distal third the buccal flange, across the posterior border of the retromolar fossa, and down to the retromylohyoid eminence on each heel.
4	Paint two to three coats of separator onto the land and tongue-space regions.

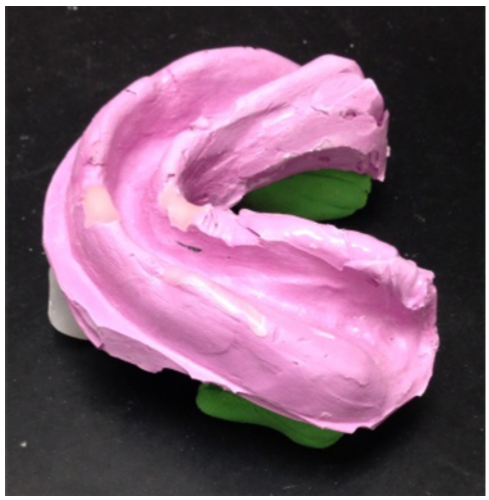


Figure 1–22A. Rubber-base impression held with ticene.

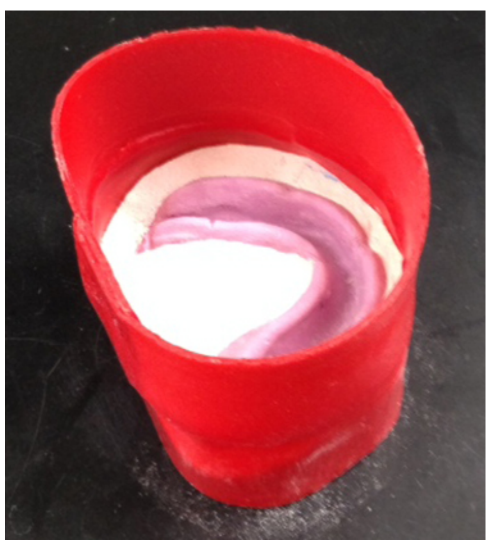


Figure 1–22B. Mandibular plaster-pumice matrix.

Pouring casts supported by plaster-pumice matrix

Most final impression materials do not require a coating of separator before a cast is poured; however, impression plaster is the exception.

NOTE: Pouring a cast against impression plaster without the use of an intervening separator causes the impression and the stone to bond together. Before pouring a cast, proportion the water and gypsum, according to the manufacturer's directions.

For maximum density and strength, use a vacuum-spatulated mix of artificial stone to pour final impressions. Use the two-step method to pour impressions for RDP construction, or box them with a 50/50 mix of plaster and pumice.

405. Construct casts from dual arch impressions

The dual arch impression technique is most often used for single units and occasionally three-unit fixed dental prostheses that have a well-defined occlusion. When using this technique, the doctor and the technician both need to pay close attention to detail when handling the impression to make sure no movement or distortion occurs. This lesson describes how to construct casts from dual arch impressions (fig. 1–23).

Figure 1–23. Dual arch impression.

Initially, the lab technician must make sure that the impression fits correctly between the sides of an assembled triple tray articulator. This can be verified by fully closing the triple tray articulator and making sure there is adequate space available for die stone placement.

Pouring the impression

The triple tray dual arch impression will create an opposing model and working model. After you have properly assembled the tray, the next step in the process will be to pour the impression. Mix the stone according to manufacturer's instructions. Place the impression on the vibrator. You will start by pouring stone into the prep of the impression (fig. 1–24). Once the prep has been sufficiently covered, flow stone into the remainder of the impression (fig. 1–25). **NOTE:** Some technicians prefer to wax the margin prior to pouring the stone to ensure they have a well-defined margin. If you choose to wax the margin, be careful not to extend wax over the margin or you will risk losing the actual margin in stone.

Figure 1–24. Pouring the impression.

Figure 1–25. Flowing stone.

Once you have flowed stone to all surfaces of the impression, hang the impression and begin to fill one side of the triple tray (fig. 1–26).

Figure 1–26. Filling the triple tray.

As the stone begins to set, flip over the poured impression into the poured side of the triple tray (fig. 1–27). Verify the occlusal plane is horizontal, and the tooth alignment is correctly oriented to the articulator and its hinge axis. Clean off the excess stone and allow to bench set for 30–45 minutes.

Figure 1–27. Turning over the impression.

After the bench set, it is time to pour the opposing side. Flip the impression over while it is still in the tray (fig. 1–28). Flow the stone from one end of the impression to the other. Fill the other side of the triple tray and carefully close together. Do not attempt to close together if the stone is too runny. You must let it thicken to ensure you do not create voids in the opposing arch by inverting it too early and to avoid making a mess (fig. 1–29).

Figure 1–28. Opposing side.

Figure 1–29. Completed triple tray pour.

Remove impression and cleanup the edges (fig. 1–30). Clear away all sharp portions of the set stone. Make sure you check the bite for accuracy.

Figure 1–30. Dual arch working and opposing model.

Self-Test Questions

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

402. Diagnostic casts

1. Alginate impressions must be poured within how many minutes after removal from the mouth?

2. When using the two-step method, why must you leave nodules and roughened peaks on the surface of the first pour?

3. Why must you never pour impressions then invert into a mound of gypsum material to form the entire cast in one step?

4. What happens to a cast if not separated from an *alginate* impression before the alginate shows signs of dehydration?

5. Why must you rinse the cast in a container of saturated calcium SDS before and during the trimming procedure?

403. Construct casts for full-arch impressions

1. What is the advantage of the solid working cast and one-piece die over removable die systems?

2. What is the purpose of die spacer?

3. When pindexing a cast, what action weakens the cast?

4. After pouring the pindexed model, what is the probable cause of the removable die not seating completely?

404. Casts for complete dentures

1. What determines the method used to box and pour an impression?

2. Why is pumice incorporated into the plaster of a plaster-pumice matrix?

405. Construct casts from dual arch impressions

1. What type of restorations is the dual arch impression most often used for?

2. How should you mix the die stone?

3. As the stone begins to set and you flip over the poured impression into the poured side of the triple tray, what must you verify?

Answers to Self-Test Questions

401

1. The residual ridges, labial, and buccal frena.
2. Labial frena.
3. It identifies the distal end of the denture that supplies the necessary soft tissue for the peripheral seal.
4. (1) Flat.
   (2) Rounded.
   (3) U-shaped.
   (4) V-shaped.
5. Class I, because it has more than 5 mm of movable tissue.
6. Retromolar pad.
7. Dimensional stability, elasticity, durability, dimensional accuracy, and the ability to reproduce intricate details.
8. (1) c.
   (2) a.
   (3) b.
   (4) d.
9. Separation is caused by prolonged air exposure. Separation is avoidable if the impression stored in a humid environment.

10. Alginate slump in a stock impression tray usually occurs in the palatal area of an impression. This slumping is typical of patients with a high-palatal vault and is caused by overly thick, unsupported alginate. Unsupported alginate beyond 3 mm in depth is prone to collapse, causing the periphery of the impression to "pull" towards the midline.
11. Mechanical spatulator not used or flowing stone trapped air during pouring.

402

1. 10–12 minutes.
2. To guarantee a union between the two pours.
3. The material tends to settle toward the base while it is setting, leaving the softer material toward the anatomic areas of the cast, producing a marginally adequate cast. The gypsum mix also has a tendency to fall away from important impression borders. In addition, it is difficult to control the thickness of the base and the orientation of the anatomic portion to the base.
4. The cast will probably show unacceptable surface damage.
5. Because the slushy debris coming off the trimming wheel falls on the dry surface and becomes permanently attached to the cast surface.

403

1. This system provides a fixed and immovable relationship between abutments, improving the accuracy of the fit and of the proximal contacts.
2. It allows room for the cement for the casting to seat completely.
3. Accelerating the drying time by heating.
4. Debris (stone and wax) in pinhole or contacting base of die.

404

1. The kind of impression material the dentist used.
2. To weaken the matrix and make separation of the poured cast easier.

405

1. For single units and occasionally three-unit FDPs that have a well-defined occlusion.
2. According to manufacturer's instructions.
3. The occlusal plane is horizontal, and the tooth alignment is correctly oriented to the articulator and its hinge axis.

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 Air Force Career Development Academy (AFCDA).

1. (401) Which is *not* a common landmark of both the maxilla and mandible?
   a. Labial frena.
   b. Buccal frena.
   c. Hamular notch.
   d. Residual ridges.

2. (401) What maxillary landmark is located at the midline posterior to the central incisors?
   a. Hamular notch.
   b. Incisive papilla.
   c. Median raphe.
   d. Rugae.

3. (401) What mandibular landmark is a fibrous band of tissue that attaches the tongue to the floor of the mouth?
   a. Retromolar pad.
   b. Mental foramen.
   c. Lingual frenum.
   d. Lingual vestibule.

4. (401) Elastic qualities of modern impression materials allow the
   a. impressions to be disinfected repeatedly.
   b. impressions to be disposable after one use.
   c. material to stretch as it is removed from undercuts.
   d. material to adhere to custom trays without adhesive.

5. (401) What is the *most* significant soft tissue undercut in a mandibular denture?
   a. Labial vestibule.
   b. Lingual vestibule.
   c. Genio-mylohyoid flange.
   d. Retromylohyoid flange.

6. (401) The peripheral seal is the positive contact of the entire perimeter of the denture base; the item that is *not* included in the seal is the
   a. labial vestibule.
   b. postpalatal seal.
   c. lingual vestibule.
   d. anterior palatal seal.

7. (402) If a cast is *not* separated from an alginate impression before the alginate shows signs of dehydration, the cast will probably
   a. be too soft to trim.
   b. be too hard to trim.
   c. show unacceptable surface damage.
   d. show distortion in the palatal region.

8. (403) Between what does pouring a solid cast provide a fixed and immovable relationship?
   a. Abutments.
   b. Occlusal surfaces.
   c. Marginal ridges.
   d. Triangular ridges.

9. (403) Ideally, who should final trim dies?
   a. Dentist.
   b. Dental assistant.
   c. Lab technician.
   d. Flight chief.

10. (403) What are the three basic types of Pindex pins?
   a. Dual, long, and short.
   b. Combo, long, and short.
   c. Dual, medium, and long.
   d. Long, short, and medium.

11. (403) What is the probable cause when the lab technician is unable to remove dies after making the saw cuts?
   a. Debris in pinhole.
   b. Saw cuts not perpendicular.
   c. Die stone not properly mixed.
   d. Adjacent teeth restrict removal of dies.

12. (404) When fabricating a master cast for a complete denture, beading and boxing the impression is the *best* method is to make sure that the
   a. setting expansion is *reduced.*
   b. setting expansion is *increased.*
   c. the impression is free of voids.
   d. all peripheral borders are complete.

13. (404) When boxing a complete denture, pumice is incorporated into the plaster of a plaster-pumice matrix impression to
   a. reduce setting expansion.
   b. increase setting expansion.
   c. weaken the matrix and make separation of the poured cast easier.
   d. strengthen the matrix and provide for maximum support for the impression.

14. (405) What is the dual arch impression technique *most* often used for?
   a. Single units.
   b. Full arch fixed dental prostheses.
   c. Dual arch fixed dental prostheses.
   d. Three unit fixed dental prostheses.

15. (405) How long do you allow the dual arch impression to bench set before pouring the opposing side?
   a. 10–20 seconds.
   b. 30–45 seconds.
   c. 10–20 minutes.
   d. 30–45 minutes.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Orthodontics

HAVE YOU EVER worn braces? You may recall that after the braces were removed, the next step in the treatment process usually involved a fixed or removable orthodontic appliance. Removable and fixed orthodontic appliances are usually made by lab technicians. Most of the appliances are designed to perform minor tooth movement. This unit introduces you to basic orthodontic appliance construction principles and techniques.

2–1. Orthodontic Fundamentals

When first learning a craft, you start at the beginning with the basics. We will begin with the way that active and passive appliances function. We then move on to the essentials of wire bending and its application in constructing orthodontic appliances. Wire bending and manipulation are the basic skills of the orthodontic profession. Bending wire is not a simple task, but it can be learned. Parts of the following material are adapted from *Dental Laboratory Procedures,* Volume 3, *Removable Partial Dentures*, by Robert M. Morrow, DDS; Kenneth D. Rudd, DDS; and Harold F. Eissmann, DDS; St. Louis: The C.V. Mosby Co.

406. Orthodontic movement

Every orthodontic appliance constructed in the laboratory has a purpose. That purpose is either to correct the positioning of teeth or prevent a problem from occurring. An appliance that is corrective in nature is said to be *active*, while an appliance that is preventive in nature is classified as *passive*.

Types

Fixed appliances are usually active and achieve extensive tooth movement over a long period. Removable appliances can perform rather complex tooth movement or act as a simple holding device. It is important to understand the dentist's intent when designing an appliance. A Hawley retainer is often requested without an indication of whether it will be passive or active. If it is meant for activation, then lighter wire is used for the labial bow and the resin base is made to accommodate the type of movement desired.

Active devices

These devices move teeth into a better esthetic or functional alignment. Movement results from forces exerted by spring-wire attachments or rubber bands. These attachments or rubber bands must be anchored to the jaw or stable teeth before moving malpositioned teeth.

Passive devices

A passive appliance holds or maintains teeth in the positions they currently occupy. The passive appliance usually follows active tooth movement and allows the teeth to stabilize in the periodontium. Anchorage is just as important for passive orthodontic appliances as it is for active devices. A passive appliance's anchorage has to be more resistant to movement than the teeth the appliance is supposed to stabilize.

Minor tooth movement

Unless assigned to an orthodontist, you will construct either passive appliances or active appliances that perform only minor tooth movements. This movement is usually no greater than a few millimeters. Corrections of severe malocclusions or skeletal defects are left to the orthodontist and specially trained technicians.

Migration

Tooth migration, or drift, is a common intraoral occurrence. Teeth normally drift mesially toward the midline, especially when a tooth is extracted or prepared. The abutting teeth will often migrate and encroach on this space. Additionally, third-molar eruption—common in young adults—forces the teeth to migrate mesially. This can result in severe overlapping of the anterior teeth. If the arch is too small, severe esthetic and functional problems could result from tooth eruption. Other causes of migration are loss of proximal and/or opposing teeth, traumatic occlusion, disease, oral habits, or accidental changes to the appliance.

Types of movement

The direction and type of tooth movement is caused by a combination of vertical and horizontal forces. The actual movement can be either tipping or bodily.

Tipping

This is a result of a linear force that is applied to some part of the crown, causing the tooth to rotate around its fulcrum point, as seen in figure 2–1. In effect, the crown goes in one direction while the root goes in the opposite direction.

Bodily movement

This on the other hand, moves the entire tooth, as seen in figure 2–2. Bodily tooth movement is usually done with fixed appliances with greater force exerted on the teeth.

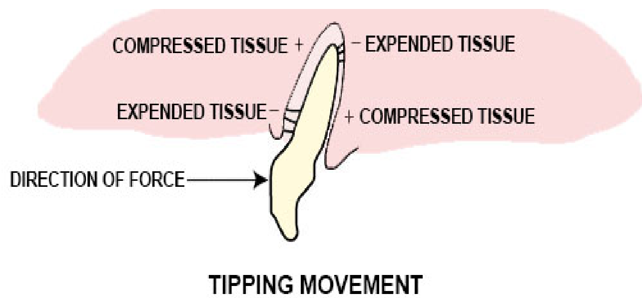


Figure 2–1. Tipping movement.

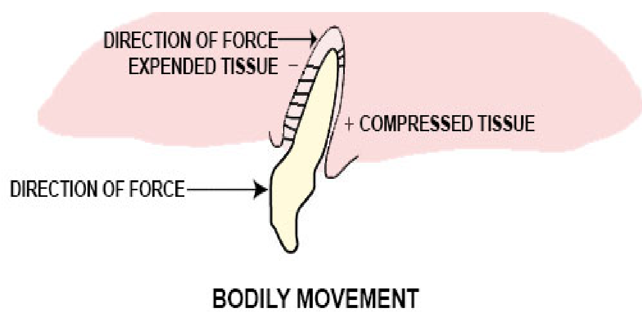


Figure 2–2. Bodily movement.

Physiologic reaction

When teeth are moved from one position to another, the periodontium breaks down. Gentle, long-term pressure stretches and compresses periodontal fibers, creating thinning of the lamina dura lining the tooth socket. When applied correctly the periodontium recovers and the teeth stabilize; however, excessive and rapid pressure crushes and may tear periodontal fibers. Improperly applied pressure causes the onset of periodontal disease, mobility, and possible loss of teeth. Figure 2–1 shows the location and types of force exerted on the periodontium.

407. Wire-bending techniques

The majority of orthodontic appliances are made of stainless steel wires that passively hold or actively move teeth. During manufacturing, the wires are drawn through dies; this identifies the wire as a wrought alloy. Do not jump to the conclusion that wrought wire and orthodontic wire are the same—*they are not.* "Wrought wire" is a term used (often abused) to describe ALL stainless steel wires. Orthodontic wire, on the other hand, is a specific composition of stainless steel wire supplied in various gauges, shapes, and tempers (hardness or springiness). Generally, the choice of wire is determined by how it will be used in appliance construction.

18–8 stainless steel

The numbers "18–8" refer to a particular variety of stainless steel wire with 18 percent chromium and 8 percent nickel as its major constituents. The wires used for the kinds of appliances made in dental laboratories are ordinarily very springy and round in cross-section. The wires most commonly used for holding, moving, and clasping applications vary from .014–.036 inches, as shown in the following table:

Common Orthodontic Wire Uses and Sizes		
Device		**Wire Size**
Arch wires	• Labial bow • Lingual arch wire	.030–.032 .032–.036
Springs	• Finger spring (anterior teeth) • Finger spring (posterior teeth) • W spring • Cuspid retractor-bicuspid	.014–.028 .025–.032 .014–.020 .030–.032
Clasps	• Adam's • C-clasp • Ball • Arrow clasp	.025–.028 .032–.036 .028–.032 .028–.032
Miscellaneous	• Space maintainer loop	.032–.036

The temper and condition of the wire are just as important as the size of the wire. Wires that are used for springs must be capable of distributing the required amount of force over a considerable distance for a long period. Usually, a medium hard orthodontic wire supplies the springiness and malleability needed to make orthodontic springs. It is important to remember that stainless steel wire must be worked and used in the originally purchased condition. Work-hardened wire or overworked wire can break during function. If it breaks, do not use it in an appliance.

Orthodontic pliers

The number of pliers available for wire bending is almost limitless, and the choice of appropriate pliers is often a matter of personal preference. For instance, the pliers illustrated in figure 2–3B, 2–3C, and 2–3D are used in several ways.

There are also many choices of cutters to consider for trimming wire. Although not considered a plier, wire cutters are necessary to fabricate any appliance that incorporates wire (fig. 2–3A).

Common Orthodontic Pliers/Cutters		
Type	**Use**	**Illustration**
Wire cutters	Used to cut stainless steel wires.	 **Figure 2–3A. Wire cutters. (Reproduced by permission from Hu Friedy Mfg Co.)**
No. 139 angle or bird beak	The most versatile of all wire-bending pliers. They can be used to make acute or gradual bends. It is also possible to bend adequate loops with pliers.	 **Figure 2–3B. No. 139 angle or bird beak. (Reproduced by permission from Hu Friedy Mfg Co.)**
No. 200 or three-prong	Used to make abrupt bends between 0 degree (°) and 90° and should not nick or dent the wire.	 **Figure 2–3C. No. 200 or three-prong. (Reproduced by permission from Hu Friedy Mfg Co.)**

Common Orthodontic Pliers/Cutters		
Type	**Use**	**Illustration**
Tweed Loop-forming pliers	Used to create closing loops in square or rectangular wire.	 **Figure 2–3D. Tweed Loop-Forming pliers. (Reproduced by permission from Hu Friedy Mfg Co.)**

Wire bending

Stainless steel wires have many other uses beyond orthodontic appliances. Wrought wire must be bent into clasps that are used for retention of interim and definitive RDP. Bending stainless steel wires can be a frustrating experience, but no matter how hard you avoid the task, the need will always exist. We offer the following guidelines to simplify the process and help reduce the complex character of wire bending:

1. Generally, when selecting wire of proper size and temper, it is better to use wire that is too large and too soft, rather than wire that is too small and too highly tempered.
2. Gradual bends in wire can be made with the fingers, while acute bends require the use of pliers.
3. Never bend round wire over a sharp-edged beak.
4. When bending short sections of wire, such as a spring or a clasp, start with the more critical areas (usually toothborne areas); then bend the easier sections. This does not apply to a labial bow or helical spring.
5. When making a complex series of bends, such as those used in a labial bow or helical spring, begin in the center of the wire and work toward either end.
6. Try to keep all bends at right angles to the long axis of the wire so that torque is not incorporated into the wire, and all bends are in the same plane. Before making the next bend, place the wire back on the working cast and check the bend just completed.

We will describe some common wire-bending methods used in making wire components for orthodontic appliances. You could consider this an exercise in wire bending. Take the time to practice making the different bends using short pieces of orthodontic wire.

Closed-end loop

Orthodontic wires anchored in acrylic resin must have some form of mechanical retention. One way to retain the wire is to use a large closed-end loop. Place the bird beak pliers with the working end facing you and the square beak pointing up. Now firmly grasp the end of a piece of wire with the pliers. The size of the loop depends on where you place the wire in the jaws of the pliers.
The smallest loop is made near the very end, while larger loops are made as you move the wire closer to the hinge.
Hold the pliers in position and turn the wire around the beak of the pliers, as shown in figure 2–4, A.

