Chapter 8--Fixed Prosthodontics

Overview

Introduction

Many excellent crown and bridge tests and courses are available, with some of them expressing seemingly contradictory opinions and approaches. This chapter of the manual is not intended to compete with any of them, but rather help you in applying concepts that you have acquired from them. The procedures described in this chapter are the result of the evolution of adopting techniques that most general practitioners can learn quickly.

New materials can make significant changes in the way dentistry is practiced. Recent advances in adhesive resin technology have had, and will continue to have, a profound effect on fixed prosthodontics. Their effect will be a recurring theme throughout this chapter.

This chapter will cover the following topics:

<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Principles of Fixed Prosthodontics</td>
<td>8-1</td>
</tr>
<tr>
<td></td>
<td>Patient Selection</td>
<td>8-5</td>
</tr>
<tr>
<td></td>
<td>Fixed Prosthodontics vs. Operative</td>
<td>8-6</td>
</tr>
<tr>
<td></td>
<td>Fixed Prosthodontics vs. Removable Partial Dentures</td>
<td>8-9</td>
</tr>
<tr>
<td></td>
<td>Ante's Rule of Abutment</td>
<td>8-11</td>
</tr>
<tr>
<td></td>
<td>Problem Areas in Fixed Prosthodontics</td>
<td>8-12</td>
</tr>
<tr>
<td>B</td>
<td>Impression Technique</td>
<td>8-15</td>
</tr>
<tr>
<td></td>
<td>Packing the Retraction Cord</td>
<td>8-15</td>
</tr>
<tr>
<td></td>
<td>Removing the Packing Cord</td>
<td>8-16</td>
</tr>
<tr>
<td></td>
<td>Injecting Impression Material</td>
<td>8-18</td>
</tr>
<tr>
<td>C</td>
<td>Standardized Tooth Preparation Sequence</td>
<td>8-23</td>
</tr>
<tr>
<td></td>
<td>Determining Indicated Amount of Tooth Reduction</td>
<td>8-23</td>
</tr>
<tr>
<td></td>
<td>Depth Guides</td>
<td>8-27</td>
</tr>
<tr>
<td></td>
<td>Working in a Prescribed Logical Sequence</td>
<td>8-32</td>
</tr>
<tr>
<td></td>
<td>Opening the Interproximal Spaces</td>
<td>8-34</td>
</tr>
<tr>
<td></td>
<td>Establishing Midtooth Depth Cuts</td>
<td>8-36</td>
</tr>
<tr>
<td></td>
<td>Reducing Occlusal/Incisal Surface</td>
<td>8-38</td>
</tr>
<tr>
<td></td>
<td>Reducing the Lingual Surface (Anterior and Posterior Teeth)</td>
<td>8-42</td>
</tr>
<tr>
<td></td>
<td>Reducing the Labial/Buccal Surface</td>
<td>8-46</td>
</tr>
<tr>
<td></td>
<td>Checking the Line of Draw/Path of Insertion</td>
<td>8-49</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>Establishing the Final Gingival Margin Configuration and Depth</td>
<td>8-51</td>
<td></td>
</tr>
<tr>
<td>Smoothing the Proximal Surfaces of Adjacent Teeth</td>
<td>8-52</td>
<td></td>
</tr>
<tr>
<td>Smoothing Line and Point Angles of Preparation</td>
<td>8-54</td>
<td></td>
</tr>
<tr>
<td>D Finish Line Configuration</td>
<td>8-56</td>
<td></td>
</tr>
<tr>
<td>Margin Configurations</td>
<td>8-56</td>
<td></td>
</tr>
<tr>
<td>Suggested Margin Configurations</td>
<td>8-62</td>
<td></td>
</tr>
<tr>
<td>Margin Discrepancies</td>
<td>8-64</td>
<td></td>
</tr>
<tr>
<td>E Variations in Tooth Preparation Sequence</td>
<td>8-68</td>
<td></td>
</tr>
<tr>
<td>Using Full Metal Crowns</td>
<td>8-68</td>
<td></td>
</tr>
<tr>
<td>Using the Porcelain Jacket Crown and Bonded Porcelain Jacket Crown</td>
<td>8-70</td>
<td></td>
</tr>
<tr>
<td>Using Porcelain Veneer</td>
<td>8-72</td>
<td></td>
</tr>
<tr>
<td>F Resin Bonded Fixed Partial Dentures</td>
<td>8-78</td>
<td></td>
</tr>
<tr>
<td>Historical Development</td>
<td>8-78</td>
<td></td>
</tr>
<tr>
<td>Indications/Contraindications for Maryland Bridges</td>
<td>8-79</td>
<td></td>
</tr>
<tr>
<td>Anterior Maryland Bridges</td>
<td>8-81</td>
<td></td>
</tr>
<tr>
<td>Posterior Resin Bonded Fixed partial Dentures</td>
<td>8-83</td>
<td></td>
</tr>
<tr>
<td>Cementation</td>
<td>8-85</td>
<td></td>
</tr>
<tr>
<td>G Dowel Cores</td>
<td>8-87</td>
<td></td>
</tr>
<tr>
<td>Patient Selection</td>
<td>8-87</td>
<td></td>
</tr>
<tr>
<td>Custom Dowel Core versus Prefabricated</td>
<td>8-88</td>
<td></td>
</tr>
<tr>
<td>Preparation of a Dowel Space</td>
<td>8-89</td>
<td></td>
</tr>
<tr>
<td>Prefabricated Patterns and Post</td>
<td>8-90</td>
<td></td>
</tr>
<tr>
<td>Cementation of the Custom Dowel</td>
<td>8-90</td>
<td></td>
</tr>
<tr>
<td>H All Ceramic Restorations</td>
<td>8-91</td>
<td></td>
</tr>
<tr>
<td>Dicor</td>
<td>8-92</td>
<td></td>
</tr>
<tr>
<td>Procera</td>
<td>8-92</td>
<td></td>
</tr>
<tr>
<td>IPS Empress I</td>
<td>8-92</td>
<td></td>
</tr>
<tr>
<td>IPS Empress II</td>
<td>8-93</td>
<td></td>
</tr>
<tr>
<td>In-Ceram</td>
<td>8-93</td>
<td></td>
</tr>
<tr>
<td>General Preparation for All Ceramic Crowns</td>
<td>8-94</td>
<td></td>
</tr>
<tr>
<td>I Implants</td>
<td>8-97</td>
<td></td>
</tr>
<tr>
<td>General Policy</td>
<td>8-97</td>
<td></td>
</tr>
<tr>
<td>Basic types of Endosseous Implants</td>
<td>8-97</td>
<td></td>
</tr>
<tr>
<td>Endosseous Implant Identification</td>
<td>8-99</td>
<td></td>
</tr>
<tr>
<td>Contacting the surgeon</td>
<td>8-99</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>8-100</td>
<td></td>
</tr>
</tbody>
</table>