With the pliers held still, bend the wire back at a 45° angle to complete the closed-end loop (fig. 2–4, B).

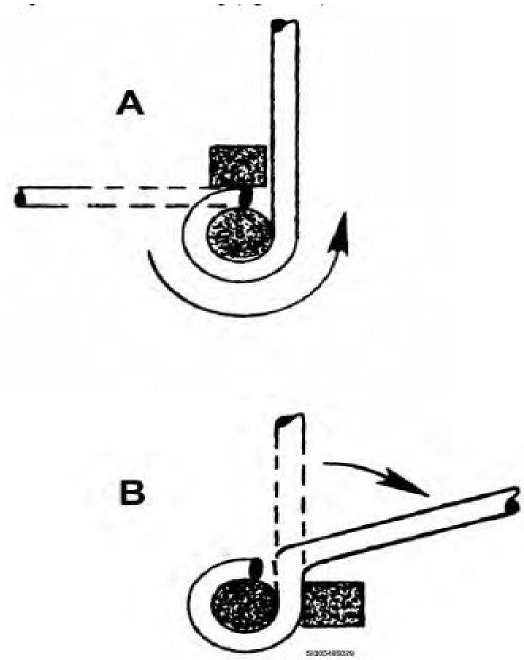


Figure 2–4. Closed-end loop.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissmann, Harold F.: *Dental Laboratory Procedures*, Volume. III. Removable partial dentures, St. Louis, The C.V. Mosby Co.)

Another wire-bending maneuver used for mechanical retention is the zigzag bend. With the three prong pliers facing you and the middle prong facing up, firmly grasp the wire. Squeeze the wire to make a slight bend in the wire. Reposition the pliers so that the middle prong faces down and make another bend. Repeat these procedures until you reach the desired length of the pattern, as shown in figure 2–5.

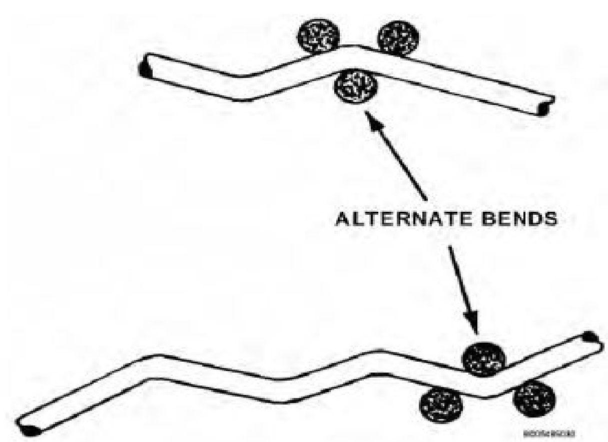


Figure 2–5. Zigzag bend.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissman, Harold F. *Dental Laboratory Procedures*, Volume III. *Removable Partial Dentures*, St. Louis, The C.V. Mosby Co.)

Right-angle bend

Many times, when making clasps and springs, the direction of the wire must change abruptly. This is another of the many uses for three-prong pliers.

With the working end of the three prong pliers facing you and the middle prong pointing up, grasp the wire. Squeeze the pliers with one hand, and apply finger pressure to the wire with the other until a 90° angle has formed (fig. 2–6).

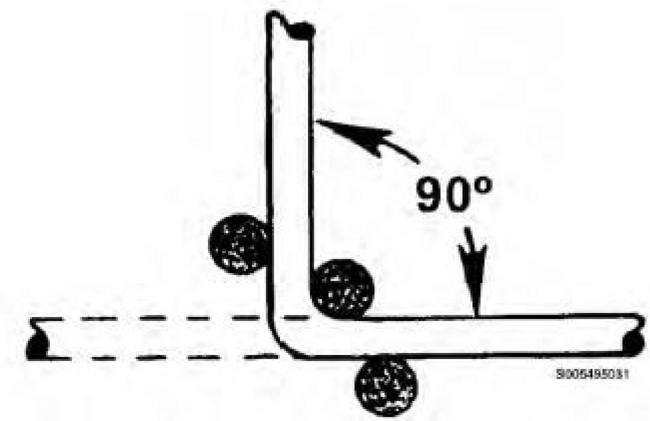


Figure 2–6. Right-angle bend.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissmann, Harold F.: *Dental Laboratory Procedures*, Volume III. *Removable Partial Dentures*, St. Louis, The C.V. Mosby Co.)

Semicircular bend

Another maneuver similar to the closed-end loop is the semicircular bend. Instead of grasping the wire at the end, the pliers are placed in the center. Earlier, the degree of temper in orthodontic wire was described as a means of applying force. Another method of using the wires to produce a spring action is to make them longer, and incorporate several bends.

With the working end of the bird beak pliers facing you and the square end pointing up, grasp the center of the wire. Hold the wire still while you gradually bend the wire downward until the semicircle is complete, as shown in figure 2–7.

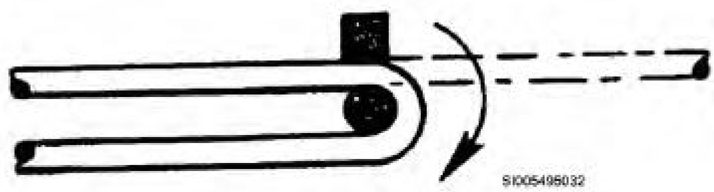


Figure 2–7. Semicircular bend.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissmann, Harold F.: *Dental Laboratory Procedures*, Volume III. *Removable Partial Dentures*, St. Louis, The C.V. Mosby Co.)

Helical bend

The helical bend, like the semicircular bend, is used in making springs. This is the preferred method of increasing the spring action of wire because the Helix produces a lighter force over a longer period of time.

Begin by making a semicircular bend in a piece of wire. Reverse the position of the wire within the loop so that the working end is facing up and the square end faces down. Now bend the wire around until a circle is formed, as shown in figure 2–8, A. Again, invert the pliers 180° and turn the wire until the Helix is complete (fig. 2–8, B).
The finished Helix should look like the one pictured in figure 2–8, C. A helical bend can be made by using either the bird beak pliers or the tweed loop-forming pliers.

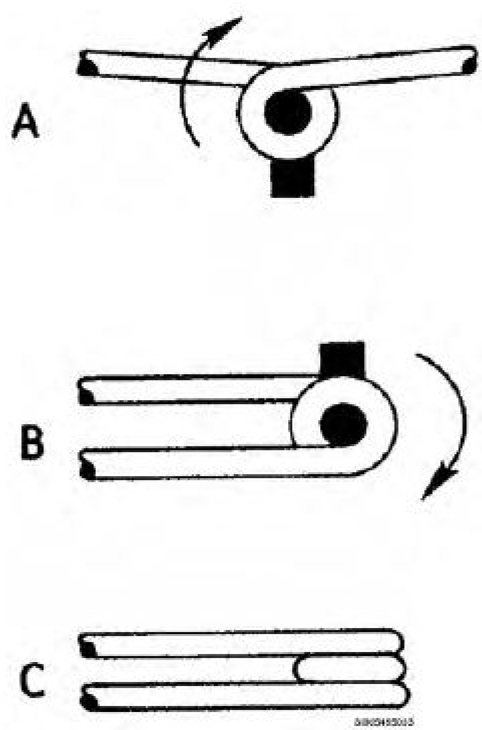


Figure 2–8. Helical bend.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissmann, Harold F.: *Dental Laboratory Procedures*, Volume III. *Removable Partial Dentures*, St. Louis, The C.V. Mosby Co.)

Deflection bend

You may have on occasion to use this bend where the wire is needed to contact an isolated tooth or clear the opposing occlusion. Grasp the wire with the bird-beak pliers, and bend one end of the wire slightly downward against the round beak. With the pliers held firmly, bend the other end of wire slightly upward until the two angles formed are equal, as shown in figure 2–9.

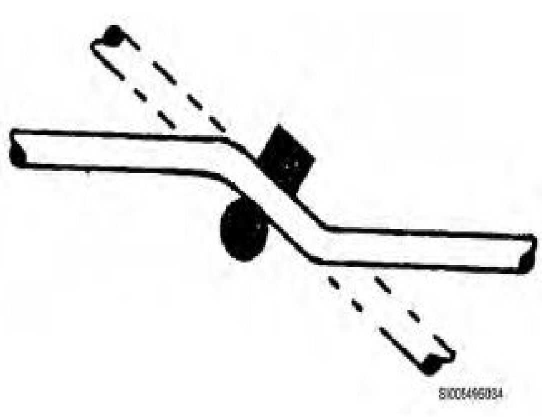


Figure 2–9. Deflection bend.
(Reproduced by permission from Rudd, Kenneth D., Morrow, Robert M., and Eissmann, Harold F.: Dental Laboratory Procedures, Volume III. Removable Partial Dentures, St. Louis, The C.V. Mosby Co.)

Smooth-curve bend

This bend is used primarily to adapt orthodontic wire to soft tissue and teeth. Grasp the wire at the point where you want to start the curve.

The wire should be placed as close to the hinge to make the largest curve possible. Slowly apply finger pressure around the beak of the pliers and, if necessary, reposition the pliers as you go (fig. 2–10).

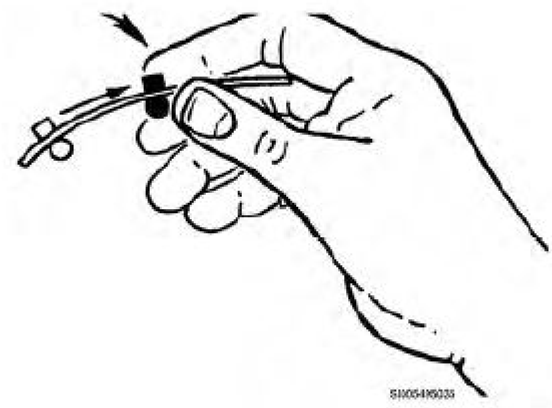


Figure 2–10. Smooth-curve bend.

Self-Test Questions

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

406. Orthodontic movement

1. What is the difference between an active and a passive appliance?

2. What causes tooth migration?

3. How does gentle and excessive force on a tooth affect the periodontium?

407. Wire-bending techniques

1. While working with a piece of 18–8 wire, you find that the wire has been repeatedly worked and reworked to the point that it is work-hardened. What should you do?

2. When you bend a clasp or spring, where should you normally start?

3. What bend is used to anchor orthodontic wires in acrylic resin?

4. Which bend is preferred when increasing the spring action of a mechanism?

5. When you make a deflection bend, what is the best tool to use?

2–2. Orthodontic Appliances

In the broadest sense, an orthodontic appliance is as an appliance used to prevent or correct irregularities of tooth position and occlusion. Malposition of teeth may be caused by several factors. Among these are tooth extraction, traumatic injury, congenital defects, thumb sucking, prolonged retention of deciduous teeth, and tooth wear. While most orthodontic treatment is done for children, adults are receiving treatment in ever-increasing numbers. In this section, we discuss the function of springs, guards, and clasps and how to construct them. We then discuss how to construct fixed and removable appliances.

408. Appliance types and components

Orthodontic treatment requires that a vast array of wires and springs be used to move a tooth or teeth. Each new orthodontic appliance must be carefully designed to fit the patient, so a proper fulcrum or anchor can be established without moving or damaging the surrounding tissue. To do this, the orthodontist requires the laboratory technician to understand that for each action, there is an equal and opposite reaction. This lesson presents a variety of common springs, guards, and clasps used in orthodontic appliances. We shall also examine a variety of appliances.

Orthodontic springs

Springs produce a force when they try to return from a stressed condition to their passive state. When you make springs, they are bent and positioned on the cast in a passive condition. The dentist then activates the spring through manipulation before placing the appliance in the patient's mouth. Springs are supposed to produce gentle pressures over as long a route of travel as possible for long periods of time. Long springs are better able to do this than short ones, but space is limited in the mouth. A shorter spring can be made with the desirable qualities of a longer one by including spiral loops or multiple bends into the spring's design.

Spring direction

The direction in which a tooth is being pushed depends upon the angle of the mechanism and its position on the tooth. Figure 2–11, shows the route that a tooth travels because of the arm's angle and its position on the tooth.

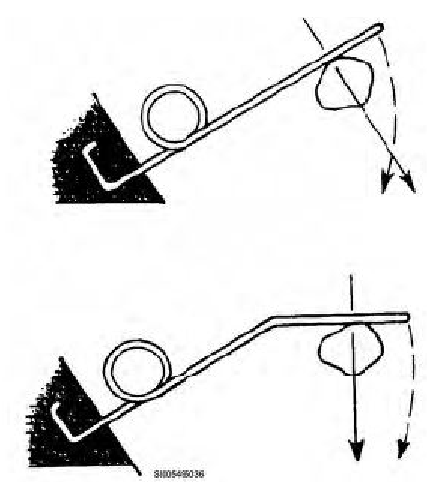


Figure 2–11. Helical loop spring and the route of travel.

Finger springs

Finger springs are generally designed to move teeth either mesially or distally. Wire sizes range between .014 and .032 of an inch. The versions of this spring made with lighter gauge wire are used on anterior teeth. Heavier gauge finger springs can perform tasks like retracting or uprighting a molar that has migrated and closed needed space (fig. 2–12).

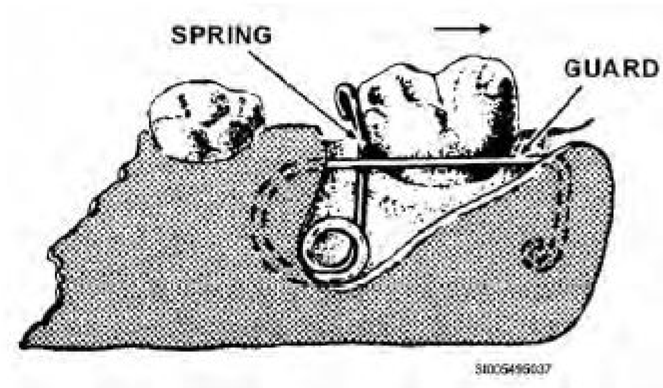


Figure 2–12. Finger spring with guard for posterior movement.

Labial bow spring

A labial bow is considered a spring and may either be active or passive (fig. 2–13). A labial bow spring can be used as a passive guard or as an active mechanism. A labial bow gets its spring action from the cuspid loops at each end of the assembly. It is used for a number of reasons, including moving teeth labiolingually, closing diastemas, and correcting minor tooth rotations. This spring can be rather difficult to make. A detailed description of the construction sequence follows:

1. The first step in making a labial bow spring is to make the bow portion. Select a length of a .030–.032-inch gauge wire that measures approximately 13 centimeters (cm) long. Begin by making the initial curvature in the center of the wire either with an arch-forming template or with pliers. Then adapt the bow to the rotations and inclinations of individual teeth.
   For best results, be sure the wire contacts the teeth in the middle third of the labial surface, unless otherwise directed by the dentist.
2. The next step involves making the cuspid loop on one side of the bow. Begin at the mesial third of the cuspid by making a right-angle bend towards the gingiva. Then use the Tweed loop-forming pliers to bend the closing portion of the loop. Make the loop long enough to extend a minimum of 2 mm past the free gingival margin. The loop's distal upright should lie in the embrasure between the cuspid and first bicuspid.
3. This side of the labial bow is complete when it is adapted to the palatal area. Make the distal upright so that the wire passes through the occlusal embrasure, just over the marginal ridge. Closely adapt the wire to the lingual embrasure, making sure that it does not interfere with the occlusion. Extend the wire onto the palate, and make a closed-end loop for retention in the resin base. The palatal portion of the labial bow spring should be elevated about ½ mm off the cast's surface to be firmly embedded in acrylic.
4. To complete the labial bow spring, make a cuspid loop and adapt the wire to the palate on the other side of the bow. One variation of this spring carries the labial bow posterior and around the distals of the last teeth in the arch. This eliminates the need to adapt the distal upright of the cuspid loop between the cuspid and first bicuspid. Use this variation when there is not sufficient space for the wire in the occlusal and lingual embrasures during centric occlusion.

Figure 2–13. Labial bow.

“W” spring

Even though this spring contains a helical loop, it takes its name from the series of bends that look like a “W.” Wire sizes range from .014 to .020 inch. The “W” springs are mostly used to move teeth facially. Since it rests on inclined tooth surfaces, a guard is constructed over the spring to keep it from sliding along the incline (fig. 2–14). Since the “W” spring is active, a passive labial bow is used to stop the central incisor after the tooth has been moved to an acceptable position.

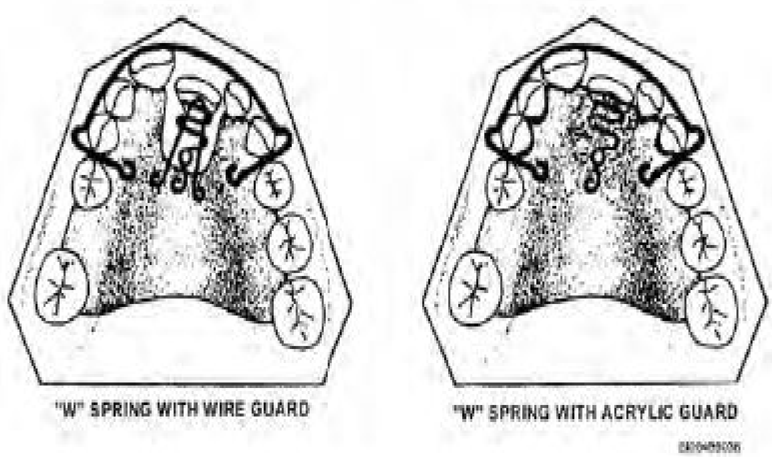


Figure 2–14. “W” spring and guard.

Cuspid retractor-bicuspid holder

The finger springs discussed so far are placed lingually. Although the cuspid retractor-bicuspid holder is obviously another style of finger spring, the holder is classified separately because it is placed facially in relation to the teeth (wire size = .030–.032 inch). When the spring is anchored at point “A” (fig. 2–15), the spring retracts the cuspid. If the spring is anchored just distal to the cuspid, it can be made to prevent the bicuspid from drifting forward.

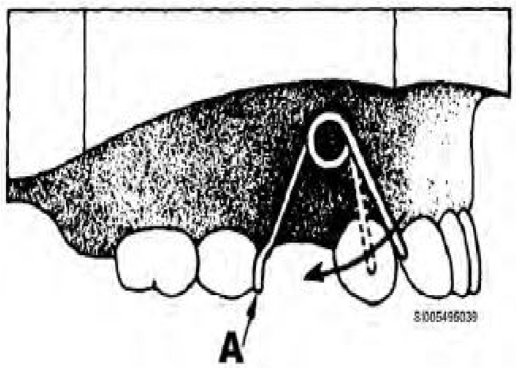


Figure 2–15. Cuspid retractor finger spring.

Guards

Guards maintain the spring’s position on the tooth and, if acrylic, protect the spring. Refer back to figure 2–14 to see a spring protected by a guard. If it were not for the guards, the springs would be less likely to maintain proper contact with the teeth that they are supposed to move. In the case of the molar retracting spring (fig. 2–12), the guard also guides the path of the molar as it moves distally. The labial bow steers or guides the path of incisor movement. Although not a primary function of an acrylic guard, it can prevent debris from obstructing the spring. Conversely, wire guards do not prevent debris from obstructing the spring. Additionally, wire guards should be avoided because of the tongue’s sensitivity. Appliances with wire guards irritate the patient’s tongue.

Orthodontic clasps

The most common clasp forms used for retaining removable orthodontic appliances are the circumferential, the Adam’s, and the ball. They are custom made from orthodontic wire and are pictured in figure 2–16A, B, and C.

Orthodontic Clasps	
Type	**Description**
Circumferential clasps	The circumferential (“C”) clasp-retentive tip engages either a mesial or a distal undercut. A thorough cast survey can identify the undercuts. The clasp approaches the undercut from the opposite occlusal embrasure and maintains intimate contact with the tooth. It is the simplest to bend of the three clasps (wire size = .032–.036 inch). When possible, the “C” clasp engages the mesiofacial undercut of the last tooth in the arch. This eliminates the need to adapt the wire through an occlusal embrasure. Prior to bending the wire, rubber the retentive tip with a rubber wheel until it is round and smooth. This decreases enamel abrasion.
Adam’s clasp	The Adam’s clasp is the most retentive of the wrought wire clasps (wire size = .025–.28 inch). Create slight depressions in the interproximals of the retaining tooth on the working cast. Bend a small semicircle one-third of the way down a 3-inch piece of wire, and then crimp the semicircle. On the long end of the wire, bend a right angle going away from the semicircle. Seat the semicircle in the mesiobuccal undercut, and contour the long end of the wire to the tooth. Repeat the right-angle bend and crimped semicircle in the distobuccal undercut. Then contour the legs of the clasp through the occlusal embrasures and into the palate. Gently bend the semicircles into the mesiobuccal and distobuccal undercuts (these are the two retentive areas for the Adam’s clasp) to increase retention.

Orthodontic Clasps	
Type	**Description**
	The horizontal bar should be approximately .5 mm away from the tooth.
Ball clasp	This clasp is usually prefabricated and available in .024-inch, .028-inch, .032-inch, .036-inch or .040-inch diameters. It is bent sufficiently to spring into mesiofacial or distofacial undercuts. The ball size increases with an increase in wire size. Variations of this clasp are the arrowhead and semicircle clasps. Like the ball clasp, they engage the undercut between two teeth. They are easy to make. Just bend a blunt point or semicircle in the end of a wire and contour it through the occlusal embrasure.

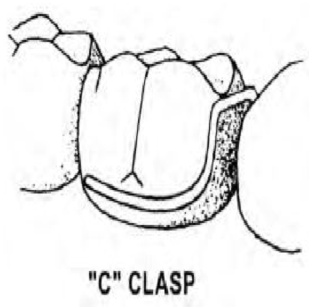


Figure 2–16A. Circumferential clasp.

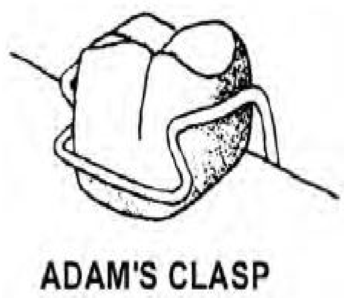


Figure 2–16B. Adam's clasp.

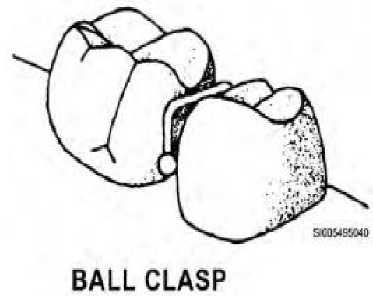


Figure 2–16C. Ball clasp.

409. Orthodontic appliances

Orthodontic appliances are constructed to meet both active and passive requirements. Active and passive appliances can be either fixed or removable. Each type of appliance is constructed to fulfill a unique need.

Types of orthodontic appliances

There are many types of orthodontic appliances. Each device is designed for a specific purpose. Let us take a look at some of them you may encounter or be asked to fabricate. Refer to figures 2–17 through 2–21 to familiarize yourself.

Types of Orthodontic Appliances	
Type	**Description**
Thumb-sucking device	The thumb-sucking device is fabricated to discourage thumb or finger sucking. The thumb-sucking device is closely adapted to the rugae area of the palate with the cage extending towards the occlusal table. This device is a reminder to the patient and serves to mitigate finger sucking.  **Figure 2–17. Thumb-sucking appliance.**

Types of Orthodontic Appliances	
Type	**Description**
Transpalatal arch	The transpalatal arch appliance is used to maintain palatal expansion. It is excellent at maintaining acquired expansion. It can be designed with a solid transpalatal bar or with an omega loop, allowing for adjustment and producing molar rotation. It can also be fabricated in a removable or fixed version.  **Figure 2–18. Transpalatal arch.**
Lower lingual holding arch	This device is either passive or active depending on the patient needs. Lingual arches are available in various lengths. Arches can either be ideally shaped or closely contoured to the existing arch configuration. They may include loops for adjustment and can also be made removable from bands.  **Figure 2–19. Lower lingual holding arch.**
Nance appliance	The Nance appliance can either be fixed (soldered to the bands) or removable and is available with either straight or recurved arms. It is an appliance that is effective at preventing mesial molar drifting. In the curved arm design, it facilitates the expansion or rotation of the molars. This appliance prevents the molars from rotating or moving forward.

<table>
<tr><th colspan="2">Types of Orthodontic Appliances</th></tr>
<tr><th>Type</th><th>Description</th></tr>
<tr><td></td><td>
Figure 2–20. Nance appliance.</td></tr>
<tr><td>Quad Helix</td><td>The Quad Helix is a versatile appliance used to correct unilateral or bilateral crossbites, expand posterior segments, and align crowded teeth. This appliance has many adjustment points, most of which can be activated intraorally. It spreads the maxillary posterior arch apart with four Helix loops. The dentist can use three-prong pliers to make the adjustments. It is commonly fabricated as a removable appliance for extraoral adjusting.

Figure 2–21. Quad Helix.</td></tr>
<tr><td>Hygienic Rapid Palatal Expander (Hyrax)</td><td>The Hygienic Rapid Palatal Expander (Hyrax) is an all-metal expansion appliance, typically providing sutural separation of 11 mm within a very short period of wear, with a maximum expansion of 13 mm. The standard design is a four-banded style (fig. 2–22), used when path of insertion is not a concern and offers the most rigidity. Two-banded versions of the Hyrax (fig. 2–23) and the Mini Rapid Palatal Expander (RPE) (fig. 2–24) are also available aiding in cases with a difficult path of insertion or missing teeth. The four-banded design is the most desired of these versions.</td></tr>
</table>

Types of Orthodontic Appliances	
Type	**Description**
	 Figure 2–22. Four-banded Hygienic Rapid Palatal Expander.  Figure 2–23. Two-banded Hygienic Rapid Palatal Expander.  Figure 2–24. Mini Rapid Palatal Expander.

Fixed appliances

Two things that should come to mind when thinking about fixed appliances are orthodontic bands and silver soldering. Orthodontic bands are routinely adapted in the patient's mouth. Occasionally, you will work with bands when constructing an appliance. Though used infrequently, silver soldering is an essential task in the construction of some fixed and removable appliances.

Fabricating a working cast

The first step in fixed appliance fabrication is to construct an accurate working cast. The dentist first adapts the preformed bands or stainless steel crowns to the patient's teeth. The impression is taken with the bands in place.

After removal, the bands are placed in the impression and secured for pouring. When the cast is separated, the band is in position on the cast. The dental officer then checks the cast for accuracy.

Soldering

Most orthodontic soldering involves silver soldering of stainless steel parts. A Hanau torch, an orthodontic soldering blowpipe, or a gas-air torch with an orthodontic tip can be used for silver soldering. The most convenient, however, is the small butane "micro" torch. Many of the rules pertaining to silver soldering are the same as other soldering techniques; however, one major difference is that the parts must be in contact with each other.

Here is a brief summary of the requirements that must be met to solder orthodontic attachments successfully:

1. Make sure the surfaces of the metals are clean and as free of oxides as possible.
2. Secure the parts to be joined firmly in place during soldering.
3. Make sure the parts are in contact with each other.
4. Use a liberal, uniform layer of fluoride-paste flux to prevent oxide formation.
5. Check that the joint is visible and accessible.
6. Use the reducing part of the flame for preheating and soldering.

Silver soldering stainless steel parts are much more critical than soldering precious metal alloys. When precious metal alloys are soldered, a third alloy is created by the union of the two parent metals. The resultant solder joint can be as strong as the parent metal; however, this does not happen with silver solder and stainless steel alloys. Soldering stainless steel alloys results only in an intimate contact between the metal and solder.

The solder joint is not as strong as precious metal alloys since a true union between the metal and solder is impossible due to the high-fusion temperature of stainless steel alloys. Proper technique is critical to ensure a union of sufficient strength to withstand normal functional stresses.

To silver solder, first lay out all the materials needed. Clean the metal surfaces to be soldered. Orient the parts together in a soldering jig or investment. Flow fluoride-paste flux into the solder joint area. Gently heat the fluxed solder joint area, and watch the action of the flux. The flux will boil, and then solder will flow.

As the flux melts, it takes the appearance of liquid glass. Concentrate the flame on the larger of the two pieces, but *do not* allow the metal to reach a bright red color. Using a handheld length of silver solder, place the tip into the solder joint area, and quickly heat the area until the solder melts and begins to flow. The flame should be removed from the assembly as it "wets" the solder joint.

Overheating the solder creates porosity, which weakens the joint. It is best to perform this procedure in subdued light to improve the visibility of the metal and solder.

The appliance can now be removed from the cast and finished. The excess solder can be removed with an abrasive stone or wheel. Blend the solder from its center to a fine feather edge at the solder's union with the stainless steel.

Hawley retainer

The most widely used removable appliance is the Hawley retainer or a modified version of the Hawley (fig. 2–25). These modifications are usually active springs, rubber-band systems, screws, or ramps. The labial bow may or may not be used in conjunction with these attachments. The Hawley retainer will have many variations. It may be designed to be active or passive.

The acrylic portion of a removable appliance can be compared to the solder joints of a fixed appliance. The acrylic base, or anchorage, holds the attachments in place and anchors the appliance in the mouth. Orthodontic autopolymerizing resins are usually sprinkled on the cast. The polymer's fine particles causes the polymer to stay in one place when it is wet down with monomer. Orthodontic resin is dense after curing; consequently, the anchorage is very strong, nonporous, and easy to clean.

Figure 2–25. Hawley retainer.

Using the sprinkle-on technique

You should be very familiar with this technique by now. Be sure to follow these guidelines when sprinkling resin:

1. Survey the cast and blockout lingual tooth and tissue undercuts that could prevent appliance placement. The presence of some lingual tooth undercut is desirable. Carve blockout wax back 1 mm gingival to the survey line. Then round off the resulting ledges.
2. Seal all springs, guards, bows, and clasps with sticky wax. *Do not* place wax on the loops that will retain them in the resin.
3. Soak the working cast in saturated calcium SDS to remove the air. Blow off excess water.
4. Paint the area to be covered by acrylic with tinfoil substitute, and let it dry.
5. Cover the active portion of all springs with baseplate wax to prevent trapping them in hardened resin. Later, when the wax is removed, the spring has space to function.
6. Apply alternate portions of powder and liquid to the desired thickness. To better control the resin, do about one-third of the total area at a time. As soon as the surface sheen disappears, add acrylic resin to another third, and so forth.
7. After the surface sheen dulls, place the appliance upside down in a pressure pot containing 115° F water. To reduce the chances of porosity in acrylic complete the powder/liquid sprinkling process and place appliance in the pressure pot for 5 minutes from when the liquid is first introduced to the powder. Placing the cast upside down minimizes porosity caused by air escaping from the cast. Escaping air bubbles will rise up and away from the unset acrylic rather than into it. Apply 20 psi for 30 minutes to ensure a dense, well-cured appliance.
8. When the resin has set, remove the cast from the pressure pot, and check the acrylic for flaws. If it is satisfactory, remove the appliance from the cast, being careful to avoid distortion.

Small bubbles on the tissue side can be filled with resin and the appliance replaced on the cast for additional curing.

Fabricating a Hawley retainer

The majority of the Hawley's components, such as the labial bow, clasps, and spring varieties were discussed in the section on wire bending. All you need now is a brief description of the major construction steps and the finishing of the Hawley retainer:

1. First, bend the wire for the labial bow, clasps, and any other mechanisms as prescribed by the dental officer.
2. Next, block out lingual undercuts on the cast as previously described, paint the cast with a tinfoil substitute, and secure the bow and clasps to the cast with sticky wax.
3. Now sprinkle the orthodontic resin onto the cast, and place it into a pressure pot to cure.
4. Shape and polish the base as you would the resin base areas of a removable dental prosthesis. (**NOTE:** Be careful not to nick the wires or distort them.)

If the dental officer is going to use the retainer as a passive appliance, leave the resin in contact with the lingual surfaces of the anterior teeth. If the appliance is going to be activated by modifying the bow or closing the cuspid loops, consult with the dental officer as to how the base should be trimmed in the anterior area. An activated labial bow moves teeth lingually.

Refer to the following table for a list of common problems, probable causes, and solutions specific to constructing orthodontic appliances:

Common Problems When Constructing Orthodontic Appliances		
Problem	**Probable Cause**	**Solution**
Orthodontic spring lacks strength to produce needed force.	Did not use wire of proper size or temper.	Use stainless steel wire with proper amount of temper.
Orthodontic clasp lacks adequate retention.	Clasp not placed in adequate undercut. Wire over worked.	Design clasp to fit into maximum undercut. Replace clasp.
Occlusal interference's and displacement problems around the embrasure area.	Wire placed too high through embrasure.	Place wire as close as possible to embrasure as it passes from buccal to lingual.
Patient gags or has speech interferences.	Acrylic too thick.	Control thickness when sprinkling and finishing.
Acrylic distortion.	Resin overheated during finishing and polishing. Appliance distorted when removed from cast.	Avoid excess pressure against polishing wheel. Block out gross undercuts of cast.
Melted solder will not flow.	Impurities on metal/wire's surface. Wire and solder are not heated to adequate temperatures.	Use sufficient amount of soldering flux. Ensure wire and solder are heated evenly to the same temperatures conducive for solder to flow.
Porosity in solder joint.	Overheating solder. Impurities on metal.	Carefully apply heat to solder and wire. Remove flame when solder "wets" joint. Clean wire and solder before soldering.
Clinical failure of solder joint.	Poor union of solder to metal.	Apply flux liberally to remove surface oxides.

Self-Test Questions

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

408. Appliance types and components

1. Where does a labial bow get its spring action from?

2. What purpose does a guard serve?

3. What are the most common clasp forms used for retaining removable orthodontic appliances?

4. How many retentive areas does the Adam’s clasp have, and where are they located?

5. What are two variations of the ball clasp?

409. Orthodontic appliances

1. What device is closely adapted to the rugae area of the palate?

2. What appliance with an omega loop allows for adjustment and produces molar rotation?

3. What device spreads the maxillary arch apart with loops in the wire?

4. What principle involving silver soldering orthodontic wires is different from other soldering procedures?

5. Why are silver soldering stainless steel parts much more critical then soldering precious metal alloys?

6. How should the anterior portion of a Hawley retainer be finished when it is a passive appliance?

Answers to Self-Test Questions

406

1. Active appliances move teeth into a better esthetic or functional alignment. Passive appliances hold or maintain teeth in the positions they currently occupy.
2. Tooth migration, or drift, is a common intra-oral occurrence. Teeth normally drift mesially toward the midline, especially when a tooth is extracted or prepared. The abutting teeth will often migrate and encroach on this space. Additionally, third-molar eruption—common in young adults—forces the teeth to migrate mesially. This can result in severe overlapping of the anterior teeth. If the arch is too small, severe esthetic and functional problems could result from tooth eruption. Other causes of migration are loss of proximal and/or opposing teeth, traumatic occlusion, disease, oral habits, or accidental changes to the appliance.
3. Gentle, long-term pressure stretches and compresses periodontal fibers, creating thinning of the lamina dura lining the tooth socket. Excessive, rapid pressure crushes and may tear fibers, allowing onset of periodontal disease, mobility, and possible loss of the tooth.

407

1. Do not use it in an appliance.
2. The more critical areas (usually toothborne areas); then bend the easier sections.
3. Large closed-end loop.
4. Helical bend.
5. Bird beak pliers.

408

1. From the cuspid loops at each end of the assembly.
2. To maintain the spring's position on the tooth, and if acrylic, protect the spring.
3. Circumferential, the Adam's, and the ball.
4. Two; on the mesiobuccal and distobuccal surfaces.
5. The arrowhead and semicircle clasps.

409

1. Thumb-sucking device.
2. Transpalatal arch appliance.
3. Quad Helix.
4. The parts to be soldered must contact each other.
5. The solder joint is not as strong as precious metal alloys since a true union between silver solder and stainless steel is impossible to achieve.
6. Leave the resin in contact with the lingual surfaces of the anterior teeth.

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 AFCDA.

16. (406) The purpose of a *passive* orthodontic appliance is to
    a. hold or maintain teeth in the positions they occupy.
    b. move teeth into a better looking or more functional alignment.
    c. move teeth into or maintain the teeth in positions they should occupy.
    d. prevent the movement of teeth in an occlusal or anteriorposterior direction.

17. (406) What is the result of a linear force that is applied to some part of the crown, causing the tooth to rotate around its fulcrum point?
    a. Tipping.
    b. Migration.
    c. Overlapping
    d. Bodily movement.

18. (406) How does the periodontium react *during* tooth movement?
    a. It reduces tooth mobility.
    b. The alveolar bone thickens.
    c. It breaks down as teeth are moved.
    d. It stabilizes the teeth within the arch.

19. (407) In what condition must stainless steel wire be used?
    a. The condition it was purchased.
    b. The condition it was adapted to form.
    c. Soft worked wire.
    d. Hard worked wire.

20. (407) Orthodontic wires anchored in acrylic resin must
    a. not have obtuse angles.
    b. not extend into the vault of the palate.
    c. have some form of mechanical retention.
    d. develop a chemical bond with the acrylic.

21. (407) Which basic bend is used when a wire must contact an isolated tooth or clear an opposing occlusion?
    a. Zigzag.
    b. Angled.
    c. Deflection.
    d. Right angle.

22. (408) A *labial bow* gets its spring action from the
    a. cuspid loops.
    b. retention loops.
    c. length of the bow.
    d. wire’s tensile strength.

23. (408) Guards are sometimes used in orthodontic appliances to
    a. embed the active portion of a spring in acrylic.
    b. maintain the spring's position on the tooth.
    c. accompany the circumferential clasps.
    d. apply pressure to opposing teeth.

24. (408) The three *most* common clasps include the Adam's, circumferential, and the
    a. ball.
    b. arrow.
    c. zigzag.
    d. deflection.

25. (409) What appliance is effective at preventing mesial molar drifting?
    a. Nance.
    b. Quad Helix
    c. Transpalatal arch.
    d. Hygienic Rapid Palatal Expander.

26. (409) What appliance is used to correct unilateral or bilateral crossbites?
    a. Nance.
    b. Hawley.
    c. Quad Helix.
    d. Thumb-sucking.

27. (409) Why is silver soldering stainless steel parts more critical than soldering precious metals?
    a. A gas-oxygen torch is required for the procedure.
    b. Oxide formation is retarded by the use of the silver solder.
    c. A third alloy is created by the union of the two parent metals.
    d. A silver-soldered steel joint results in only intimate contact between the metal and solder.

28. (409) An activated labial bow moves teeth
    a. mesially.
    b. facially.
    c. distally.
    d. lingually.

Please read the unit menu for unit 3 and continue ➔

Unit 3 Treatment Appliances and Articulator Principles

MANY DENTAL patients expect to leave the dentist's office with a smile and a boost to their self-esteem. Imagine the patient who is uncomfortable leaving home because of his or her appearance. Each year many people acquire—through accident or disease—some form of facial disfigurement. This unit will present information about the design and use of special prostheses to improve the patient's oral function and facial appearance.

3–1. Treatment Appliances

There are times when a patient will need more treatment than a single dentist can provide. When this need arises, a team of providers—prosthodontist, oral surgeon, and other dental specialists—combine their expertise, knowledge, and skill to serve a patient in need. These specialists serve a unique group of prosthetic patients who suffer from a variety of defects. Typically, these defects are caused by acquired or congenital defects, facial trauma, disfigurement, cancer, or other diseases.

410. Fabricating treatment appliances

There are many types of treatment appliances a dentist can prescribe. This discussion is limited to the following prostheses:

- Surgical stent.
- Athletic mouthguard.
- Fluoride carrier.
- Sleep apnea device.
- Periodontal stent.
- Record bases and occlusal rims.
- Surgical template.

Surgical stent

A surgical stent is a device that maintains the hard or soft tissue in a predetermined position. The purpose is to stabilize bone segments into normal alignment and fix them into position during healing. Surgical stents can be composed of thin metal, with less bulk than acrylic resin; however, clear acrylic resin is radiolucent allowing periodic X-rays to be taken to check the healing process. The procedures for making a surgical stent are as follows:

Steps in Fabrication of an acrylic Surgical Stent	
Step	**Action**
1	Pour maxillary and mandibular casts.
2	Have dentist design stent.
3	Mount casts on articulator then section to achieve proper occlusion and reattach.
4	Blockout undercuts.
5	Apply separator to casts.

Steps in Fabrication of an acrylic Surgical Stent	
Step	**Action**
6	Mix clear acrylic into a doughy consistency.
7	Apply a rope of acrylic to occlusal and incisal edges of the cast.
8	Close articulator and trim excess acrylic.
9	Gently close articulator and tap together until acrylic sets up.
10	Finish appliance. Clean, disinfect, and package with proper labeling prior to delivery.

Athletic mouthguard

An athletic mouthguard is a thick, but soft appliance used to protect teeth and parts of the maxillary or mandibular arch. As their name implies, athletic mouthguards are most often used in sporting events; especially those involving physical contact or impact forces.

It is important to know that nonathletic mouthguards may also be requested. These are frequently provided to patients in high-stress environments such as a deployed location. High stress can cause individuals to clench and possibly damage their teeth due to the strong forces. Like an athletic mouthguard, nonathletic mouthguards provide a protective barrier between the teeth to cushion strong biting forces. Mouthguards do not last a long time because they are made of soft resilient materials. Over time, the dentist may request a hard nightguard, made of a more durable material, to replace the mouthguard. The following table lists athletic mouthguard fabrication steps:

Steps in Fabrication of Athletic Mouthguard	
Step	**Action**
1	Pour the diagnostic cast as an arch only (without the palatal area or tongue space, similar to cast fabrication using the Pindex System). Trim the arch flat on bottom (fig. 3–1).
3	Draw outline of mouthguard on cast. (Mouthguard should extend 5 mm below the labial-gingival margin of the teeth).
4	Follow thermoforming machine manufacturer’s directions for heating material.
5	Trim excess material with heated blade; follow design line.
6	Smooth areas with mounted felt wheel.
7	Use flame torch to remove any cloudiness with mouthguard. *Do not overheat*—the mouthguard will distort and no longer serve its intended purpose.
8	Clean, disinfect and package with proper labeling prior to delivery.

Figure 3–1. Cast example.

Fluoride carriers

Fluoride carriers act as delivery systems for fluoride gel during clinical fluoride treatments. The carriers may be disposable, prefabricated carriers, or fabricated in the laboratory. You construct fluoride carriers by “vacuum forming” a durable semirigid material over standard arch forms. The material is best trimmed with scissors.