**Variables in Prosthodontics**
There are three variables in restorative dentistry:

- operator variables
- material variables
- patient variables

Without denying the importance of material and patient variables, the operator and the skill that must be applied in selecting and treating prosthodontic patients is by far the most important. The best materials available today can be misused and fail. No one can successfully place a prosthodontic restoration without the patient's cooperation in maintaining it.

**Responsibilities**

An attitude of being a continuous student and making a commitment to excellence will go a long way in making your restorative dentistry rewarding. There is a very strong correlation between one's interest and skill in operative dentistry and in fixed prosthodontics. One is an extension of the other.

Every dentist capable of preparing and placing sound composite and amalgam restorations is capable of preparing and placing sound fixed prosthodontic restorations. Not every IHS clinician can or should be providing a significant amount of prosthodontics treatment. The clinician should be able to practice enough prosthodontics to maintain and improve all skills to a desired level.

Attention to detail seems to be one of the main ingredients in achieving long-lasting restorations. This does not equate to spending a long time to accomplish a procedure. It does equate to spending time up front to master the mechanics of the procedure. To do this you should--

- participate in hands-on courses
- practice
- Read

**Section A--Principles of Fixed Prosthodontics**

**Overview**
Introduction

This section discusses some of the basic principles of fixed prosthodontics to help you in the decision-making process. Most of this information will serve as a review to you. Although new technology and materials have impacted on the choices available to you, the guidelines presented in this section should hold true with or without these new materials. However, some interesting variations are occurring already as the fact and fiction of these materials are sorted out.

Patient Selection

Introduction

Given that the need for treatment grossly exceeds the ability to provide it, the decision on who should receive treatment must be made. On a clinical level, it seems appropriate to direct our efforts toward including as many people as possible and getting the maximum service life out of the treatment we do provide.

General Guidelines

The following general guidelines will assist you in your case selection decision making:

• The prognosis for a restoration is better for a patient that already demonstrates good oral hygiene.

• Well-aligned teeth and well-designed restorations require less effort to achieve good oral hygiene.

• The simpler the restorative needs of the patient the better the prognosis.

• Other considerations being equal, the long range usefulness of a prosthesis decreases as the patient's age increases.

• In general, prosthodontics should not be started prior to the completion of other needed preventive and corrective services.

• The potential effect of dental aesthetics on a person's self-esteem deserves recognition. It is fully appropriate that aesthetics receive due deliberation with function in treatment planning.

Note: It would not be entirely facetious to say that you could limit your IHS crown and bridge
treatment to single crowns and three-unit bridges for young patients with good oral hygiene and who are missing one front tooth.

**Fixed Prosthodontics vs. Operative**

**Introduction**

There are many factors that you must weigh when deciding between fixed prosthodontics and operative procedures. You must weigh each carefully, considering the functional and aesthetic impacts of each.

**Decision-Making Considerations**

The following considerations will assist you in deciding between fixed prosthodontics and operative procedures:

- Apply as many sound operative procedures as are practical prior to committing to crown treatment for a tooth. Well-placed amalgam and composite restorations can provide excellent service life and in many cases outlast a crown.

- Consider not crowning a complex amalgam just because of its size, especially if it has some history of successful function and adequate deep subgingival margins. Achieving good crown margins on sound tooth structure apical to a deep proximal box is not easily accomplished, nor are crown lengthening procedures if there are approximating teeth.

  The service life of amalgam restorations with adequate subgingival margins can be extended greatly by dressing down the accessible margins, recontouring as appropriate, and polishing the margins with an abrasive rubber cup.

  If marginal breakdown is more severe than polishing will correct, localized repair of the margin is feasible with sealant, amalgam, or composite.