Custom fluoride carriers use a polyvinyl material vacuum formed over the patient's diagnostic cast. Design the custom carrier as designed by the dentist. The following table lists steps for fluoride carrier fabrication:

Steps in Fabrication of Fluoride Carriers	
Step	**Action**
1	Pour the diagnostic cast as an arch only (without the palatal area or tongue space, similar to cast fabrication using the Pindex System). Trim the arch flat on bottom (fig. 3–1).
2	Draw outline of fluoride carrier on cast. Fluoride carriers should be 0.5 mm to 1.0 mm below the labial gingival margin of the teeth.
3	Follow thermoforming machine manufacturer's directions for heating material. The .020-inch material is most often used.
4	Trim the trays with a knife or scissors; smooth periphery of fluoride carrier using an abrasive stone.
5	Clean, disinfect, and package with proper labeling prior to delivery.

Sleep apnea device

Sleep apnea is a condition of restricted airflow to the lungs during sleep. For many patients the problem is that their airway fails to remain fully open during sleep; the airway is said to be obstructed. Those with partial obstructions will typically snore. Those with complete obstruction may actually appear to stop breathing altogether. Breathing interruptions during sleep prevent normal sleep patterns and can lead to daytime sleepiness and other poor health outcomes.

A sleep apnea device advances or repositions the lower jaw and tongue forward during sleep and opens the airway sufficiently to prevent the airway from closing. The appliance maintains the mandible in approximately 75 percent protruded position with an incisal opening of 10 mm. One method of fabrication uses kits with adjustable metal parts and prefabricated plastic/polyvinyl sheets. The sheets are vacuum formed to each cast and then connected with adjustable metal parts in the desired positon. The adjustable metal parts allow the doctor to adjust to the amount of mandibular advancement. A simpler method involves only the vacuum-formed sheets splinted together with auto-polymerizing or light-cured acrylic resin in a fixed relationship. Other fabrication methods include sprinkle, pour, and flasking techniques. The following table provides the steps in fabricating a sleep apnea device using the flasking method:

Steps in Fabricating a Sleep Apnea Device Using the Flasking Method	
Step	**Action**
1	Block out any interproximal undercuts on the master casts.
2	Duplicate the casts.
3	Use the bite registration provided to articulate the casts.
4	Apply a uniform 2–3 mm thickness of baseplate wax to the design of the maxillary and mandibular cast.
5	Fill the interocclusal space between the maxillary and mandibular arches from the first bicuspid to the second molar. Leave an opening in the anterior area from cuspid to cuspid.
6	Because of the vertical height of the wax-up, flasking must be done in a jumbo flask or two maxillary flasks combined. When using two maxillary flasks, combine two lower sections with one center section between them.
7	Apply separator to the casts.
8	Half-fill the center and lower section of the flask with flasking stone.
9	Adapt the flasking stone into the tongue space of the wax-up, and then submerge the wax-up into the flask, covering the entire wax up with stone.
10	Smooth the surface of the lower-half flasking before the stone sets completely, and then apply separator to the stone.
11	Mix the flasking stone for the upper-half flasking.

Steps in Fabricating a Sleep Apnea Device Using the Flasking Method	
Step	**Action**
12	Fill the areas around the cast. Then fill the remaining lower-flask section with stone, and invert it onto the lower-half flasking.
13	Boil out after stone sets.
14	Apply a runny mix of separator to the mold while it is still warm. Then tip the mold on end to allow excess separator to drain.
15	Pack and cure with a soft, heat-cured acrylic. This allows the appliance to flex over the contours of the oral cavity without any other retention devices.
16	Mix the material according to the manufacturer's directions, and pour it into the lower-half mold.
17	Place the mold into a flask carrier, and cure it according to the manufacturer's directions.
18	Deflask.
19	Place the cast in warm water to soften the acrylic, and then gently remove the appliance from the cast.
20	Before finishing, soak the appliance in cold water to keep the acrylic hard while finishing.

Periodontal stent

The periodontal stent is a clear resin appliance. It acts as a bandage that maintains a graft's position or covers the surgical site where the graft was harvested. The graft is usually taken from the hard palate and placed at the roots of periodontally diseased teeth. A clear maxillary stent, made of autopolymerizing resin, extends from the soft-palate boundary into the lingual embrasures of the teeth. Once in place, the dentist can check the healing progress through the clear stent.

Steps in Fabrication of Periodontal Stent	
Step	**Action**
1	Pour maxillary and mandibular casts.
2	Return to dentist for design.
3	Blockout undercuts.
4	Apply separator.
5	Sprinkle clear autopolymerizing resin to design line.
6	Cure in pressure pot in accordance with (IAW) manufacturer's instructions.
7	Trim excess and finish to ensure a uniform thickness.
8	Pumice and polish, check for fit.
9	Clean, disinfect and package with proper labeling prior to delivery.

Record bases

Record bases cover the same area that the complete denture will cover. The record base should be well-adapted to the cast. It is the foundation for the occlusal rim and must not rock on the cast or in the mouth. It should be comfortable and cover the same area as the finished denture. The record base should be strong enough to withstand functional stress without being too thick. It should be dimensionally stable, and the material should be a natural color.

Several materials are available for making a record base. Heat-cured resin, thermoplastic resin, and even record baseplate wax are used with varying degrees of success. However, the material most often used in the dental labs is auto-polymerizing resin. Self-curing (autopolymerizing) (cold-cure) resin meets all the requirements, and it is inexpensive and easy to use.

Steps in Fabrication of Record base	
Step	**Action**
1	Prepare the cast. Create the posterior palatal seal.
2	Blockout all undercuts on the cast. (Make sure you blockout all fragile areas on the cast such as: rugae, frenum, and the incisive papilla.)

Steps in Fabrication of Record base	
Step	**Action**
3	Apply separator.
4	Apply acrylic using the sprinkle technique.
5	Once record base is completely cured, separate it from the cast with a blast of compressed air.
6	Remove wax and record base from the cast. Check for fractures and abrasions.
7	Gently try to seat the record base on the cast and remove any interferences.
8	Relieve the frenum attachment sights to prevent dislodging the record base during the occlusal registration appointment.
9	Trim the record base borders the same as you would for a complete denture.
10	Thin the ridge area of the record base to allow room to set teeth.

You may want to do less than a 0° block-out. A slight concavity in the labial undercuts and retromylohyoid area can improve stability. If you do this, cover the lateral part of the ridge above the undercut with wax to prevent abrasion.

Improve the record base by stabilizing it. A stabilized record base has good adaptability to the cast and is dimensionally stable. The record base's retention can be improved by lining the record base with a soft liner that can move in and out of undercuts.

Occlusal rims

Occlusal rims are an arch shaped wax buildup that occupies the space formerly occupied by the patient's natural teeth. They are made either freehand or in a rim former. When using either method, ensure the wax rim is a solid piece that will not peel away in layers when the dentist adjusts it.

The purpose of occlusal rims is for the dentist to record the important information for the dental laboratory technician such as:

- Establishing midline.
- Occlusal plane.
- Lip line.
- Cuspid line.
- Amount of horizontal and vertical overlap.
- Support for the cheeks and lips.

Maxillary occlusal rim measurements for anterior height are 22 mm measured from the deepest point on the labial flange, beside the labial notch. The anterior width is 8 mm and the posterior height is 18 mm from the deepest point on the buccal flange to the occlusal plane (fig. 3–2).

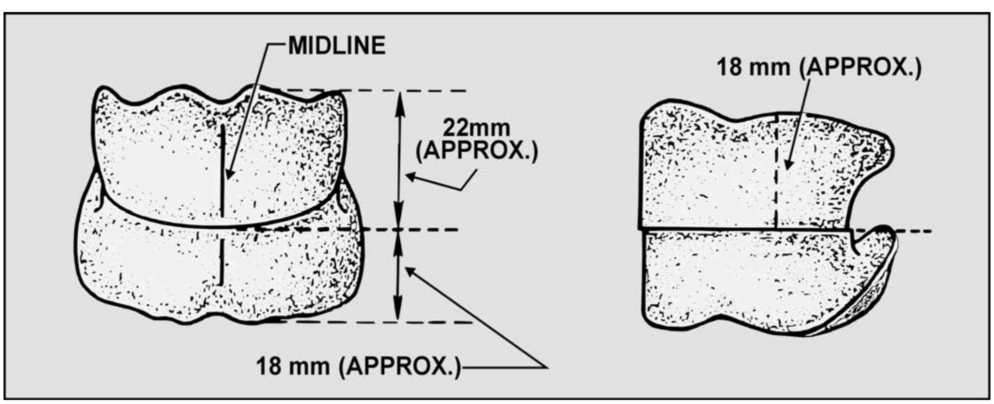


Figure 3–2. Maxillary occlusal rim measurements.

Mandibular occlusal rim measurements include an anterior height of 18 mm measured from the deepest point on the labial flange, besides the labial notch, to the occlusal plane. The labial surface of the rim falls on a line that extends from the depth of the sulcus perpendicular to the occlusal plane. The anterior width is 8 mm, the posterior height is 2/3 of the way up the retromolar pads, and the posterior width is 10 mm with the rim centered over the crest of the ridge.

Steps in Fabrication of Occlusal Rims	
Step	**Action**
1	Mark crest of ridge. Extend line on land area in anterior/posterior (max and man).
2	Adapt a preformed wax rim to the record base.
3	Heat wax to workable state. Soften preformed wax rim by passing through a Bunsen burner or soaking in a bowl of hot water.
4	Center wax over the crest of the ridge in the posterior area and seal the wax rim to the record base.
5	Once luted to the record base, adjust the rims to the dentist’s specifications.
6	*Adjust the maxillary occlusal rim height to 22 mm in the anterior and 18 mm in the posterior, measuring from the deepest part of the buccal sulcus. End the rim just anterior to the tuberosity.
7	Adjust the mandibular rim to 18 mm in the anterior and end 2/3 the way up to the retromolar pad.
8	Make the anterior measurements next to the labial frenum.
9	Flatten the rims so they are approximately parallel with their ridges anteroposteriorly and laterally.
10	Take the record base and rim off the cast to prepare it for delivery. Remove wax and debris from cast and occlusal rim.
11	Ensure anything that might interfere with seating the record base is eliminated to include sharp spots on the tissue surface of the record base.
12	Lightly rub the interior with your finger and relieve potentially uncomfortable spots.
13	Lightly flame the rim to give it a uniform appearance.
14	Polish the rims with a wet cotton roll, soap and water.
15	Place the rims on the cast for delivery.
	***NOTE:** The following measurements are most often used since they are derived from average heights of natural maxillary and mandibular teeth in the arch.

Some problems, probable causes, and solutions are shown in the following table:

Problem-Solving Chart for Record Bases		
Problem	**Probable Cause**	**Solution**
Record base difficult to remove/fractures	Undercuts not properly blocked out Separator contaminated or not applied on cast	Block out all undercuts Coat cast with uncontaminated separator before resin
Uneven record base thickness	Flow of acrylic resin not controlled during application	Tilt cast to one side, sift resin on upward facing surfaces, then tilt to other side in similar manner; use enough acrylic powder to stabilize flow of mixture
Cured record base too flexible	Record base too thin/ridge flat Incompatible polymer/monomer Record base removed before completely cured	Make the record base thicker Use compatible polymer/monomer Allow mixture to cure for 30 minutes (min) in 115° F water under 20 pounds per square inch (psi)
Porous record base	Some areas dried prior to curing	Keep acrylic resin moist with monomer to prevent drying
Record base does not fit cast	Record base heated by grinding/polishing Record base warped when removed from cast Vacuum method resin material not hot enough Vacuum molding period too short Peripheral roll not filled	Use slow speed during finishing and polishing procedures Block out undercuts on cast to aid in removal of record base Make certain resin material sags about 1 inch before starting vacuum Maintain vacuum for 30 seconds after heat is turned off Adapt material into sulcus during vacuum forming

Problem-solving chart for record bases.
(Reproduced by permission from the C.V. Mosby Company.)

Surgical template

A surgical template is a clear resin template used to aid the dentist in determining potential fit of immediate denture. Surgical templates are not directly part of the immediate denture process. Surgical templates cover the ridge in the same manner in which the completed denture would. Clear resin is used so the dentist can see pressure points. Pressure points noted on the template should be trimmed down on the alveolar ridge. Pressure points from the denture will cause pain, in extreme cases the patient will not heal and the area can become infected.

Steps in Fabrication of a vacuum formed Surgical Template	
Step	**Action**
1	Duplicate trimmed casts.
2	Heat and vacuum form a thick sheet of clear plastic sheet of tray material.
3	Trim template above any deep undercuts to remove it from the cast.
4	Ensure all trimmed cast areas are covered by template.
5	Clean, disinfect, and package with proper labeling prior to delivery.

411. Fabricating a hard nightguard

It is common to see people clench their teeth when visibly stressed; in fact, many people even "grind" their teeth during sleep. This disorder, called bruxism, can cause a myriad of problems for the patient. Bruxism and temporomandibular joint (TMJ) disorders are often treated with a hard nightguard. This lesson discusses the use and fabrication procedures for a hard nightguard.

Purpose

A hard nightguard can correct several illnesses that affect occlusion and the TMJ. It can be used to protect the stability and occlusal surfaces of the teeth by eliminating excursive interferences. In cases where muscle tension is a problem, a hard nightguard is used to increase the patient's vertical dimension and relax muscles. It can also reposition the mandible as part of the treatment. Since it is common for patients to experience TMJ problems at night, a nightguard is often worn while sleeping. The device can be made of acrylic resin or mouthguard material, depending on the dentist's treatment plan. An appliance can be made for either the maxilla or the mandible. For this lesson, we will discuss the fabrication procedures for the maxilla.

The following disorders may be improved through the use of a hard nightguard:

- Incorrect placement of the condyles in their fossae.
- Muscle spasm.
- Imbalanced centric jaw relation with elimination of occlusal interference.
- Bruxing of the opposing teeth.
- Lack of vertical dimension of occlusion.

The appliance must be constructed with certain features to carry out its purpose. The hard nightguard must be made in centric relation with simultaneous, even contact of all mandibular cusps and incisal edges on the appliance. An anterior bite plane keeps the condyles in centric relation and prevents the mandible from sliding forward. In addition, this anterior bite plane acts as a guiding ramp to disclude all posterior eccentric contacts. In this manner the normal Class III lever system is maintained, which reduces stress within the TMJ.

As you study this lesson, you may want to refer to mandibular movement and the disclusion theory of occlusion in volume 2. The centric relation position of the mandible, or terminal hinge position, as it is sometimes called, provides the ideal placement of the condyle in the glenoid fossa, resulting in unrestricted movement of the mandible. The hard nightguard provides a protective mechanism that prevents posterior occlusal interferences. The lack of occlusal interferences allows the condyles to remain in the glenoid fossa. This condylar relationship is the key to understanding how a hard nightguard is used.

Preparation

Self-curing acrylic resin is the material of choice when constructing a hard nightguard. Self-curing acrylic resin is preferred because it is softer than heat-cured acrylic and wears at a faster rate than tooth enamel. Recall that one of the purposes of the nightguard is to prevent tooth wear caused by grinding of teeth. Additionally, this softer resin is easier to adjust and minimizes the transfer of stress between the maxilla and mandible. Constructing a hard nightguard begins by mounting the cast on an articulator in centric relation with the desired amount of space separating opposing teeth.

Although it is essential that the maxillary cast be mounted using a facebow transfer, it is recommended. Lateral records can also be used to adjust the horizontal condylar guidance. If the dentist provides these records, you can adjust the articulator to simulate the mandibular movements of the patient. If not, then the dentist must be willing to accept some degree of interference in lateral excursions and make the necessary adjustments at the chair.

If the prescribing dentist does not provide a facebow transfer, then he or she must provide a centric relation record (interocclusal record) of the same thickness and relationship as the finished hard nightguard. In other words if the dentist plans a high nightguard that opens the patient's vertical dimension of occlusion (VDO) 10 mm and positions the mandible in centric relation, then the interocclusal record must be made with the mandible in the same position. Without a facebow transfer, it is impossible to increase the vertical dimension and accurately maintain the proper position of the mandible because the arc of closure on the articulator would differ from the arc of closure in the mouth.

Procedures

Hard nightguards can be fabricated in several ways. We will examine the sprinkle technique and the pour method.

Sprinkle technique

Once the casts have been properly mounted on the articulator, with the prescribed amount of VDO, block out the undesirable undercuts on the maxillary cast (fig. 3–3). Using baseplate wax, block out undercuts along the lingual gingival crevice, embrasures, margins of restorations, deep occlusal grooves, and prominent rugae. Apply utility wax along the facial surfaces of the teeth and inside the palate to establish the border of the appliance.

A well-made hard nightguard fits the maxillary teeth with precision. To minimize the shrinkage and distortion that always accompany the polymerization of acrylic resin, apply the resin in sections, as shown in figure 3–4, using the sprinkle-on technique. The first three applications of acrylic provide a *minimum* thickness of resin and must not be allowed to contact the mandibular teeth. Orthodontic acrylic resin is the material of choice since it yields the best results and is easiest to control. Be sure to apply tinfoil substitute to the maxillary arch and opposing occlusal surfaces.

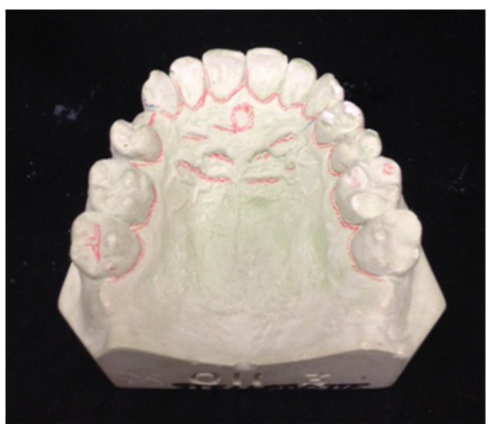


Figure 3–3. Areas requiring block out.

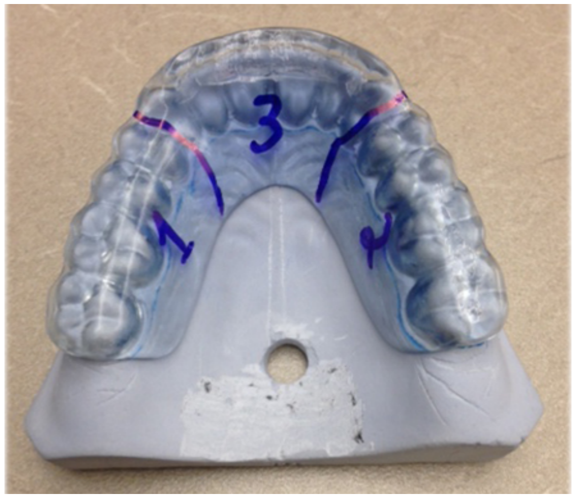


Figure 3–4. Apply acrylic in three sections.

The procedures to construct a hard nightguard are as follows:

Sprinkle Method for Fabricating a Hard Nightguard	
Step	**Action**
1	Survey and blockout cast. Adjust incisal guide pin for anterior guidance. (Raise incisal pin until VDO is open at least 2 mm).
2	Apply utility wax along the facial surfaces of the teeth and inside the palate to establish the border of the appliance.
3	Apply tinfoil substitute to the arch and opposing occlusal surfaces.
4	Sprinkle the polymer on one of the posterior sections to include the occlusal and lingual surfaces of the teeth and tissue only.
5	Moisten the powder with monomer, and keep it moist to prevent porosity.
6	Close the articulator, and check to see that none of the opposing cusps contact the resin.
7	Allow each section to cure before proceeding to another section.
8	It may be helpful if the cast is placed in a closed container with a monomer-soaked cotton roll while the curing process takes place.
9	After you join the three sections together, prepare a mix of acrylic resin for the occlusal portion of the hard nightguard. Mix acrylic resin by adding the polymer to the monomer until the liquid no longer absorbs any powder.
10	Tap the mixing jar on the bench top and discard the excess powder. By not stirring the mixture, you avoid incorporating air and improve the strength of the resin. When the resin becomes tacky, it is ready to apply to the entire arch form.
11	Roll the acrylic resin into a cigar shape, and moisten the previously formed base with monomer.
12	Adapt the resin roll to the maxillary arch, and close the articulator into centric relation.
13	Repeatedly close the articulator, and move the upper member through lateral and protrusive excursions while the resin is still in the doughy state.
14	In the anterior region, you want to create an incline plane that discourages the mandible from sliding forward and provides minimal disclusion of the posterior teeth in eccentric movements.
15	When all the centric, lateral, and protrusive contacts have been established, close the articulator and allow the resin to polymerize (usually 25–30 minutes).