  In vital teeth with existing complex amalgam restorations, an isolated natural tooth cusp in danger of fracture--

  - can be reduced and polished
  - probably will not fracture
  - probably will still be restorable with a crown if it does fracture
- probably will result in a nonrestorable fracture right after you tell the patient not to worry

• Consider a cusp-protecting amalgam in preference to a crown. There are far more teeth that would benefit from cusp protection than we can provide with crowns. The literature supports their longevity and most clinicians have more experience with amalgam than they do with crowns. This suggestion is very important to consider on endodontically treated teeth. If a crown is done even years later, these restorations provide an excellent buildup for the crown preparation.

The amount of cusp reduction required to achieve sufficient bulk/strength in amalgam is significant. If you are not familiar with the requirements of a cusp-protecting amalgam, you should seek advice from clinicians who use them.

• Bonded amalgams are one of the areas that will be receiving significant attention in dental literature. While these bonding agents are not going to negate sound principles of operative dentistry, they may be of great benefit in the complex and cusp-protecting amalgam situations. The author suggests that all amalgams be bonded.

• Where aesthetics will allow, indirect metal restorations will last longer than tooth-colored restorations. Additionally, you should be aware that--

  - Two composites, notably Herculite and Heliomolar, have established long-term records for resistance to wear. There is no reason to believe that other composites are not capable of achieving similar resistance-to-wear records.

  - The major concerns relative to current composites involve their high coefficient of thermal expansion and contraction, questionable bond to dentin, and polymerization shrinkage. All of these concerns are being addressed at this time. In aesthetics situations, where crown and bridge are difficult to provide and where all of the restoration margins can be placed on well-isolated tooth structure, nonstandard composite restorations can provide a very adequate service life.

  **Caution:** It is easy for many of these restorations to become more difficult and time consuming than placing a crown.

• Partial coverage restorations (e.g., onlays, 3/4, and fractional crowns) are initially more conservative of tooth structure. They are technically more difficult to perform and are frequently associated with a high rate of failure. Full-coverage crowns constitute the majority of crowns provided by the IHS. Given the IHS's emphasis on exhausting operative procedures prior to committing to a crown, full-coverage crowns seem justified.
• In contrast, the remarkable retention and resistance to dissolution provided by resin cements bonded to etched enamel are bringing about the increased use of very conservative preparations to bond partial coverage indirect restorations to the tooth.

This includes such restorations as--

- tooth-colored veneers and onlays
- bonded porcelain jacket crowns
- sandblasted or etched base metal inlays, onlays, fractional crowns, and bridge retainers

The use of such restorations in the IHS is complicated by the necessary inclusion of a laboratory service and the associated fees.

Also, the need to preserve sufficient enamel with which to bond requires an early commitment to prosthodontics rather than extensive operative procedures.

• The classic G.V. Black Class II preparation should be put aside, since hydrophilic sealants, preventive resin restorations, bonded amalgams, composites, aesthetic and metal inlays, and retainers do work. We need to accept and use them. The resin-bonded bridge retainer (Maryland Bridge) is one of these restorations that can be of great value in the IHS.

• The final consideration prior to committing to a crown involves how complicated it will be to provide the crown and how important it is to keep the tooth.

- The decision to extract rather than crown the tooth is simple if you can provide a Maryland Bridge and keeping the tooth might involve--
  o endodontics
  o post and core treatment
  o crown lengthening
- Considerable effort to keep the tooth is justified if the tooth is--
  o a cuspid
○ only remaining distal abutment in a mandibular arch

**Fixed Prosthodontics vs. Removable Partial Dentures**

**Introduction**

There are also many factors that you must weigh when deciding between fixed prosthodontics and operative procedures. You must weigh each carefully, considering the functional and aesthetic impacts of each.

**Decision-Making Considerations**

The following considerations will assist you in deciding between fixed prosthodontics and removable partial dentures:

- When a fixed bridge is possible, it usually becomes the restoration of choice.

- The most easily agreed upon indications for removable partial dentures involve--
  - long-span situations where support for a bridge is questionable
  - cases where the restoration must replace both missing teeth and substantial amounts of alveolar tissue

- Removable partial dentures that replace only one or two teeth are generally not desirable appliances. Unilateral partial dentures (Nesbitt Bridges) have significant risk associated with possible aspiration or swallowing of the appliance. Their use is generally discouraged.

- Considerable disagreement over fixed versus removable can be generated in cases involving multiple areas of missing teeth. It has been estimated that there are over 65,000 possible combinations of teeth and edentulous spaces in a single arch.
  - Prior to evaluating fixed versus removable, consider if any restoration is indicated at all.
  - Second bicuspid occlusion, while far from ideal, has support in literature as being acceptable.
- Removable appliances that do not replace aesthetically important teeth, or make a significant improvement in the patient's ability to masticate, usually end up in a drawer rather than in the mouth.

- If the posterior occlusion is such that the remaining teeth already are, or likely will be stable, the patient may be better served without restoration of the posterior edentulous space.

- Many patients will accept a compromised posterior occlusion if their anterior aesthetic needs can be met. Be aware that frequently the posterior occlusion must be corrected in order to properly fabricate anterior restorations.

- As a matter of practicality, we favor partials to treat arches with multiple edentulous areas. However, to the extent that modification spaces can be eliminated and the partial designed to treat the spaces not amenable to fixed restoration, the better the partial will function.

- The use of the Maryland Bridge concept to fully restore many of these cases with fixed prosthodontics in two to three appointments is one of the most dramatic demonstrations of their potential.

- The mandibular alveolar ridge can be expected to incur significant loss of bone when removable prostheses oppose maxillary natural dentition. Maxillary ridges can be expected to do better than the mandibular ridge in supporting removable prostheses opposing natural dentition, but it is important to design the partial for maximum palatal support. Cantilevered Maryland-style bridges have been used very successfully to aid in solving some of these situations (especially in the mandibular arch).

- Level and improve the plane of occlusion as often as you can. This applies to both fixed and removable prosthodontics.

Note: Too often prostheses are fabricated to accommodate an existing occlusal problem, i.e., an opposing supraerupted tooth. For fixed restorations in particular, this can result in a worse situation than if no prosthodontics had been provided.

Even with well-aligned arches, the occlusion and performance of a prosthesis generally will be improved by recontouring and polishing opposing restorations and teeth before the prosthesis is fabricated.
Ante's Rule of Abutment

Introduction

Most clinicians are familiar with Ante's Rule of Abutment. It is a useful guide in determining--

- the number of abutments to use
- fixed versus removable

It is only a generalization, and it is not the only factor to consider.

Ante's Rule

Ante's Rule states: The combined pericemental area of the abutment teeth should be equal to or greater than the pericemental area of the teeth being replaced.

Implications

Because of the length of the lever arm and the direction of forces, maxillary bridges replacing teeth 7, 8, 9, and 10 should frequently utilize four abutments (canines and first bicuspids). Mandibular bridges replacing teeth 23, 24, 25, and 26 will usually do well with bilateral single canine abutments.

When utilizing multiple abutments, it is critical that the gingival embrasure area be kept open and properly contoured. When this is done, teeth anterior to the molars (bicuspids, canines, and incisors) seem to perform well and tolerate the condition without bone loss. Molars do not do well in multiple abutment situations, and they are frequently associated with periodontal bone loss from double abutting. An exception to double abutting with molars is the postperiodontal surgery patient with wide open gingival embrasures who is maintaining good oral hygiene.

Problem Areas in Fixed Prosthodontics

Introduction

Dental laboratories are in a unique position to identify trends common to clinicians. It is clear from their perspective that clinicians share two major problems that seriously impede the fabrication of sound restorations:

- poor impressions of the gingival margins (primarily due to the lack of hemorrhage control)
• inadequate reduction of tooth structure

Other problems exist, but these are the most frequent and important to address. Each of these problems is discussed on this and the following pages.

Problem Area 1: Poor Impressions and Hemorrhage

Poor impressions of the preparation margin are probably the main source of recurrent decay and failure of fixed prosthodontic restorations. Fortunately, they are also one of the easiest problems to solve.

Lack of hemorrhage control is the primary difficulty.

Solutions for Problem Area 1:

The following solutions are provided for these related problems:

• **Poor impressions.** To obtain high-quality, bubble-free impressions, try the technique described in this chapter. (See Injecting Impression Material)

• **Hemorrhage.** Use any packing technique that you prefer as long as hemostasis is properly attained prior to final packing. (See Packing the Retraction Cord) The easiest solution to hemorrhage control is virtually product specific.

Contact: Ultradent Products, Inc.
505 West 10200 South
South Jordon, UT 84065
(800) 552-5512
(801) 572-4200

Their "Tissue Management Infusion Technique" is highly effective and easily mastered. The technique is clearly presented in their catalog and videotape. The tape is especially useful and recommended.

Supplies can be purchased as kits or separately. The essential items are--

- Astringedent solution (ferric sulfate solution)

- dento-infusor tips (especially the metal tip--UP#0122)
- Ultrapak knitted retraction cord [purchase kit first (UP#1030) then buy individual refills]

- plastic Leur-Lock syringe (UP#0124)

- Brasseler cord packing instrument (250N113-SR) (Ultradent's is also good.)

**Caution:** Astringedent is sometimes listed as one of the many possible contaminants to cause a surface nonset of polyvinyl siloxane impression materials. It is actually blood products combined with almost any of the hemostatic agents that can cause the surface nonset. Surface nonset can be prevented by thoroughly washing the prepared tooth and sulcus till free of coagulum. This is easily done. Also since Astringedent is acidic, there is minor concern that it may inadvertently etch the tooth, opening the dentinal tubules and increase the pulpal trauma/ sensitivity.

**Problem Area 2: Inadequate Tooth Reduction**

No matter what kind of prosthodontic preparation is being cut, conservative clinicians almost universally under prepare the tooth. This is usually done with the best intention—desiring to preserve tooth structure and avoid pulpal exposures. In almost every instance, under preparation works to the detriment of the restoration and the tooth. The norm for underprepared teeth is unaesthetic, easily broken, and overcontoured restorations with poor gingival response which result in a loss of periodontal support.

Conservation of tooth structure is well ingrained in most dentists as they leave dental school. Prosthodontics by nature is not conservative. Conservative treatment has already failed by the time a tooth requires a crown. If a crown is indicated, the tooth should be fully reduced consistent with the restoration being provided.

**Solutions for Problem Area 2:**

The following steps to adequate tooth reduction are recommended:

- Determine the amount of tooth reduction required for the intended restoration.
- Use some form of depth guide to ensure sufficient reduction.
- Work in a prescribed logical sequence.

Each of these steps is described in detail in Procedures for Reducing Teeth.
Section B--Impression Technique

Overview

This section details the impression technique that residents and Continuing Dental Education (CDE) participants have found the easiest to use.

It is highly suggested that you master this technique prior to employing variations. This addresses Problem Area 1--Poor Impressions and Hemorrhage. It is probably the most important area to resolve first.