Duplicate and pour technique

This technique uses a wax up of the appliance similar to the cold-cure packing technique. The difference is that the cast and wax up is duplicated instead of flasked and packed. Beginning with the cast and wax-up with refined occlusal contacts, the fabrication procedures are as follows:

Duplicate-and-Pour Technique for Fabricating a Hard Nightguard	
Step	**Action**
1	Survey and blockout cast. Adjust incisal guide pin for anterior guidance. (Raise incisal pin until VDO is open at least 2 mm).
2	Adapt two sheets of baseplate wax over the design and extend the wax 1 mm past the facial buccal design and palate design, then seal with wax.
3	Adjust the occlusal contacts and anterior guidance in wax.
4	Unlock condyles on upper member. Heat wax in the anterior area and slide the articulator into protrusion. Build anterior ramp.
5	Ensure you have lateral and excursive movements.
2	Attach wax sprues to wax-up, if using a flask that allows pouring channels.
3	Soak cast in SDS for approximately 45 minutes.
4	Create a mold using duplication or denture flasks using alginate or reversible hydrocolloid.
5	Remove the cast from the impression.
6	Remove the wax-up leaving block out material on the cast.
7	Apply separator to cast.
8	Mix pourable self-curing orthodontic acrylic resin, and pour into the mold.
9	Seat cast into mold, if using a flask without pouring channels.
10	Cure according to manufacturer’s directions.
11	Recover cast and appliance.

Finishing the hard nightguard

The finishing procedures are identical for each method of fabrication. Before the hard nightguard can be finished, the occlusal contacts must be refined through proper identification and adjustment. The following steps are for finishing an occlusal device:

1. Use different colored articulating film—red and black—to distinguish between the centric and eccentric contact areas.
2. Place a piece of red articulating film on the occlusal surfaces, and close the articulator with a gentle tapping motion. Next, use the black articulating film on the occlusal surface to identify the eccentric contact areas. Your objective in adjusting the centric contact areas is to reduce the broad base contact to a smaller point contact. Only permit the cusp indentations at the greatest depth to remain. In lateral and protrusive movements, the anterior bite plane bears the functional load for the appliance. Therefore, all excursive posterior contacts must be eliminated. Anterior guidance is ground-in to produce a smooth gliding motion.
3. The contacts should appear like those in figure 3–5.

Figure 3–5. Centric and excursive contacts.

4. Do most of the finishing while the appliance is still on the cast to minimize distortion or warpage. Once all occlusal contacts are established, you may remove the appliance from the cast.
5. Trim the borders of the appliance using a flame bur following the buccal contour.
6. Reduce the overall bulk of the hard nightguard until you obtain a uniform thickness. Be careful not to eliminate any of the centric stops or anterior guidance.
7. Trim the incisal overlap to create a uniform horizontal overlap.
8. For esthetic reasons, the acrylic resin on the anterior teeth should extend only 1 mm onto the facial surface above the incisal edge.
9. The amount of acrylic that covers the buccal surfaces of the posterior teeth depends on the need for bracing and retention.
10. Be sure you consult with the dentist about the design of the appliance, and exercise extreme caution not to overheat the resin and warp the appliance.
11. Finally, inspect the tissue side of the device, and remove any rough spots or interferences (fig. 3–6). Contacts should resemble the cross-sectional views shown in figure 3–7.

Figure 3–6. Refining the tissue surface.

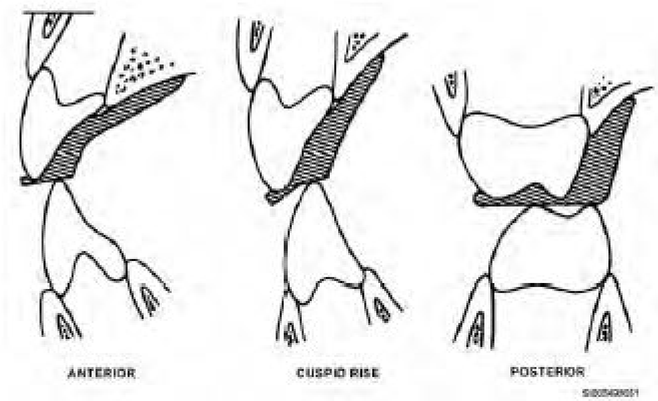


Figure 3–7. Cross-sectional view of the completed hard nightguard.

Self-Test Questions

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

410. Fabricating treatment appliances

1. What is the purpose of a surgical stent?

2. What prosthesis is used to protect the teeth and parts of the maxillary or mandibular arch?

3. What purpose do fluoride carriers serve?

4. What is the condition that restricts airflow to the lungs during sleep that results in breathing interruptions during sleep?

5. What appliance acts as a bandage that maintains the graft’s position or covers the surgical site where the graft was harvested?

6. What material is inexpensive and easy to use when fabricating a record base?

7. What are the purposes of occlusal rims?

8. What can happen if the pressure points on a surgical template are not trimmed down on the alveolar ridge?

411. Fabricating a hard nightguard

1. What disorder is caused by grinding your teeth during sleep?

2. What disorders may be improved through the use of a hard nightguard?

3. Why is the initial application of acrylic resin during the sprinkle-on method made in three sections?

4. What is built into the hard nightguard to disclude posterior teeth?

5. Most of the finishing should be done where? Why?

3–2. Articulator Design Principles

Understanding the structure and function of articulators is critical to the fabrication of dental prostheses. When properly adjusted, articulators can closely duplicate many of the patient's mandibular movements. In this section, we will discuss how to mount casts and adjust Hanau and Whip Mix articulators.

NOTE: The following information is adapted from *Hanau Arcon H2 Series Articulators Technique for Full Denture Prosthodontics* by Teledyne Hanau, and *Whip Mix Articulator and Quick Mount Facebow Instruction Manual* by Whip Mix Corporation.

412. Mount casts using arbitrary method

There are two ways to mount semi-adjustable Hanau and Whip Mix articulators: (1) the arbitrary method, and (2) the facebow transfer method. Let us begin with the arbitrary method. Dentists often request the arbitrary mounting method for cases limited to small restorations. The reason that a semi-adjustable articulator is used in these cases, rather than a smaller fixed guide articulator, is based on dimensions. The articulator hinge axis and the intercondylar distance of the larger semi-adjustable articulator more closely resemble human dimensions. The arbitrary method is an *estimate* of the maxilla's relationship to the transverse hinge axis. The facebow method, in contrast, is a comparatively accurate recording of this relationship.

If you must hand-articulate casts in centric occlusion, ensure that the occlusal surfaces are bubble-free, and then place the casts into maximum intercuspation and check to see that the casts do not rotate from their centric position. With some practice, you will learn to detect bubbles, blebs, and other positive anomalies and be able to remove them to achieve true centric occlusion.

Preparing the articulator

Let us review some procedures common to both the Hanau and Whip Mix. With both procedures, the articulator must be clean and function freely. In addition, all surfaces exposed to stone should receive a light coat of petrolatum.

Hanau H2

The steps for preparing the Hanau H2 are as follows (refer to fig. 3–8 as we discuss this articulator):

Preparing the Hanau H2	
Step	**Action**
1	Rotate the horizontal inclination of both condylar guidances to the vertical (90°) position to prevent any possible lateral movement of the articulator members during mounting.
2	Adjust the lateral inclination of both condylar guidances to 0°, and tighten the thumbnuts of both the lateral and horizontal guidances.
3	Adjust the incisal guide to “zero” and tighten the locknut.
4	Adjust the incisal pin to align the median registration groove with the underside of the upper member, and tighten the thumbscrew.
5	Tighten the centric locks to restrict the articulator to opening and closing movements only.
Preparing the Hanau H2	
Step	**Action**
6	Attach the extension stud.
7	Apply petrolatum and attach the mounting plate to the upper member.

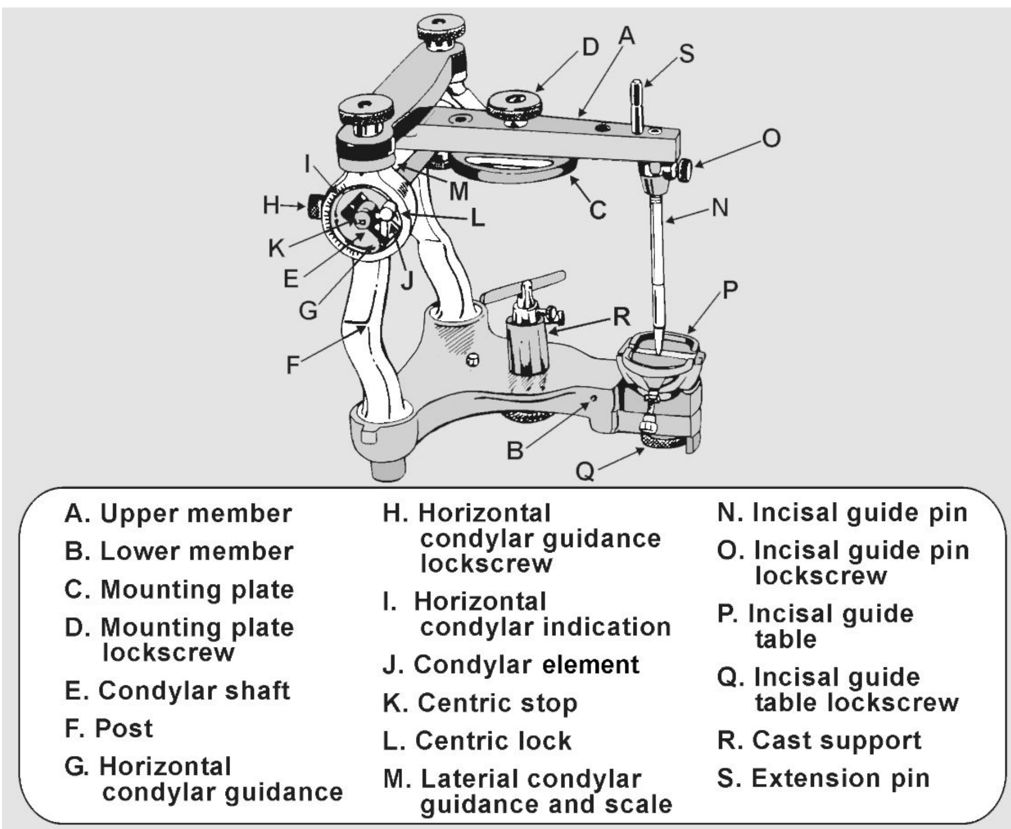


Figure 3–8. Parts of the Hanau H2 158-series articulator.

Although Hanau articulators are precision made, you have probably noticed the mounting rings have a certain amount of slippage. To keep the original centric occlusion relationship between the two casts from being significantly altered, apply pressure to the mounting ring in the same direction the lockscrew is turned. This way, the mounting ring is always consistently positioned on the upper member (fig. 3–9).

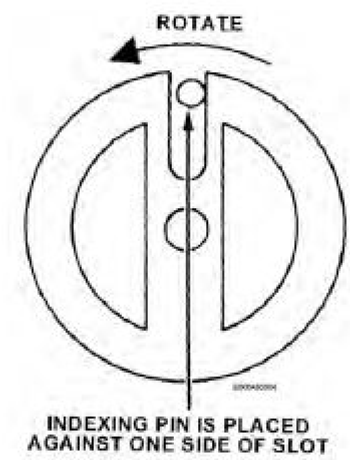


Figure 3–9. Rotating the mounting ring on a Hanau articulator.

Whip Mix

There are three intercondylar widths available on most Whip Mix articulators. A quick mount facebow indicates the appropriate width for the patient; however, for an arbitrary mounting, the medium position is usually selected. The steps are as follows (refer to fig. 3–10 as we discuss this articulator):

Preparing the Whip Mix Articulator	
Step	**Action**
1	Tighten the condylar elements with the box wrench provided.
2	Set the upper frame of the articulator to the same width by removing the correct number of spacers. • Replace the shafts so that the spacers are in tight contact on both sides, between the articulator frame and the condylar guides. Always place beveled spacers closest to the condylar guides with the bevels next to the guides. • The horizontal line on each spacer should align with the line on the frame. • Remember that spacers are unique to each articulator and should be kept with the respective articulator.
3	Set the condylar guides to 30°. Some articulators have the fallback (FB) setting. Do *not* lock the sideshift guides at this point.
4	Zero the incisal table and adjust the incisal pin, so the upper and lower frames are parallel.
5	Apply petrolatum and attach the mounting plates.

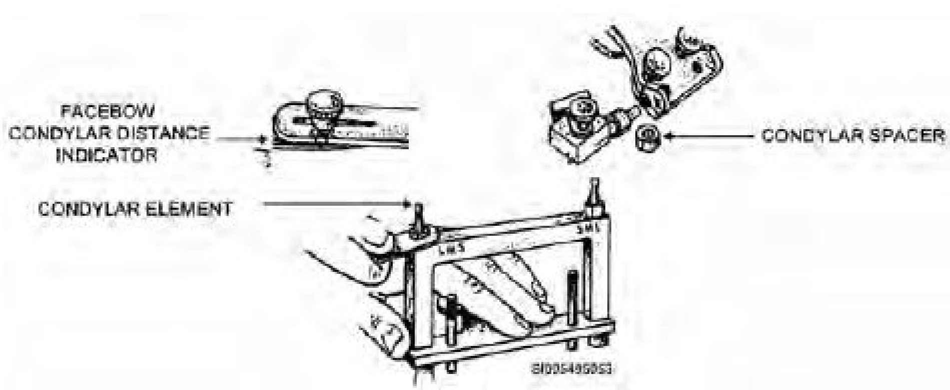


Figure 3–10. Adjusting intercondylar distance (Whip Mix). (Reprinted by permission.)

Mounting the casts

Cast mounting is relatively the same for both articulators. Key the casts and orient the two casts together with an occlusal registration (if provided). Once firmly placed together, put the casts on a projection of clay. Manipulate the casts so the maxillary's occlusal plane parallels the articulator's upper member. The maxillary cast should be under the upper mounting plate. Check to ensure that the casts are firmly attached to the clay and articulator.

Apply the separator to the keys and dampen the stone to aid bonding. Mix the stone according to the manufacturer's directions. Apply a small amount to the keys and then the rest of the cast. Gently lower the upper member into contact with the incisal table. *This must be done before the stone begins to set.* Forcing the upper member into partially set stone could alter the occlusal plane due to cast movement or cause the incisal pin to fail to contact the incisal table. Remove excess stone to reveal the cast-mounting juncture and the mounting-plate juncture.

When the final set is reached, invert the articulator and remove the clay. Apply the separator to the keys and dampen the cast. Apply the mounting stone and close the articulator. There must be metal-to-metal contact between the incisal guide pin and table. Remove excess stone and leave in the inverted position until reaching final set.

413. Mount casts using facebow transfer technique

The facebow transfer is the preferred method for mounting most prosthodontic cases. There are two advantages of the facebow transfer method over the arbitrary method. First, small adjustments can be made to the vertical dimension of occlusion without remounting since the arc of closure between the articulator and patient is the same. Second, there is less of a chance of cusp interferences due to proper positioning of cusps and cuspal contacts in relation to the articulator hinge axis.

The Hanau facebow transfer

To perform the facebow transfer for a dentulous or edentulous case, you need the following:

- A facebow record to locate the maxillary cast on the articulator.
- A centric interocclusal record for mounting the mandibular cast on the articulator.
- A protrusive interocclusal record for the adjustment of the condylar inclination on the articulator.

All of the facebows Hanau makes can be used with the Hanau H2–158 series articulator. A special earpiece facebow is available with condyle compensator to help the dentist locate the condyle centers or the "true hinge axis."

Preparing the articulator

Prepare the articulator as stated above. Upon receipt of the facebow record, make a note of the readings on the slide-bar scales. (The facebow should have been centered on the patient at the time the recording was made.) Then perform the following procedures:

Preparing the Hanau H2–158 Articulator	
Step	**Action**
1	Move the slide bars in or out an equal amount until the facebow springs gently over the ends of the condylar shaft.
2	Secure the slide bar by tightening the slidebar locks.
3	Adjust the elevating screw until the plane of occlusion is parallel to the base of the articulator, as shown in figure 3–11.
4	Carefully seat the maxillary cast into the baseplate or occlusal bite registration. Support the maxillary cast with a cast support or with clay.
5	Attach the cast to the upper mounting with a thick mix of dental stone. After final set, loosen the elevating screw and remove the facebow from the articulator.

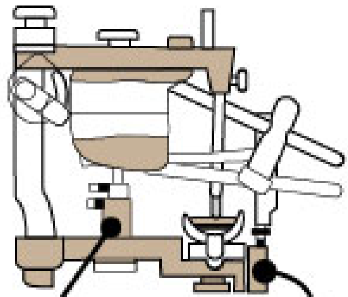


Figure 3–11. Mounting the maxillary cast (Hanau H2–158). (Reprinted by permission.)

To mount the mandibular cast with a centric relation-vertical dimension of occlusion record, it may be necessary to extend the incisal pin 1–2 mm to compensate for the thickness of the interocclusal record. (**NOTE:** this *does not* change the maxillary cast's relationship to the condylar element.) Then follow these procedures to mount the mandibular cast:

1. Invert the articulator and seat the interocclusal record on the maxillary cast. Once the mandibular cast has been properly oriented to the maxillary, reinforce this relationship with wire compound, as depicted in figure 3–12.
2. Mount the mandibular cast with a thick mix of dental stone, and ensure the incisal pin contacts the incisal table.
3. After the final set, remove the interocclusal record.

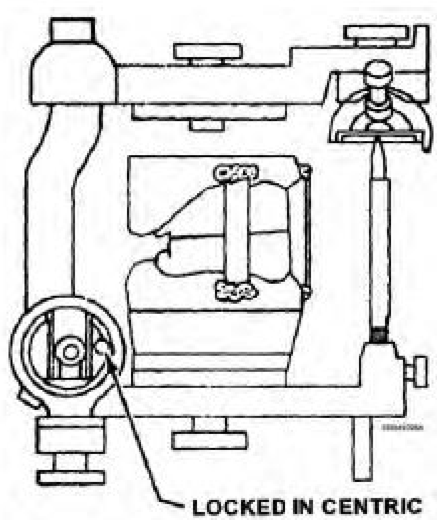


Figure 3–12. Mounting the mandibular cast (Hanau H2–158). (Reprinted by permission.)

Adjust articulator settings using occlusal registrations

On all Hanau H2 articulators, the horizontal condylar guidance is adjusted using a protrusive interocclusal record. The procedure is performed in the same manner for an edentulous or dentulous patient. Raise the incisal pin out of contact with the incisal table. Loosen the centric locks and thumbnuts for the horizontal condylar guide inclines. Seat and lute the protrusive relation record onto the mandibular cast. Carefully guide the upper member into protrusive to engage the maxillary cast in the protrusive relation record. Rocking the mechanism up and down can set the right and left condylar guidance.

When the angle is too shallow, the anterior teeth will lift out of the checkbite, as shown in figure 3–13, A. When the angle is too steep, the posterior teeth will lift out, as shown in figure 3–13, B. When the angle is correct, the cast is completely seated, as shown in figure 3–13, C.

Another technique to be used only with an edentulous case is illustrated in figure 3–14. This method is easier and more accurate for adjusting the condylar guidance in a complete denture arrangement. The maxillary cast and rim is removed from its mounting and luted to the mandibular rim using a protrusive relation record. Condylar guidance is properly adjusted when the maxillary mounting seats into the base of the maxillary cast. Once the articulator is adjusted, the maxillary cast can then be luted to the upper mounting stone.

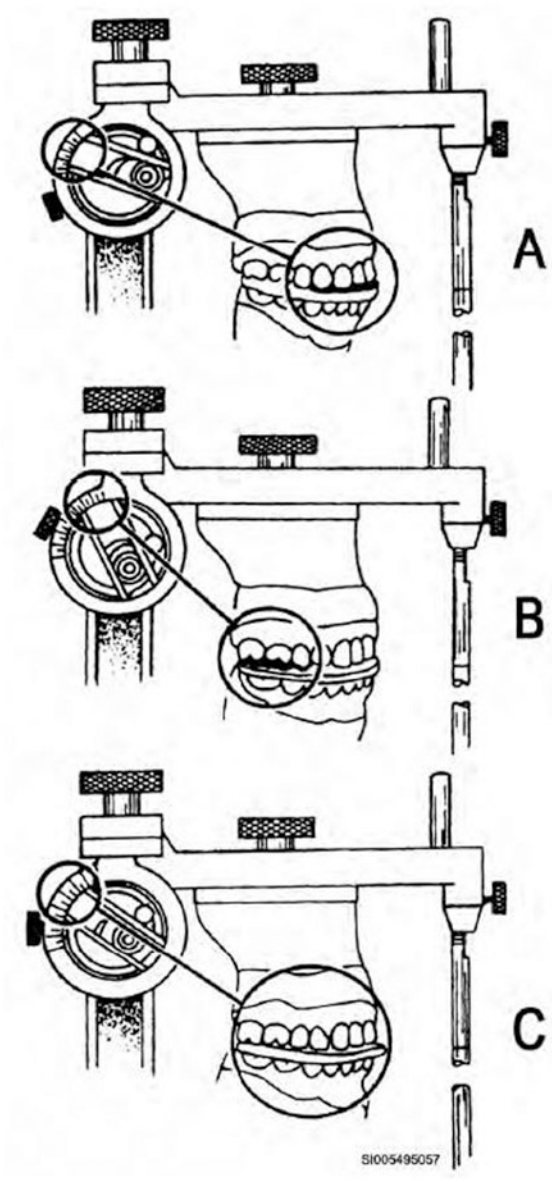


Figure 3–13. Adjusting horizontal guidance (H2–158, dentulous). (Reprinted by permission.)