Packing the Retraction Cord

Introduction

Proper packing is obtainable using any of the following techniques that you prefer:

• prepreparation packing
• postpreparation packing
• one-cord packing
• two-cord packing
• aluminum chloride on one cord and Astringedent on the other

As long as hemostasis is properly attained prior to final packing, any of the techniques will work.

Procedures for Packing the Retraction Cord

The following clinical technique has been well accepted consistently by residents and CDE participants:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1    | Remove all prepacked cords prior to using the infuser tip.  

**Note:** Use water, Visine, or aluminum chloride to dampen prepacking cords. Astringedent (ferric sulfate) offers no advantage at this point. |
<p>| 2    | Select the diameter of cord that you estimate will fill the smallest most delicate area of the sulcus, i.e., the labial or buccal aspect of anterior preparations (usually Ultradent size #1) |
| 3    | Use one long (approximately 2 inches) cord for each preparation. |
| 4    | Place the cord in a dappen dish/medicine cup containing Astringedent solution. |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Allow cord to soak</td>
</tr>
</tbody>
</table>
| 6 | Use the infuser tip as directed.  
   **Note:** Angle the tip toward the gingiva (not the tooth) and gently rub the sulcus while slowly expressing Astringedent solution. |
| 7 | When bleeding stops, wash all coagulum off the tooth and out of the sulcus. |
| 8 | Continue to use the syringe and Astringedent until the sulcus can be vigorously washed with the three-way syringe without bleeding.  
   **Caution:** Do not pack retraction cord prior to obtaining this degree of hemorrhage control. If necessary, localized areas of persistent bleeding can be infiltrated with anesthetic containing epinephrine. |
| 9 | Begin packing where the sulcular tissue is least likely to be damaged, i.e., palatal aspect of maxillary preparations or deepest part of sulcus. |
| 10 | Start packing at the end of the cord (not in the middle of the cord). |
| 11 | Pack the soaked cord once around the tooth in a deliberate manner so that all (not just portions) of the sulcus receives and is displaced by cord.  
   **Note:** This is a critical step. A frequent error is attempting to pack too rapidly and leaving portions of the sulcus unpacked |
| 12 | Use the extra length of cord to double pack and displace those areas of the sulcus not adequately displaced while avoiding those areas already adequately displaced by the single first layer of the cord.  
   **Note:** Portions of the sulcus are not adequately displaced since the diameter of the cord was selected to fill the smallest most delicate area of the sulcus. |
| 13 | Cut off any remaining excess length of cord leaving an unpacked tag at the end to aid removal. |
| 14 | Wait approximately 5 minutes.  
   **Note:** Approximately 5 minutes is adequate time for the tissues to be displaced and yet short enough to minimize ischemic damage. While not promoting extended waiting times, waiting beyond 5 minutes may still result in successful tissue recovery. |
| 15 | Obtain bite records or allow the patient to take a break.  
   **Note:** After completion of packing, it is not necessary to maintain isolation. |

**Removing the Packing Cord**
Introduction

There are several variations in the techniques used to remove the packing cord depending on the number and types of preparations:

- partial coverage preparations
- multiple preparations
- preparations separated by edentulous areas

Removing the Packing Cord (Partial Coverage Preparations)

For impressions of partial coverage preparations (e.g., veneers with minimal subgingival involvement) one short length of cord will usually expose all of the margins as well as some tooth structure apical to the margin.

In this case, rinse, dry, isolate, and take the impression with the cord in place. Remove the cord after inspecting the impression for accuracy.

Removing the Packing Cord (Multiple Preparations)

For multiple preparations choose one of the following two techniques:

- The first technique involves pulling the cord prior to final rinsing, drying, and isolating. If any bleeding does occur when the cord is pulled, reenter the sulcus with the syringe and infuser tip until hemorrhage is controlled, then rinse, dry, isolate, and take the impression. This technique can be used for multiple preparation impressions, but it probably is at its best for one or two preparations. It is an excellent technique to use when first gaining confidence that you do have some control over the situation. Since bleeding rarely occurs, and since the technique involves a protracted waiting time to maintain isolation while the impression material is mixed, the next technique may be preferable.

- In the second technique, prior to pulling the retraction cord for the impression, wash and thoroughly dry the entire arch, re-isolate the preparation area, and specifically dry the sulci of the prepared teeth (including the cord).

Removing the Packing Cord (Multiple Adjacent Preparations)

For multiple adjacent preparations, it generally is easier to pull all of the cords prior to injecting
the impression material.

Removing the Packing Cord (Preparations Separated by Edentulous Areas)

For preparations separated by edentulous areas, it is often more convenient to start with the most distal preparation and work anteriorly pulling the cord and injecting impression material, one preparation at a time.

You may also lightly dry the sulci with an air syringe after pulling the cord to ensure that moisture is not left apical to the cord (especially in areas containing two layers of cord).

Injecting Impression Material

Introduction

Injection of the impression material is another critical step. With all of the techniques that are advocated by various clinicians, the technique described on this and the following pages has been consistently one of the easiest ones to use with excellent results.