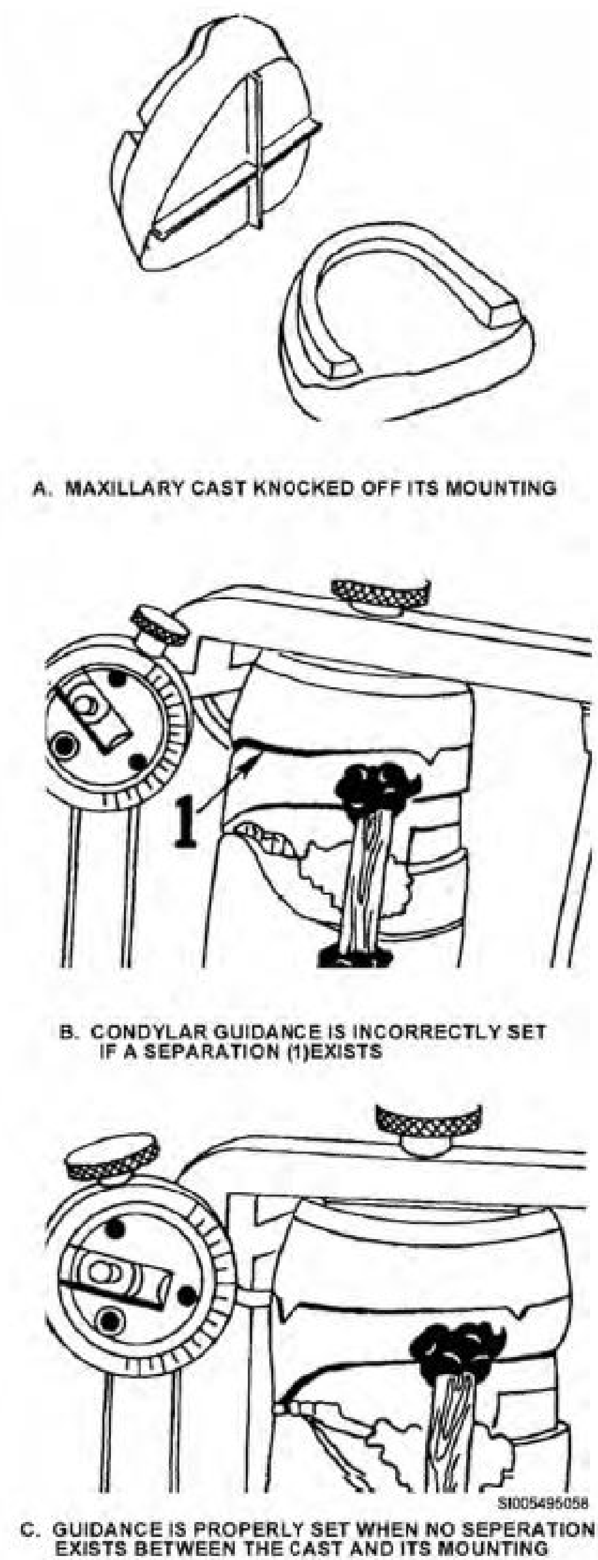


Figure 3–14. Adjusting horizontal guidance (H2–158, edentulous). (Reprinted by permission.)

Adjusting the lateral condylar guidance of a Hanau H2 articulator is usually done with the following formula:

$$L = H/8 + 12$$

To use this formula, first set the horizontal guidance on each side. Then divide each horizontal (H) setting by 8. Add 12 to the resulting figure, and you have the lateral (L) guidance for that side— then repeat this process to determine the patient's lateral guidance for the other condyle. Adjust the articulator's lateral guidance to these figures.

You can use the incisal guide table to maintain existing horizontal and vertical overlaps between upper and lower teeth or create new ones. The incisal table can prevent cast abrasion during excursions. This is when the incisal guidance has been established. Once established the incisal pin is set and will remain in contact with the incisal table. The vertical dimension of occlusion is maintained, and ultimately this prevents the teeth from abrading during excursive movements.

Analyze the patient's occlusal pattern using the wear facets, and set the table to correspond with them. If this is not possible, have a definite occlusal pattern programmed into the articulator. Adjust the appliance's horizontal and vertical overlap to conform to the chosen occlusal pattern. Tighten the locknuts of the table to maintain this setting.

Here is the procedure to set the anterior guidance mechanism for a dentulous patient. The procedure for setting the incisal guide table for a complete denture case is discussed in a later volume. Once the occlusal pattern is selected, the first step is to examine the mounted casts.

Setting the Anterior Guidance Mechanism	
Step	**Action**
1	Look for balancing contacts that prevent the anterior teeth from remaining in contact in all excursions. If balancing interferences exist, discuss their removal with your noncommissioned officer in charge (NCOIC) or laboratory officer.
2	Perform a diagnostic wax-up of anterior teeth that are missing or out of contact due to lost tooth structure. This restores the guidance pattern desired in the final product.
3	Loosen the locknut under the incisal table at the front end of the lower member of the articulator. The incisal pin should be in contact with the incisal table. Protect the casts from excessive abrasion by applying a die hardener to the occlusal surfaces.
4	Gently move the upper member of the articulator back to bring the maxillary and mandibular teeth into end-to-end contact. The incisal pin will be out of contact with the incisal table.
5	Rotate the table until it again contacts the incisal pin (fig. 3–15, A) and tighten the locknut.
6	Move the casts into a right lateral excursion. The pin will move to the left side and again will be out of contact with the table.
7	Loosen the small thumbnut under the left side of the table, and turn the elevating screw until the table's left wing contacts the corner of the incisal pin (fig. 3–15, B).
8	Repeat the process by moving the casts into a left lateral excursion and adjusting the right wing (fig.3–15, C).

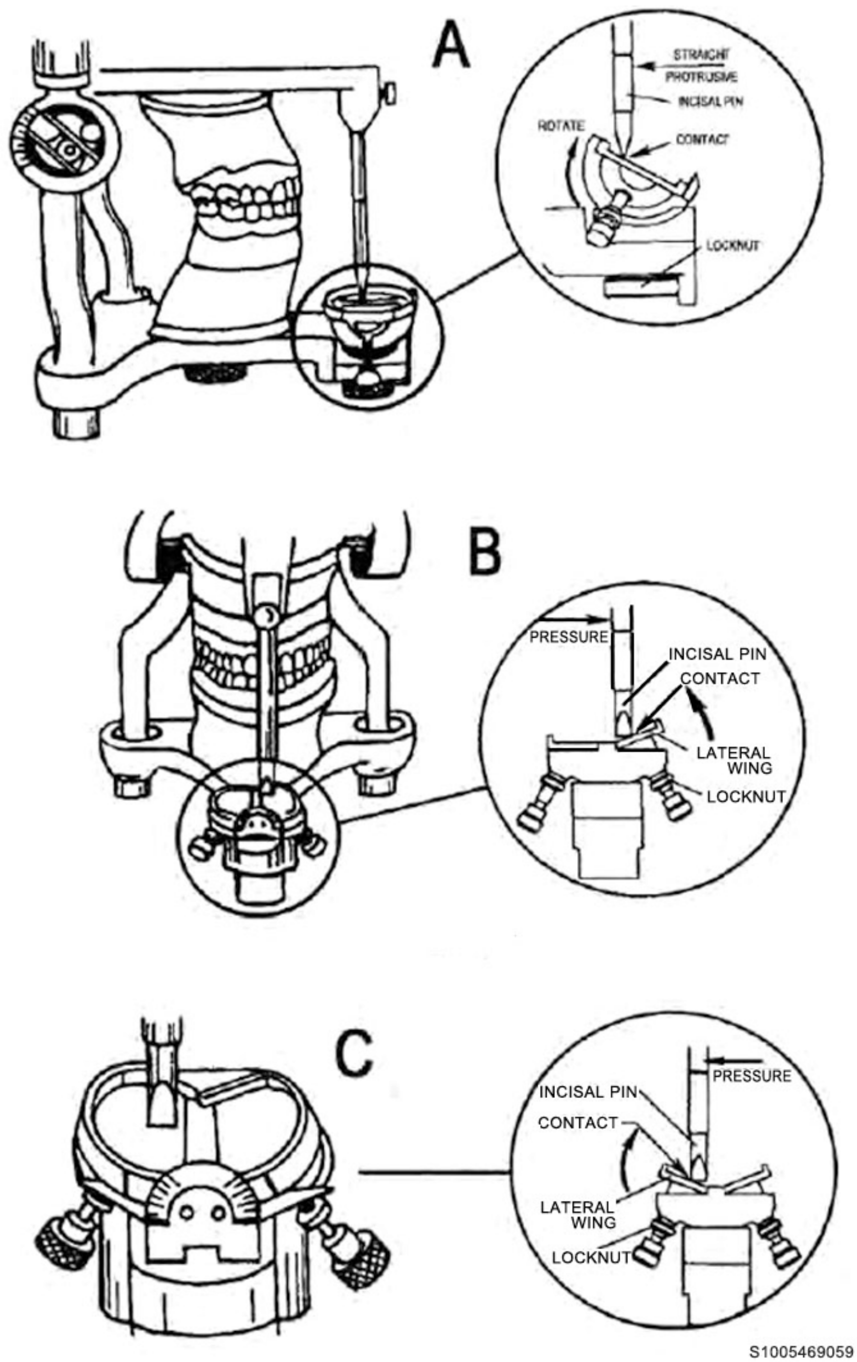


Figure 3–15. Adjusting anterior guidance. (Reprinted by permission.)

The Whip Mix facebow transfer

The Whip Mix articulator (arcon) was primarily designed for use with fixed dental prosthesis; however, it can be used with other appliances as well. The Whip Mix articulator’s condylar elements are adjustable to three intercondylar distances: small (88 mm), medium (100 mm), and large (112 mm). The Whip Mix facebow automatically records the intercondylar distance to the nearest measurement of small, medium, or large. Then, it is simply a matter of adjusting the condylar post and related spacers. The large intercondylar width results in a *narrower* angle between the working and nonworking cusp paths and allows slightly longer cusps.

The small intercondylar width results in a *wider* angle between the working and nonworking cusp paths and forces the wax-up of shorter cusps, with less chance of cuspal interference. When in doubt, it's better to have a wider path of travel (arch angle) with a greater amount of sideshift than to run the risk of locking the patient's eccentric paths into a narrower than natural path.

Preparing the articulator

Perform the following steps to prepare the articulator:

Preparing the Whip Mix Articulator	
Step	**Action**
1	Adjust the intercondylar distance using the width indicated on the facebow.
2	Set the horizontal guidance at 30° and the incisal table at 0°. The side-shift guide settings are irrelevant at this point.
3	Once the mounting plate is attached to the upper member, remove the incisal guide pin.
4	Loosen the three thumbscrews on the top of the facebow frame to allow attachment to the articulator.
5	Hold the facebow in one hand and the upper member of the articulator in the other. Guide the first pin and then the other pin on the outer surfaces of the condylar guides into the holes on the inner surfaces of the plastic earpieces.
6	Hold the facebow frame firmly against the upper frame of the articulator, and tighten the three thumb screws on the facebow.
7	Place the upper frame and attached facebow back onto the lower frame of the articulator.
8	Carefully seat the cast into the occlusal bite registration record.
9	Attach the maxillary cast to the upper frame with dental stone. Be sure to support the cast as you close the upper frame down until it touches the transverse bar of the facebow (fig. 3–16).
10	Remove the facebow when the stone reaches its final set.
11	Mount the mandibular cast in the manner described in the arbitrary mounting method for the Whip Mix articulator.

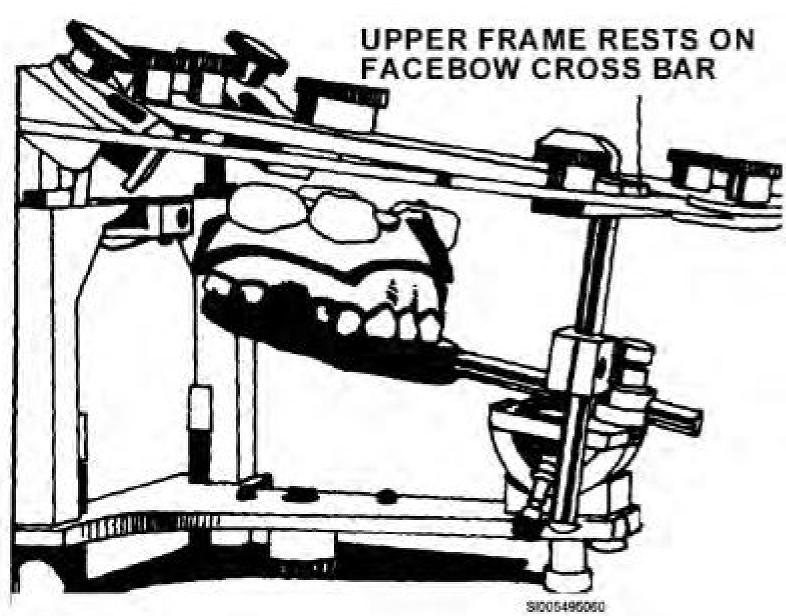


Figure 3–16. Facebow attached with upper frame (Whip Mix). (Reprinted by permission.)

Adjusting the articulator

The dentist provides right and left lateral interocclusal records (checkbites) to set the horizontal and lateral condylar guidance. After removing the centric registration record, the procedures are as follows:

Adjusting the Whip Mix Articulator	
Step	**Action**
1	Set the condylar guides to 0° and the side shift control to their most open (45°) position. Raise the incisal pin to prevent interference.
2	With the upper frame and its cast inverted, carefully seat the left lateral excursion record on the upper cast.
3	Holding the upper frame in one hand and the lower frame in the other, place the left condylar element into the left condylar guide.
4	Gently seat the lower cast into the indents of the lateral record, and lightly hold the articulator and casts in position with one hand. Notice the right condylar element has moved away from both the superior and posterior surfaces of the condylar guide and, in most cases, toward the median line (fig. 3–17).
5	Set the inclination of the right guide, loosen its holding screw and rotate the guide toward the condylar element until contact occurs. It is best to judge contact by sight, as shown in figure 3–18, rather than by touch. This helps to ensure that the casts are not forced out of position from the interocclusal record.
6	Then set the correct amount of side shift. Loosen the side-shift–guide-locking screw, and then move the guide into contact with the condylar element (fig. 3–19).
7	Tighten the locking screw. After the right horizontal and lateral condylar guidances are set, adjust the left side of the articulator with the right lateral excursion record.

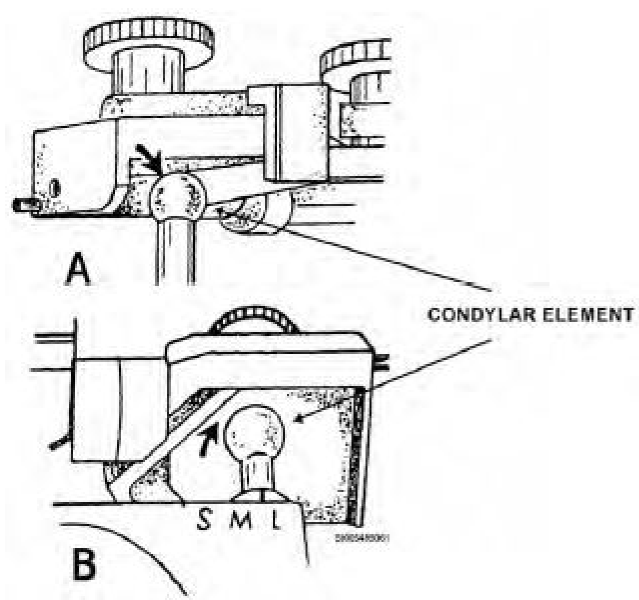


Figure 3–17. Right condylar guide position with left lateral record in place (Whip Mix). (Reprinted by permission.)

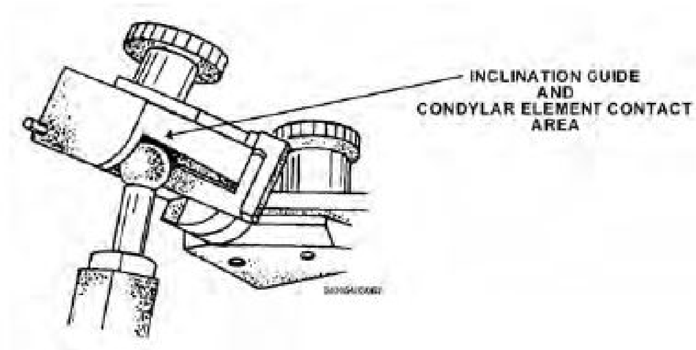


Figure 3–18. Adjusting horizontal guidance (Whip Mix). (Reprinted by permission.)

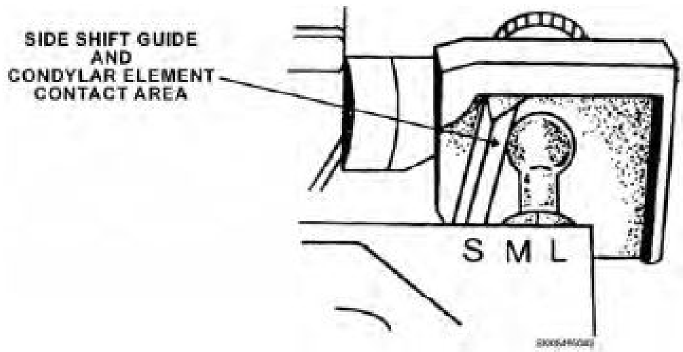


Figure 3–19. Adjusting lateral guidance (Whip Mix). (Reprinted by permission.)

The adjustments for anterior guidance on the Whip Mix articulator are the same as for the H2. Once the occlusal scheme for the restoration is selected, set the incisal guide table using the same procedures outlined earlier for the H2.

Mounting-error correction

No matter how careful you are when mounting casts, errors still occur. They could be the result of a slight discrepancy in handling the articulator or even the expansion of the stone used for the mounting. A list of mounting problems, their probable causes, and solutions are in the following table.

Mounting errors and solutions		
Problem	**Probable cause**	**Solution**
Casts cannot be separated from stone mounting.	Indexing grooves are undercut or separating medium applied improperly.	Do not create undercuts when indexing; cover index with appropriate separator.
Condyles do not seat completely with upper member.	Condyles not held against metal walls of assembly during mounting.	Remount mandibular casts.
Incisal pin does not touch table.	Upper member not completely closed during mounting.	Remount mandibular cast for gross error.
Upper and lower members are not parallel.	Incisal pin in incorrect position during mounting or no allowance for interocclusal record.	Remount mandibular cast for gross error.
Obvious error in centric relation.	Cast not held together or articulated in proper relation.	Remount mandibular cast.
Obvious error in occlusal plane.	Facebow not supported by elevating screw, or cast not supported.	Obtain new facebow and remount.
Relationship of edentulous cast incorrect.	Incorrect jaw-relationship record used. Cast not seated accurately in record base. Occlusion rims not secured to record base. Cast moved during mounting. Vertical dimension of occlusion altered.	Obtain new jaw-relationship record. Seat casts completely in record bases. Secure occlusion rim to record base. Remount. Incisal pin was not moved down to compensate for thickness or interocclusal record.
Cast broken loose from mounting.	Stone allowed to set too long before using, or mixing will be too dry.	Remount or use compound to reattach cast to mounting.

Perform cast equilibration

Equilibrating the casts after mounting is one of the most neglected steps. The importance of this easy step is the key to producing a more accurate prosthesis for the patient. The process includes using the mounted casts that are in a cusp-to-fossa/maximum-intercuspation relationship and marking the contact points with occlusion paper. The technician will remove the marks and repeat the process until balanced contacts are achieved throughout the arch. A way to check the even thickness is when the same thickness of shim stock is held between the teeth.

The goal of cast equilibration is to provide our doctors with a prosthesis that requires little to no adjustments during insertion. It also provides the patient with a more efficient and effective device. The following information is the systematic process for equilibrating the casts:

1. Pour the casts according to manufacturer's instructions, ensuring you use the correct water-to-powder ratio.
2. After final set, clean occlusal surfaces of the teeth, removing all bubbles and other blebs.
3. Mount the casts in maximum intercuspation (MI) with the bite registration provided by the doctor.
4. Use articulating paper to mark the current contact points on the casts. Remove the contact points on ridges and fossas.

   NOTE: Do not remove contacts on cusp tips.
5. Continue the process until you have equal shim-stock drag throughout.

Self-Test Questions

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

412. Mount casts using arbitrary method

1. How does the arbitrary mounting method differ from the facebow mounting method?

2. Why are the horizontal condylar guidances of the Hanau H2 locked in a vertical (90°) position?

3. What undesirable action could happen if an articulator's upper member is forced into setting mounting stone?

413. Mount casts using facebow transfer technique

1. What are two advantages of using a facebow transfer?

2. On all Hanau H2 articulators, what is adjusted using a protrusive interocclusal record?

3. What helps prevent cast abrasion during excursive movements?

4. What handling discrepancy could cause mounting errors?

5. What is one of the most neglected steps after mounting the casts?

Answers to Self-Test Questions

410

1. To stabilize bone segments into normal alignment and fix them into position during healing.
2. Athletic mouthguard.
3. They act as a delivery system for fluoride gel during clinical fluoride treatments.
4. Sleep apnea.
5. Periodontal stent.
6. Self-curing (autopolymerizing) resin.
7. Establishing midline, Occlusal plane, Lip line, Cuspid line, Amount of horizontal and vertical overlap, support for the cheeks and lips.

8. The denture will cause pain, and in extreme cases the patient will not heal and the area can become infected.

411

1. Bruxism.
2. Incorrect placement of the condyles in their fossae, muscle spasm, imbalanced centric jaw relation with elimination of occlusal interference, bruxing of the opposing teeth, lack of vertical dimension of occlusion.
3. To minimize the shrinkage and distortion that always accompanies the polymerization of acrylic resin.
4. An incline plane is built into the anterior region.
5. On the cast to minimize the chance of distortion or warpage.