Procedures for Injecting Impression Material

The following technique has consistently produced bubble-free impressions:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beginning at the disto-lingual line angle of the most distal preparation, place the injection tip into, or just barely above, the sulcus touching both the prepared tooth and the distal approximating tooth (Figure 8-1).</td>
</tr>
<tr>
<td>2</td>
<td>With the curve of the tip angled toward the buccal, express enough impression material to fill the distal interproximal sulcus to the disto-buccal line angle (Figure 8-2).</td>
</tr>
<tr>
<td>3</td>
<td>Continue to express the impression material.</td>
</tr>
</tbody>
</table>
| 4    | Without raising the tip, turn the syringe and begin advancing the tip mesially along the lingual sulcus (Figure 8-3).  

**Note:** Impression material is being expressed into the sulcus **ahead** of the injection tip. Always keep the impression material flowing ahead of the tip. |
| 5    | Advance the tip along the lingual surface and into the mesial interproximal area until blocked by the mesial approximating tooth.  

**Note:** At this point, impression material will be extruded far enough ahead of
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Raise the tip just high enough to pass to the mesio-buccal without breaking contact with the impression material being pushed ahead of the tip.</td>
</tr>
<tr>
<td>7</td>
<td>Turn the mesio-buccal line angle while the impression material flows ahead of the syringe and moves distally to fill the buccal sulcus (Figure 8-5).</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Do not stop until the syringe tip itself makes contact with, and is immersed in, the originally injected impression material at the disto-buccal line angle (Figure 8-6). The impression material being extruded ahead of the syringe will make contact with the originally extruded material before the syringe tip reaches the point (Figure 8-7). Failure to advance the tip until it is immersed in the originally extruded impression material will frequently result in a fold or a bubble-like defect.</td>
</tr>
<tr>
<td>8</td>
<td>Use the same technique of encircling each tooth one at a time for multiple adjacent preparations.</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> The impression material is always expressed ahead of the advancing syringe tip and can be visualized flowing into the sulcus.</td>
</tr>
</tbody>
</table>

**Step 1 Illustration**

![figure 8-1](image)

**Step 2 Illustration**
Step 4 Illustration

Figure 8-2

Impression material through interproximal to disto-buccal line angle
Impression material **ahead** of tip

**Step 5 Illustration**

Material ahead of tip to mesio-buccal line angle

**Step 7 Illustrations**
figure 8-5

Keep impression material ahead of tip

figure 8-6

Do not stop syringing when impression material meets
**Limitations**

This technique is easier to master than other techniques such as blowing the impression material into the sulcus with an air syringe. Although this is a good technique, unless you are familiar with blowing air on polyvinyl siloxanes, there is a strong tendency to blow them completely off the tooth.

On the occasions that bleeding does occur when the cord is pulled, this technique does not allow time to reuse the Astringedent and infuser tip since the impression material is already mixed.

Blowing air into the sulcus at the bleeding site can be used quite successfully at this time. However, the emphasis is on blowing the blood out of the sulcus while still using the same injection technique rather than blowing the impression material in.
Section C--Standardized Tooth Preparation Sequence

Overview

This section addresses Problem Area 2--Inadequate Tooth Reduction. Emphasis is placed on rapid bulk reduction of roughed in tooth preparation followed by refinement of the details of the preparation.

The description is for a porcelain fused to metal (PFM) restoration. The principles apply to all restorations. Section E of this chapter describes variations related to full metal crowns, porcelain veneers, and bonded porcelain jacket crowns.

Determining Indicated Amount of Tooth Reduction

Introduction

Most clinicians are familiar with the indicated amount of reduction as described in textbooks. The difficulty is in actually achieving the stated amount of reduction, even though you will rarely cause yourself or the tooth harm by taking slightly more reduction.

Porcelain fused to metal restorations are perhaps the most frequently underprepared restorations and the least forgiving. Figures 8-8 through 8-11 are presented for review. Remember the depths listed in texts usually represent the minimum required reduction.

Full Metal Crown

[Diagram of Full Metal Crown]

Occlusal reduction follows occlusal contours (somewhat)

0.8 - 1.5mm

0.8 - 1.0

0.3mm

Lingual

Buccal

Two plane reduction

figure 8-8
Porcelain Fused to Metal Crown (With Margin Configurations)

Porcelain Fused to Metal Crown

Side view

Labial view

1/3

2/3

1.5

1.0

0.5

0.3

Two plane labial reduction

Disappearing metal margin

Deep Chamfer or shoulder

Beveled Chamfer or shoulder

Porcelain margin

0.3-0.5

0.5

0.5-0.8

figure 8-9

Porcelain Jacket Crown (PJC)
Porcelain Veneer (with Incisal Configurations)

Note: Reductions for Bonded Porcelain Jacket Crown (BPJC) are indicated in parentheses.
Depth Guides
**Introduction**

You should use some form of depth guide to ensure sufficient reduction and to maintain relative position of the preparation.

Preparation depth guides generally involve--

- cuts placed with a bur of known diameter at appropriate or convenient locations
- uncut tooth structures compared (or referenced) to sections of the tooth prepared to full reduction
- combination of the above two techniques

With all three techniques, you must know the diameter of the bur you are using. Keep a measuring gauge available and measure the burs you use until you are familiar with their dimensions. For example, the--

- 1557L carbide bur is 1 mm in diameter with a rounded tip
- 5856-016 tapered cylinder diamond (Brasseler) is 1.6 mm at its greatest diameter and tapers to just over 1 mm at the rounded tip

Both make excellent depth guide burs and can be used to rough in tooth preparations without necessitating a bur change. The 1 mm size is an easy reference by which to judge the depth of a cut.