412

1. The arbitrary method is an estimate of the maxilla's relationship to the transverse hinge axis. The facebow method is a comparatively accurate recording of this relationship.
2. This prevents the possible lateral movement of the articulator members during mounting.
3. The occlusal plane could be altered by cast movement or the incisal pin could metal-to-metal contact between the incisal guide pin and table.

413

1. (1) Small adjustments can be made to the vertical dimension of occlusion without remounting since the arc of closure between the articulator and patient matches; (2) There is less of a chance of cuspal interferences due to proper positioning of cusps and cuspal contacts in relation to the articulator hinge axis.
2. The horizontal condylar guidance.
3. The incisal table.
4. A slight discrepancy in handling the articulator or expansion of the stone used for the mounting.
5. Equilibrating the casts.

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 AFCDA.

29. (410) What is the purpose of a surgical stent?
    a. Prevent the patient from speaking.
    b. Guide the oral surgeon's incisions.
    c. Stabilize bone segments into normal alignment.
    d. Act as a working model of the surgical objective.

30. (410) What function does a *fluoride carrier* serve?
    a. Properly distributes fluoride flux when soldering.
    b. Attaches to the hygienist's treatment instruments.
    c. Acts as a container for fluoride solutions during home care use.
    d. Acts as a delivery system for fluoride gel during fluoride treatments.

31. (410) What appliance acts as a bandage that maintains a graft's position or covers the surgical site where the graft was harvested?
    a. Surgical stent.
    b. Surgical template.
    c. Periodontal stent.
    d. Periodontal template.

32. (410) What appliance is the foundation for the occlusal rims?
    a. Record base.
    b. Hard nightguard.
    c. Sleep apnea device.
    d. Athletic mouthguard.

33. (410) What appliance covers the ridge in the same manner the completed denture would?
    a. Periodontal stent.
    b. Periodontal template.
    c. Surgical stent.
    d. Surgical template.

34. (411) Which occlusal device feature places the condyles in centric relation?
    a. Simultaneous centric contact.
    b. Posterior excursive contact.
    c. Anterior bite plane.
    d. Centric stop.

35. (411) What excursive contacts should be eliminated on a hard nightguard?
    a. Anterior.
    b. Posterior.
    c. Buccal.
    d. Lingual.

36. (412) How is the patient's intercondylar width determined for setting a Whip Mix articulator?
    a. With a slow mount facebow.
    b. With a quick mount facebow.
    c. It cannot be determined on a Whip Mix articulator.
    d. With an estimated measurement that is based on the dentist's experience.

37. (412) Forcing the upper member into partially set stone could alter the occlusal plane due to
    a. cast movement.
    b. over closing the articulator.
    c. the incisal pin touching the incisal table.
    d. interference with the set of the dental stone.

38. (413) What is an advantage in mounting casts with the facebow transfer method?
    a. It is easy to use.
    b. There are fewer cusp interferences.
    c. Articulator adjustments are unnecessary.
    d. The articulator hinge axis is closer to the cast.

39. (413) The lateral interocclusal records are used to adjust the Whip Mix's
    a. protrusive condylar guidance.
    b. lateral condylar guidance only.
    c. horizontal condylar guidance only.
    d. horizontal and lateral condylar guidance.

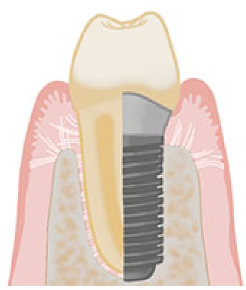
40. (413) After mounting the casts in centric occlusion, what is the probable cause of the upper and lower members *not* being parallel?
    a. Maxillary cast not completely closed during mounting.
    b. Incisal pin in incorrect position during mounting.
    c. Stone allowed to set too long before using.
    d. Incorrect haw relationship record used.

41. (413) After mounting the casts, when do you know that the casts are completely equilibrated?
    a. Equal shim-stock drag.
    b. Equal excursive contacts.
    c. Progressive sideshift is achieved.
    d. Progressive occlusal contacts maintained.

Please read the unit menu for unit 4 and continue ➔

Unit 4. Dental Implants

INSTEAD OF conventional prosthetic treatment, some prosthetic patients may be considered as candidates for dental implants. A dental implant is a device that is placed within the mandible or maxilla for the purpose of providing support for the replacement of missing teeth. The implant itself basically acts as a root or foundation. The prosthesis, which may be fixed or removable, is the equivalent of the crown portion of the teeth. Combining these two parts—the implants and the prosthesis—results in good function and esthetics being achieved for patients. This section will present information about dental implants, variables that must be considered prior to fabricating an implant-supported appliance and general laboratory procedures to fabricate an implant appliance.



4–1. Dental Implant Procedures

A dental implant is a type of restoration that requires the expertise of the entire dental staff. This includes the prescribing dentist, dental assistant, and the dental laboratory technician. The lab technician must gain a true understanding of why a patient will require an implant and what the basic principles are behind implant selection. This begins with an understanding of the different types of implants and the treatment procedures associated with an implant.

414. Implant types and components

This lesson describes the variety of types and uses of dental implants.

Types of implants

Dental implants can be classified into three categories: (1) subperiosteal (2) transosteal (3) endosteal. The following table provides more information:

Types of Implants	
Type	**Description**
Subperiosteal	Used to anchor dentures in completely edentulous patients. Placed under the gum but on, or above the mandible. Commonly used in patients who do not have enough healthy natural bone. A metal framework is secured on the bone but the framework lies below the gumline. To ensure proper fit, the implants have to be customized according to the width and height of the mandible, which can be very costly.

<table>
<tr><td>Transosteal</td><td>Similar to subperiosteal, these implants are fitted only to the mandible. The procedure involves attaching a metal plate at the bottom of the mandible with screws running through the bone. Posts are embedded within the gum tissue.</td></tr>
<tr><td>Endosteal</td><td>The most commonly used type of implant. These implants are partially submerged and placed directly in the jawbone. Typically made of titanium.

Endosteal implants can be divided into two categories: (1) plate form (2) root form shown in figure 4–1.
Plate form implants are used when the jawbone is too narrow or short for a root form implant. Sometimes referred to as blade. The plate form implant is a flat, long implant, which is set directly on top of the jawbone under the gums. Bone and tissue will eventually grow around this type of implant.
Root form implants are the most common type of endosteal implant. It is a screw type of implant, shaped like the root of a tooth, which is set directly into the jawbone under the gums.

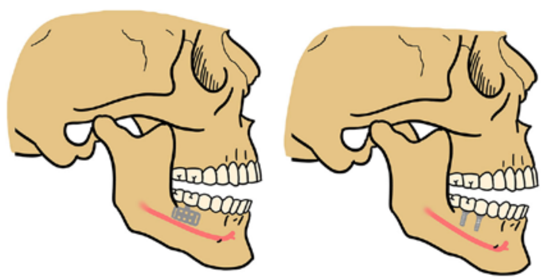



Figure 4–1. Plate form, root form implants.</td></tr>
</table>

Osseointegrated implants

The great advantage of an endosteal implant is its ability to osseointegrate with bone. The osseointegration process actually fuses the bone to the implant during the healing phase. The osseointegrated implant (fig. 4–2) forms a firm, direct, and lasting connection between vital bone and the implant. These implants are constructed of titanium; they are harmless to human tissue and rarely cause any rejection reactions. A fixed or removable denture may be attached to the extensions of the implant (abutments) that protrude through the oral mucosa.

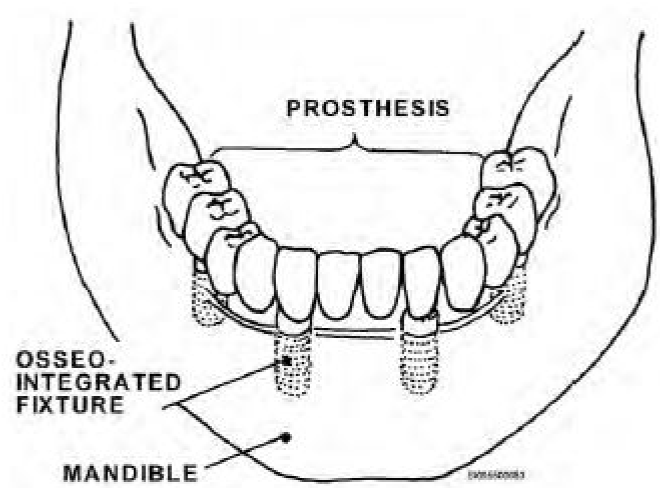


Figure 4–2. Mandibular osseointegrated implant and prosthesis.

Though each implant is integrated into the bone, repeated horizontal (lateral) forces can cause bone resorption and loss of the implant.

Implant components

Implants usually can consist of three components shown in figure 4–3, which are (1) fixture, (2) abutment, and (3) supported restoration (artificial tooth).

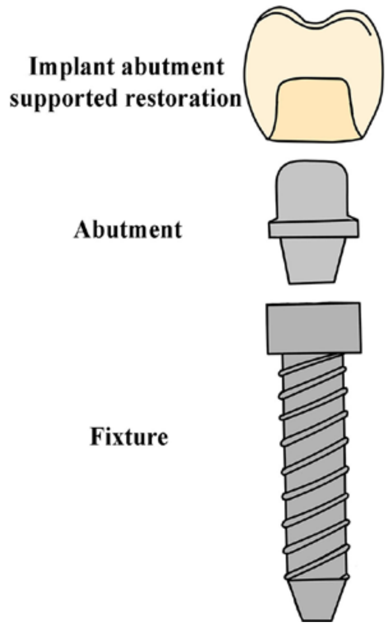


Figure 4–3. Implant components.

The implant fixture is the component that is surgically placed into the bone. It is a permanent device that osseointegrates with the patient's bone.

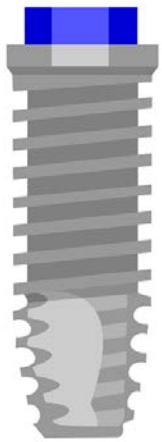


Figure 4–4. Implant fixture.

The abutment is a post like structure that attaches to the fixture that supports and retains the restorative components. There are several types of abutments the dentist must choose from. Two important implant abutments to understand are prefabricated abutments and custom abutments.

Types of Abutments	
Type	**Explanation**
Prefabricated	A very versatile machine manufactured post that comes in standard sizes. All prefabricated implants can either be straight or angled and are typically cement retained.
Custom	A custom made post fabricated to address specific angulation or esthetic requirements. **NOTE**: It can be either machined or cast, and is used in situations where esthetics are important.

The implant abutment supported restoration or what is referred to as the artificial tooth is a customized crown fabricated to match the adjacent teeth.

415. Treatment planning

This next section examines the treatment sequence and the related laboratory procedures of the implant process.

Factors for implant-supported appliances

The factors that must be considered by the dentist are as follows:

- Remaining bone in either maxilla or mandible.
- How many abutments can be placed in remaining bone.
- Opposing occlusal surfaces.
- Type of occlusal scheme.
- Diseases that may adversely affect osseointegration.

Each of these factors must be considered during treatment planning. The dentist is the one primarily responsible for this. The dentist coordinates all phases of treatment for the dental implant patient. As a dental laboratory technician, your primary concern is focusing on the factors that will influence the fabrication of an implant prosthesis.

Treatment procedures

After evaluation and examination, a treatment plan is presented to the patient. The typical treatment sequence for endosteal implants is illustrated in figure 4–5.

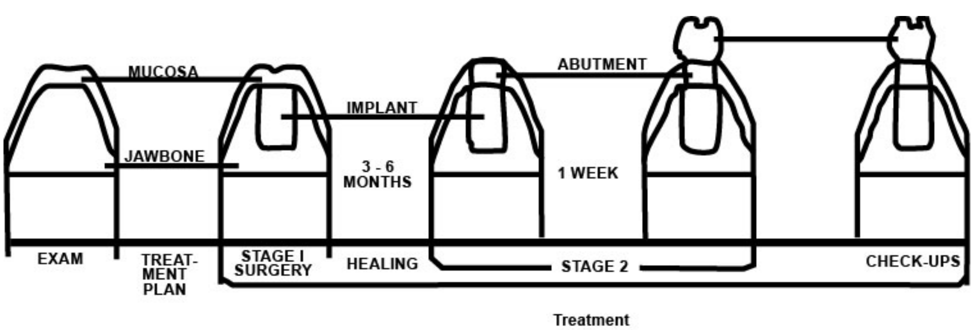


Figure 4–5. Basic treatment sequence for endosteal implantology.

The actual treatment is usually divided into two stages. The first stage consists of surgically placing the implant fixture into the bone.

During the healing phase of the initial surgery, a screw is placed in the top (superior) portion of the implant. This is illustrated in figure 4–6, A. After three to six months, the dentist evaluates the condition of the implants. If acceptable, the dentist then performs a second minor soft tissue surgery and then places the healing caps onto the implants. This is illustrated in figure 4–6, B. The healing caps are left for two to six weeks until the soft tissue has recovered. In some cases, it is appropriate at this point to make a provisional restoration with suitable height, form, and color. A properly designed provisional can enhance soft tissue healing.

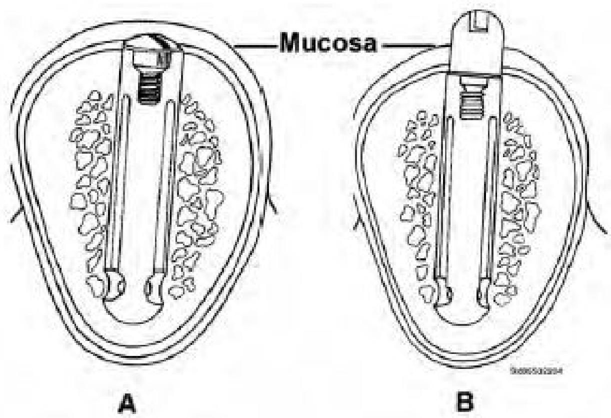


Figure 4–6. Fixture attachments following initial surgery—screw (A) and healing caps (B).

When satisfied with the patient's progress, the dentist prepares the abutment(s) for an impression. To do this the dentist places an impression coping onto each abutment or implant (fig. 4–7). Once the copings are positioned and secured, the dentist takes the impression. After the impression "sets," the dentist removes the impression with the embedded impression copings from the patient's mouth. This impression procedure provides an accurate fixture-to-abutment orientation, which is reproduced in the master cast.

Figure 4–7. Impression coping.

Laboratory analogs are then attached to the impression copings, and the impression is poured in low expansion stone. The purpose of the laboratory analog is to provide an accurate reference and orientation of the dental implants between the cast and the patient's implants. Laboratory analogs are constructed of metal and are machined to represent the implant (fig. 4–8).

Figure 4–8. Laboratory analog.

After final set, waxing sleeves are attached to the laboratory analogs. The waxing sleeves are made of either plastic or metal. Plastic sleeves are burned out, with the framework and cast as part of the final restoration. Metal waxing sleeves are incorporated into the framework when it's cast to the metal alloy cylinder.

The sleeves create a cylinder canal called the access channel, and this is where the prosthetic retaining screw secures the final prosthesis to the fixture, as shown in figure 4–9.

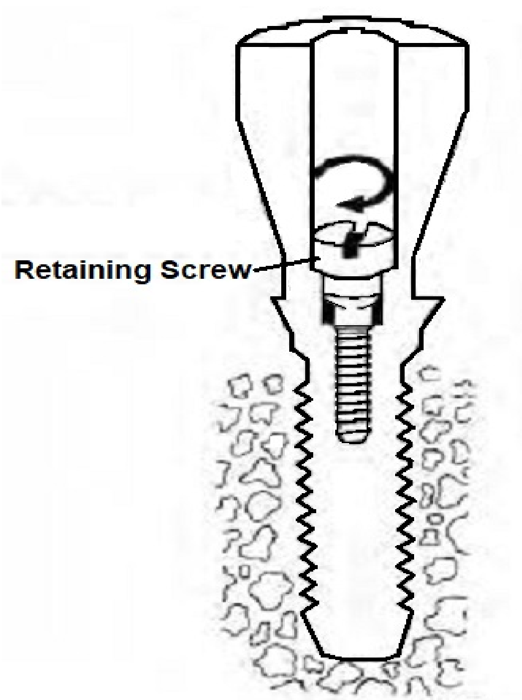


Figure 4–9. Retaining screw.

Once the implant abutment supported restoration(s) have been anchored to the abutments, the patient's oral condition must be checked regularly by the dentist. Eventually, the follow-up appointments may be extended to every six months or once a year.

Self-Test Questions

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

414. Implant types and components

1. What are the three categories of dental implants?

2. What forces should be avoided when using osseointegrated implants?

3. What three components do implants usually consist of?

4. What implant component is surgically placed into the bone?

5. What are the two types of implant abutments?

415. Treatment planning

1. What factors must be considered by the dentist for implant-supported appliances?

2. What action should occur in the first stage of endosteal implantology treatment?

3. What is the purpose of the laboratory analog?

4. What component creates a canal where the prosthetic retaining screw secures the final prosthesis to the fixture?

4–2. Dental Implant Fabrication

The laboratory plays an important role in the treatment plan long before the implants begin to osseointegrate. This section describes the laboratory procedures involved in fabricating an implant.

416. Laboratory procedures

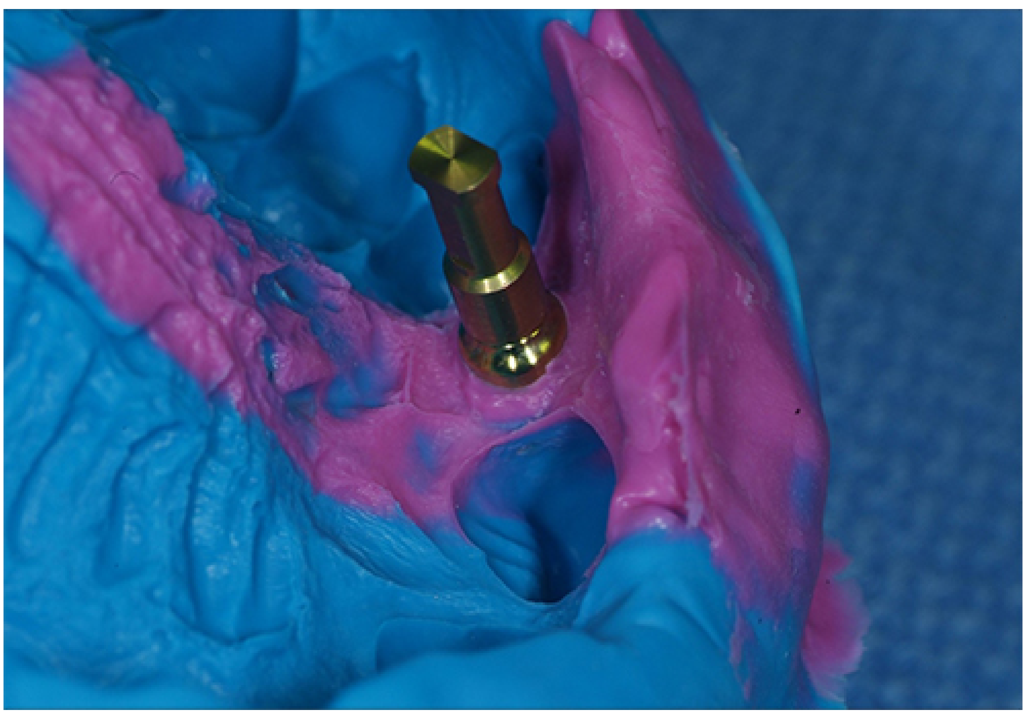
This lesson describes the laboratory procedures required prior to and including actual implant appliance fabrication.

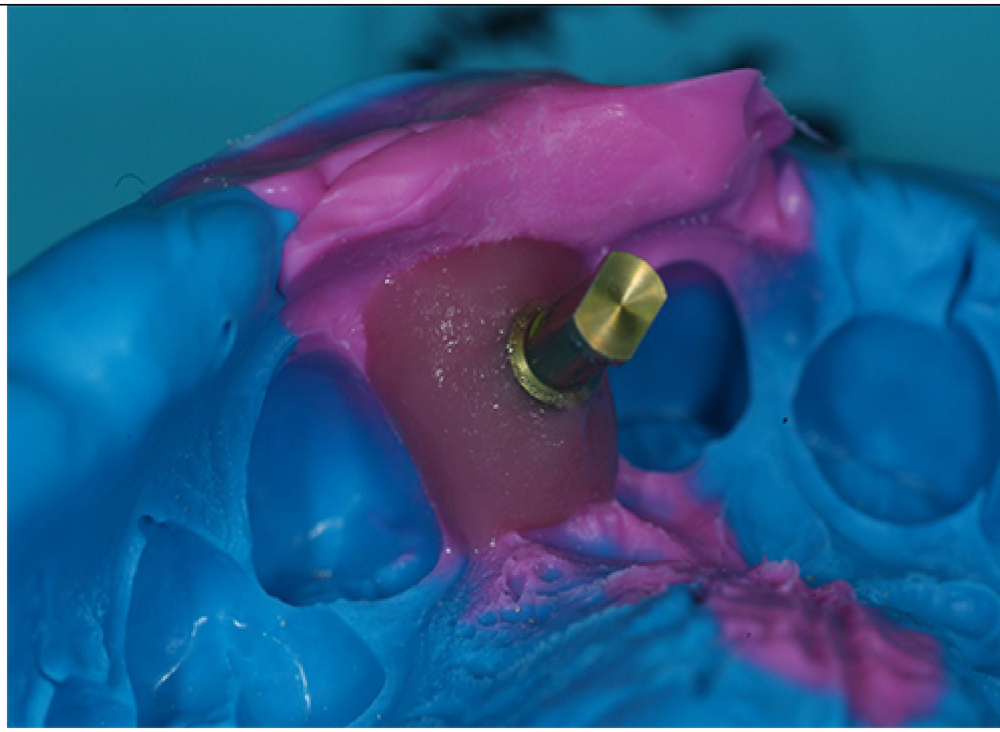
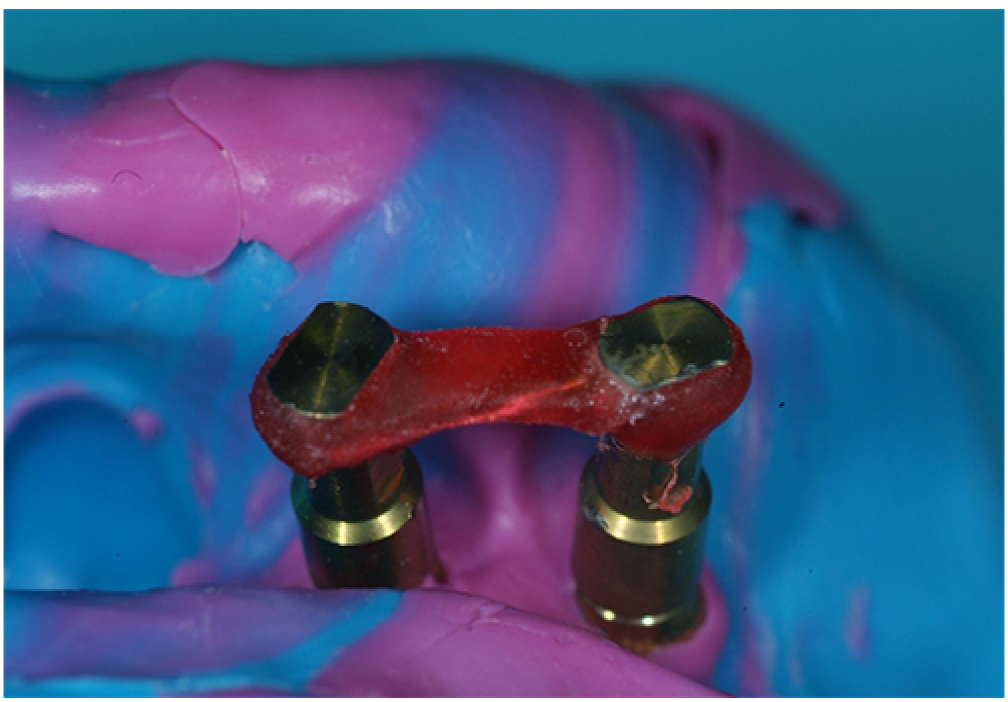
Associated laboratory procedures

Laboratory fabrication procedures are comprised of the following tasks:

1. Pouring a preliminary cast.
2. Constructing a custom tray.
3. Impression preparation—this is when the laboratory analogs are placed.
4. Constructing a final working cast (fabricating soft tissue).
5. Transferring jaw relation records to the articulator.

NOTE: The dentist performs many of these steps with support from the laboratory.
An accurate master cast is *critical* when fabricating implant restorations. The dentist will go to great lengths to ensure that the impression provides an accurate representation of the position and orientation of the newly placed implant. From this impression, you will produce an implant soft tissue master cast and working cast.

Making a Cast from an Implant Impression	
Step	**Action**
1	Insert the laboratory analogs into the copings in the impression (fig. 4–10). The analogs will be encased in the stone cast and will simulate the implant in the patient's mouth.  **Figure 4–10. Implant impression with analog.**
2	Apply a lubricant to the impression at the base of the analog and tissue area around the analog to prevent the soft tissue material from sticking to the analog and/or impression, and then add silicone soft tissue cast material to simulate gingival tissue (fig. 4–11). The soft tissue simulation will aid with contours of the final restoration.

	 **Figure 4–11. Silicone soft tissue cast material in impression**.
3	If two or more adjacent analogs are used, splint the analogs together with quick-curing resin (fig. 4–12). This helps stabilize the analogs.  **Figure 4–12. Splinted analogs.**
4	Bead, box, and pour the impression.

The implant abutment

The implant abutment for a single tooth must be designed to be antirotational. The implant abutment interface interlocks, preventing the abutment cylinder from rotating upon its implant.

The lab technician has a variety of abutment material options available to choose from. The one you use is determined by the prescribing provider and what is available in your clinic. Titanium, gold, polyether ether ketone (PEEK), surgical grade stainless steel, and zirconia are some of the most common materials you will find.

Titanium bases commonly referred to as the product name TiBase are used with computer-aided design (CAD) and computer-aided manufacturing (CAM) systems. Dental scanners and milling machines are used to digitally fabricate the implant supported restoration and or custom abutment. If this option is available to you at your clinic, you must use in accordance with manufacturer's instructions.

An implant custom abutment is used when a standard prefabricated abutment cannot be used. A custom abutment is a custom-made post attached to the superior part of the metal dental implant that protrudes through the gingival tissues and onto which the restoration is fitted. The procedures for fabricating an implant custom abutment are as follows:

Fabricating an Implant Custom Abutment	
Step	**Action**
1	Insert the coping assembly into the corresponding location in the impression, ensuring that the flat side of the coping aligns with the corresponding implant in the impression.
2	A soft tissue model material is recommended around the analog to simulate the actual soft tissue around the implant; this will aid with contours of the final restoration. Verify analogs are seated properly, and apply lubricant around the analogs where soft tissue needs to be added to prevent the soft tissue material from sticking to the analogs.
3	Pour the standard crown & bridge impression in low expansion stone. A reinforced die may be helpful if the preparation is extremely thin. Articulate and prepare according to standard laboratory procedures.
4	Fabricate a working cast. Articulate, according to DD Form 2322, Dental Laboratory Work Authorization, instructions/laboratory procedures.
5	Seat the custom cast abutment (hexed) onto the implant analog in the working cast.
6	Hand-tighten the guidescrew to the analog.
7	Customize the plastic sleeve of the abutment with a cutting disk or bur for correct vertical and interproximal clearances.
8	Use wax to incorporate the modified custom abutment into the pattern. Final contours of the pattern may be built up with crown and bridge wax. Wax to full contour then cut back as needed for materials used.
9	Sprue according to standard laboratory procedures. Apply a thin layer of wax at the junction of the abutment and the plastic sleeve to ensure a smooth casting.
10	Invest and cast the coping pattern in noble or high-noble alloy, according to manufacturer's instructions. Divest, fit, and finish the casting, following standard laboratory procedures.
11	Redefine the screw access channel within the casting with a reamer as needed. **CAUTION: Do not sandblast the implant!** Doing so will cause a poor fit between the abutment and implant.
12	Confirm the fit of the coping to the implant on the working model. Return the coping and the abutment screw to the clinician for patient try-in.
13	Prepare the custom coping to receive the opaque layer, according to routine laboratory procedures. Apply veneer material and finish, according to manufacturer's specification. Polish any metal margins and return to dentist for insertion.

417. Fabricating implant prostheses

Patients who had distal edentulous extensions use to be restricted to removable prostheses. Dental implants are becoming more popular and many patients are enjoying fixed rather than removable prostheses. In this lesson, we look at information about the fabrication of single and multiple unit implant prostheses.

Traditional methods of replacing a single tooth required a three-unit fixed dental prosthesis, a removable dental prosthesis, or a resin-retained FDP are being replaced with implant technology. The advent of the single tooth implant prosthesis provides a good alternative to the traditional methods of single tooth replacement.

Screw-retained implant crown

A screw-retained implant crown is held in place with a screw that passes through an access channel in the occlusal portion of the crown shown in figure 4–13. The main advantage of a screw-retained crown is its retrievability. It is always nice to have the option to easily remove an implant crown or re-tighten the screw whenever it is needed without any damage to the restoration. When waxing the implant, closely adapt the wax to the abutment margins. It is very important for tissue health that the contours of the crown transition smoothly from the abutment margins to the height of contour with absolutely no concavities in the emergence profile.

With all implant crowns, ensure light occlusal contact, generally 2 shim stocks out of occlusion. Implants, unlike natural teeth, do not absorb shock, and heavy contacts can cause damage to the surrounding bone and loss of the implant. Ensure that no wax is placed within 0.5 mm of the machined mating surface, as it will prevent proper seating of the implant crown. To properly sprue, a reservoir of at least 1½ times the weight of the restoration (including the weight of the machined metal part) must be used to prevent porosity. When casting, if using the broken-arm casting machine, reduce the number of turns on the casting machine by one turn. An example would be turning the casting arm three times for a crown to be cast in Olympia metal. For a prefabricated abutment, you would only turn the casting arm two times.

When investing, it is imperative to slowly fill the screw access channel under low vibration to prevent voids and entrapping air bubbles. Nodules formed in the hex or screw seat are very difficult to remove and could cause a costly remake. Use only precious alloys to cast to prefabricated abutments. Never use nonprecious alloys to cast custom abutments because the melting temperatures of the alloy is higher and will melt and damage the abutment.

Figure 4–13. Screw-retained implant crown.

Procedures for waxing a screw-retained implant crown follow:

Procedures for Waxing a Screw-Retained Implant Crown	
Step	**Action**
1	Ensure the abutment fits on the implant analog correctly.
2	Check to be sure there is enough space to fabricate the implant crown as requested, especially at the marginal, facial, and incisal/occlusal areas.
3	Shorten the plastic sleeve to allow room for proper occlusal design.
4	Shape the plastic sleeve by either grinding on it with a bur or cutting it with a sharp instrument.
5	Apply wax to the abutment. Use super-heated inlay wax or a thin layer of sticky wax to help adapt it to the plastic sleeve, down to the occlusal edge of the machined metal pattern.
6	Wax the crown to full contour, leaving the screw access channel open—**DO NOT FILL IN WITH WAX**.
7	Remove the implant crown from the cast to complete waxing procedure.
8	Attach a polishing cap, a separate implant fixture analog, or the lab holder instrument used with 3.5 mm screws to help hold the implant crown as you work and to prevent wax from getting onto the mating surface.
9	Shape emergence profile without any concavities to accommodate proper contours of the completed restoration.
10	Keep occlusal contacts light; at least two shim stock thicknesses should drag, unless the provider specifies differently.
11	For metal-ceramic restorations, wax to full contour and then cut back for proper thickness and support of the porcelain. A minimum of 0.5 mm of metal must remain around the access channel.
12	Refine the wax margins under magnification, ensuring wax perfectly seals the wax-to-metal junction on the pattern. Keep the wax at least 0.5 mm away from the mating surface of the abutment. Ensure no wax covers the mating surface.
13	For full porcelain coverage, it is best to wax a small handle on the lingual side of the margin to aid in handling the implant during build-up process.
14	Create a sprue reservoir 1½ times the weight of the implant crown (including the weight of the machined metal portion to prevent porosity). It may be necessary to run auxiliary sprues and chill vents.

The following table shows the procedures for investing and finishing a screw-retained implant crown:

Investing and Finishing a Screw-Retained Implant Crown	
Step	**Action**
1	When investing with a low viscosity investment, position the pattern in the casting ring with the mating surface of the pattern angled upward (vertical, not horizontal).
2	Ensure the investment fills the screw access channel from the occlusal aspect and slowly flows out of the pattern.
3	When using thicker, higher viscosity investment, such as beauty cast, sprue the custom abutments at a 45° angle on the thickest part of the crown.
4	Apply extremely small amounts of investment to the screw access channel under low vibration, while watching the investment flow all the way through, and fill in the machined- hex and mating surface.
5	Allow the investment to bench set. Burnout, cast, and divest casting in the normal manner. Never use nonprecious alloys to cast to a prefabricated custom abutment since the melting temperature of the alloy is higher and will melt and damage the abutment.
6	***Do not*** air abrade the mating surface with aluminous oxide.
7	Use extreme care when divesting the cast abutment to prevent structural damage.
8	Desprue, seat, and finish the implant crown using a polishing cap to protect the machined mating surface.
9	Check fit on cast.
10	During finishing of the restoration, keep a polishing cap securely screwed on to protect the machined mating surface.

11	When applying porcelain to the restoration, remove the polishing cap.
12	Ensure porcelain is cleaned from the mating surface and screw access channel prior to firing.
13	Use the polishing cap whenever grinding or polishing.

Computer-aided design and computer-aided manufacturing

Given the complex nature of implant-supported restorations and a greater demand for such restorations, necessities arose to research and develop alternative fabricating methods. One alternative, involves the use of CAD or CAM.

Technicians now have the ability to scan a traditional implant cast and attach positional devices to accurately duplicate the orientation and placement of dental implants. After the scanning machine transfers the placement of the implant to a digital format, along with pertinent anatomical landmarks and opposing dentition, CAD software is used to design the custom abutment or framework. Most CAD or CAM fabricated implant custom abutments and frameworks are made from a multitude of materials. The most commonly used materials are zirconium oxide (Zro2), lithium disilicate (LiS2). The final restoration, which can often be an all-ceramic crown or bridge, and custom abutment are designed at the same time.

CAD provides the technician with superior fabricating versatility by allowing alterations to both the custom abutment and final restoration prior to the milling stage (fig. 4–14).

Figure 4–14. CAD or CAM image.

After both the custom abutment and implant supported restoration have been designed to ideal contours, CAM is used to fabricate the restorations. CAM is where the restoration is actually milled. Once the restoration is milled only minor alterations should be made if the restoration was designed properly using the CAD software. The next stage can involve sintering for Zro2 or crystalizing for LiS2; these processes are used to give zirconium oxide its ideal size and strength and lithium disilicate its full strength and shade. **NOTE:** During the sintering stage, zirconium oxide will shrink on average 25 percent and change from white to the desired shade. For lithium disilicate during the crystallization stage, it will change from its purple color to the desired shade. The final stages of fabrication are synonymous with producing the appropriate restoration type.

Self-Test Questions

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

416. Laboratory procedures

1. What purpose do the analogs in the master cast serve?

2. The implant abutment for a single tooth the must be designed to be?

3. Which implant abutment is fabricated using digital scanners and milling machines?

4. Why should you *not* sandblast an implant?

417. Fabricating implant prostheses

1. What kind of implant crown is retained or held in place with a screw that passes through an access channel in the occlusal portion of the crown?

2. Given the complex nature of implant supported restorations, what method for fabricating these restorations is an alternative from the traditional methods?

Answers to Self-Test Questions

414

1. (1) subperiosteal (2) transosteal (3) endosteal.
2. Repeated horizontal (lateral) forces.
3. Fixture, abutment, and supported restoration (artificial tooth).
4. The fixture.
5. Prefabricated and custom.

415

1. Remaining bone in either maxilla or mandible, how many abutments can be placed in remaining bone, opposing occlusal surfaces, type of occlusal scheme, and diseases that may adversely affect osseointegration.
2. Titanium implants are surgically inserted into the alveolar bone as a foundation for the prosthesis.
3. To provide an accurate reference and orientation of the dental implants between the cast and the patient's implants.
4. The sleeve.

416

1. To simulate the implant in the patient.
2. Antirotational.
3. Titanium bases commonly referred to as TiBase.
4. It will cause a poor fit between the abutment and the implant.

417

1. Screw-retained implant crown.
2. CAD or CAM.

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 AFCDA.

42. (414) Which type of repeated forces associated with osseointegrated implants can cause bone resorption?
    a. Parallel.
    b. Vertical.
    c. Horizontal.
    d. Perpendicular.

43. (414) Which type of abutment is used to address specific angulation or esthetic requirements?
    a. Osseointegrated.
    b. Prefabricated.
    c. Component.
    d. Custom.

44. (415) What implant component helps provide an accurate fixture-to-abutment orientation?
    a. Retaining screw.
    b. Impression coping.
    c. Abutment cylinder.
    d. Impression guide pin.

45. (415) Laboratory analogs are constructed of metal and are machined to represent the
    a. coping.
    b. implant.
    c. clinical analog.
    d. abutment cylinder.

46. (416) The impression for a dental implant case will include impression copings, and the impression coping
    a. receives the implant fixture.
    b. simulates the implant fixture.
    c. receives the laboratory analog.
    d. simulates the laboratory analog.

47. (416) What implant abutment is used when a prefabricated abutment *cannot* be used?
    a. Custom.
    b. Standard.
    c. Customary.
    d. Traditional.

48. (416) When fabricating a custom abutment, what form must you follow for laboratory instructions?
    a. Department of Defense (DD) Form 2321, Reservation and Packing Data.
    b. DD Form 2322, Dental Laboratory Work Authorization.
    c. Air Force (AF) Form 2321, Preservation Worksheet Summary.
    d. AF Form 2322, Workload Tracking Data.

49. (417) What implant crown is held in place with a screw that passes through an access channel in the occlusal portion of the crown?
    a. Screw-retained implant crown.
    b. Cement retained implant crown.
    c. Double screw-retained implant crown.
    d. Double cement retained implant crown.

50. (417) When waxing a screw-retained implant crown, what must you do to the screw access channel?
    a. Fill channel with wax.
    b. Leave channel open.
    c. Insert putty into the channel.
    d. Place channel under a flame.

51. (417) What must be used to protect the machined mating surfaces whenever you desprue, seat, and finish a screw-retained implant crown?
    a. Polishing cap.
    b. Finishing cap.
    c. Polishing sleeve.
    d. Finishing sleeve.

52. (417) What system provides the technician with superior fabricating versatility by allowing alterations to the restorations prior to the milling stage?
    a. Computer-aided manufacturing(CAM).
    b. Manufacturing aided computer (MAC).
    c. Computer-aided design (CAD).
    d. Design-aided computer (DAC).

53. (417) What system is used to mill the restorations?
    a. Computer-aided manufacturing (CAM).
    b. Manufacturing aided computer (MAC).
    c. Computer-aided design (CAD).
    d. Design-aided computer (DAC).

Glossary

Terms

Adjacent—Immediately preceding or following

Alginate—Impression material; irreversible hydrocolloid

Analog—Something similar to something else; a replacement or substitute. Laboratory analogs simulate an implant.

Arbitrary mounting method—Uses average patient dimensions when mounting a cast

Arcon articulator—Condyles are located on the articulator's lower member.

Bruxism—Involuntary grinding and clenching of teeth

Cold–cure—Refers to any self-curing acrylic resin

Contour—Outline of a curved or irregular figure

Cyanoacrylate—Quick-setting adhesive

Dentulous—Having teeth

Diastemas—spaces between teeth

Disclude—Separation of the maxillary and mandibular teeth

Distal—Surface facing away from the median sagittal plane

Edentulous—Toothless

Embrasure—Space created by the curved proximal surfaces of teeth

Endosteal—Occurring or located within a bone

Facebow—Measures the maxilla's relationship to the temporomandibular joint

Foramen—Opening in bone

Frenum—A mucosal fold attaching the cheeks to the maxillary and mandibular mucosa

Gingiva—Mucosa immediately surrounding the teeth

Guard—Structure used to protect orthodontic springs

Humidor—Container used to maintain a humid atmosphere

Hydrocolloid—Agar base impression material; can be reversible or irreversible

Incisive papilla—Soft tissue covering the incisive foramen

Interproximal—Between the proximal surfaces of teeth

Malocclusion—Defective occlusion

Malposition—Incorrect positioning of teeth

Median raphe—Ridge of soft tissue covering the median suture

Mesial—Surface facing the median sagittal plane

Mucosa—Soft tissue lining of the oral cavity

Periodontium—Tooth supporting tissue

Plaster–pumice—A mix of plaster and pumice used in making master casts

Retromolar pad—Soft tissue mass at most distal part of the mandibular residual ridge

Rugae—Irregular ridges of mucosa in the anterior part of the palate

Soft palate—Soft tissues posterior to the hard palate

Sleep apnea device—A sleep apnea device allows air to freely pass into the lungs, thereby reducing the chances of breathing interruptions

Splint—A rigid or flexible appliance used for the fixation of movable parts

Stent—An acrylic or plastic mold for keeping a graft in place. It may be sprinkled or vacuum formed

Sulcus—Groove in the oral cavity

Temper—The degree of hardness or resiliency

Template—A pattern or mold used as a guide

Tuberosity—Bony elevation

Zinc oxide and eugenol—Impression paste

Glossary of Abbreviations and Acronyms

º	degree
CAD	computer-aided design
CAM	computer-aided manufacturing
cm	centimeter
DDS	Doctor of Dental Surgery
FB	fallback
FDP	fixed dental prosthesis
H	horizontal
Hyrax	hygienic rapid palatal expander
IAW	in accordance with
L	lateral
LiS2	lithium disilicate
MI	maximum intercuspation
min	minute
mm	millimeter
MSD	Master of Science in Dentistry
NCOIC	noncommissioned officer in charge
PEEK	polyether ether ketone
psi	pounds per square inch
RDP	removable dental prosthesis
RPE	rapid palatal expander
SDS	sulfate dihydrate solution
TiBase	titanium base
TMJ	temporomandibular joint
VDO	vertical dimension of occlusion
Zro2	zirconium oxide

Student Notes

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