**Placement of Depth Guide Cuts**

The most critical areas for placing depth guide cuts are--

- occlusal/incisal surfaces
- any surface to be covered with porcelain (generally labial or buccal surfaces)

**Types of Depth Cuts**

The following types of depth cuts are described in this section:

- multiple-depth guide cuts
Multiple Depth Cuts

Multiple depth cuts (Figure 8-12) have the advantage of forcing the timid operator to achieve adequate reduction. The system has the disadvantages of making it more difficult to stabilize the handpiece during preparation, encouraging lumpy preparations, and consuming time.

Gingival Crest and Midtooth Depth Cuts

The combination of a gingival crest and a midtooth depth cut, usually prepared with a round bur.
or diamond bur, can be a very useful approach. The gingival crest cut can establish a well contoured rough-in of a deep chamfer finish line as well as indicate gingival crest position. The deep cut does, however, complicate placement of prepreparation retraction cord.

figure 8-13

**Incisal and Midtooth Depth Cuts**

Perhaps the ultimate in combining depth guide cuts with using uncut tooth structure as a reference is presented by Dr. John W. McLean in his *Monographs on the Science and Art of Dental Ceramics*. After placing incisal and midtooth depth cuts (Figure 8-14A), Dr. McLean fully prepares one half of the tooth leaving the uncut half of the tooth as a depth guide reference (Figure 8-14B). You must work rapidly and use a minimum number of bur changes to employ this technique.

figure 8-14A

figure 8-14B
**One Midtooth Depth Cut**

The technique recommended by the author is the one midtooth depth cut (Figure 8-15).

1. Its apical extension is placed at the operator's desired reference point to the free gingival margin (above, at, or below).

2. The incisal meeting point of the labial and lingual depth cuts indicates the level of necessary incisal reduction. It also maintains the proper labio-lingual position of the incisal edge of the preparation.

3. Gingival crest information can be supplemented by scribing a line with an alcohol pen or the tip of a diamond bur.

**Note:** Prepreparation packing techniques result in differing amounts of gingival retraction even within the same sulcus. It may be necessary to prepare the tooth to the level of the prepacked cord. The scribed or scratched line will provide that information.

---

**Depth Cut in Grooves and Fossa**

For molars, the occlusal portion of the depth cut should be placed in the grooves and fossa, rather than on cusp tips, to ensure adequate reduction in these areas.
Working in a Prescribed Logical Sequence

Introduction

While most operators have a reasonably good mental image of the final preparation they want to achieve, how to create it often is not clear. Working in a logical sequence each time simplifies the procedure to a routine.

The following lengthy discussion of crown preparation sequence is sincerely not meant to insult anyone's intelligence. The vast majority of CDE participants and residents have found the use of this sequence to be of value. Practicing the sequence a few times on extracted teeth is highly encouraged.

Procedures for Reducing Teeth

The following procedures are for reducing teeth in a prescribed logical sequence. The technique is intended to employ both depth cuts and reference to uncut tooth structure. Details of each of these steps are provided on following pages of this section.

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open the interproximal embrasures.</td>
</tr>
</tbody>
</table>
**Note:** For posterior teeth with deep interproximal alloys, find the tooth structure at the gingival floor of the proximal box.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Establish midtooth depth cuts.</td>
</tr>
<tr>
<td>3</td>
<td>Reduce occlusal/incisal surface.</td>
</tr>
<tr>
<td>4</td>
<td>Reduce the axial wall (parallel walls, cervical 2/3 to 3/4 of tooth).</td>
</tr>
<tr>
<td>5</td>
<td>Reduce the lingual surface of the anterior teeth (nonparallel lingual wall).</td>
</tr>
<tr>
<td>6</td>
<td>Reduce the second plane labial or buccal surface (nonparallel walls, occlusal/incisal 1/4 to 1/3 of tooth).</td>
</tr>
<tr>
<td>7</td>
<td>Check the line of draw/path of insertion.</td>
</tr>
<tr>
<td>8</td>
<td>Establish final gingival margin configuration and depth.</td>
</tr>
<tr>
<td>9</td>
<td>Smooth proximal surfaces of adjacent teeth.</td>
</tr>
<tr>
<td>10</td>
<td>Round off/smooth line and point angles of preparation.</td>
</tr>
</tbody>
</table>

**Reduction of Preparation Time**

Working in the sequence just described for full-coverage restorations will reduce preparation time by--

- isolating the tooth to be prepared from adjacent teeth
- dividing the tooth in half to allow visualization of the preparation by tooth sections (reference to uncut tooth structure)
- encouraging full-depth, rough-in cuts rather than nonproductive paint brush strokes of the bur
- organizing occlusal reduction of molars and bicuspsids into 1/4 of the occlusal surface at a time (or one cusp at a time)
- organizing occlusal reduction of incisors and cuspids into mesial and distal cuts off the incisal edge
- dividing axial wall reduction into parallel wall reduction first, in the cervical 2/3 to 3/4 of the tooth, and then second plane or tapered reduction of the occlusal 1/4 to 1/3 of the wall later
- dividing circumferential reduction into full depth cuts by sections of tooth
- following a rapid rough-in of the preparation, the preparation is refined, and final margin
placement and configuration can be addressed as one separate step. Full attention can be given to creating definite continuous margins.

Note: The 1557L carbide bur or the 5856-016 super coarse round-end tapered diamond (Brasseler) are the "workhorse" burs for roughing in the preparation. Make changes as desired; the concept, not the instrument, is the important item. Generally carbide burs will cut more rapidly than diamonds, but will result in a rougher outline form in need of more refinement. Most operators will prefer to use the carbide bur to open the interproximal spaces and then use the diamond bur for the remainder of the preparation.

### Opening the Interproximal Spaces

#### Introduction

Isolating the teeth to be prepared from adjacent teeth will minimize damage to adjacent interproximal surfaces and allow the operator to concentrate on the tooth being prepared. During this step in reducing teeth, no attempt is made at establishing an interproximal gingival margin. The goal is only to open the interproximal areas and isolate the tooth to be prepared (Figure 8-17).

![Figure 10-17](image)

Note: The rounded end of the 1557L is useful in not involving the start of any sort of gingival cut.

#### Finding the Apical Tooth Structure for Teeth with Interproximal Alloys

Attempting to place a gingival margin on sound tooth structure apical to a proximal box, without first locating the depth of the box usually leads to carrying the margin much further apically than necessary. Therefore, it is highly recommended that for any box that does not clearly demonstrate tooth structure apical to the restoration following the interproximal cuts, that the dentist switch burs and locate the gingival floor of the box (Figure 8-18).
Finding Sound Tooth Structure Apical to a Proximal Box

Three basic approaches can be used to locate sound tooth structure apical to a proximal box:

- **Approach 1.** Remove part (or all) of the restorative material only in the proximal box to the gingival floor, and then proceed with crown preparation. The resulting box can be used as a retentive feature of the crown preparation if necessary.

- **Approach 2.** Remove all of the old restoration and base it back out using dentin bonding agents, composite, glass ionomer, or new amalgam. Leave the cavosurface of the floor of the box uncovered and visible. 
  
  **Note:** This approach is time consuming but indicated if you question the adequacy of the old restoration.

- **Approach 3.** Rough in the crown preparation with the margin intentionally left occlusal to the gingival floor of the box. Then remove part (or all) of the old restoration to identify sound tooth structure. This approach offers the best visibility and access to the box. Remember to modify the roughed-in crown margins to be continuous with the floor of the box prior to proceeding further when using this approach.

Every effort should be made to end crown margins on sound tooth structure. It should be rare that a crown margin ends on an existing restoration, i.e., crown margin occlusal to amalgam.
Establishing Midtooth Depth Cuts

Introduction

The next step in reducing teeth is to establish midtooth depth cuts. The midtooth depth cut--

! provides depth guide information

! divides the tooth in half making visualization of the tooth sections more meaningful

Procedures for Establishing Midtooth Depth Cuts

The following procedures are for establishing midtooth depth cuts (Figure 8-19):

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Starting at the midfacial of the tooth (at or just above the free gingival crest), scribe a depth cut up the labial/buccal surface and across the incisal/occlusal surface.</td>
</tr>
<tr>
<td>2</td>
<td>Use a 1 mm diameter bur to accurately judge and vary the depth of the cut. <strong>Note:</strong> View the bur laterally.</td>
</tr>
<tr>
<td>3</td>
<td>Make a lingual depth cut extending from the intended finish line location and connecting with the first cut at the occlusal/incisal surface.</td>
</tr>
</tbody>
</table>

Illustration of Procedures for Establishing Midtooth Depth Cuts
Reducing Occlusal/Incisal Surface

Introduction

The next step in reducing teeth is to reduce the occlusal/incisal surface. The following pages provide procedures and details to consider when reducing the occlusal/incisal surface of--

! molars

! bicuspid
### Procedures for Reducing Occlusal Surface of Molars

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>From the buccal or lingual turn the bur horizontally to match the contour of the occlusal surface and place it into the depth cut with the tip of the bur extending to the central groove (Figure 8-20).</td>
</tr>
<tr>
<td>2</td>
<td>Following cusp contours reduce one cusp (mesial or distal) in a deliberate full-depth cut (Figure 8-21A).</td>
</tr>
<tr>
<td>3</td>
<td>Refer to uncut walls of remaining tooth structure to judge adequacy of reduction (Figures 8-21A and 8-21B).</td>
</tr>
<tr>
<td>4</td>
<td>Reduce remaining (same side) cusp still using deliberate full-depth cut following cusp contours (Figure 8-21B).</td>
</tr>
<tr>
<td>5</td>
<td>Refer again to the uncut walls of the remaining cusps and make further reduction for the entire 1/2 of the occlusal surface if indicated.</td>
</tr>
<tr>
<td>6</td>
<td>When reduction appears adequate, turn the bur horizontally in the other direction, and starting at the depth cut, reduce the remaining cusps one at a time. <strong>Note:</strong> The tip of the bur should simply rest on the already established surface in the central groove area. Full depth, contour following cuts are still used.</td>
</tr>
<tr>
<td>7</td>
<td>Verify that there is adequate occlusal reduction. <strong>Note:</strong> The confirmation of occlusal reduction is best accomplished after axial wall reduction but is described here for convenience.</td>
</tr>
</tbody>
</table>

### Step 1 Illustration
Steps 2 through 4 Illustrations

Mesiolingual Cusp Reduced

figure 8-20

figure 8-21A
Distolingual Cusp Reduced

Verification of Adequate Occlusal Reduction

Verify adequate reduction by--

- visually inspecting with the teeth occluded
- using a feeler gauge concept whereby you draw a soft material of known thickness between the occluded teeth and the preparation
  - Belle de Saint Claire markets these type of gauges.
  - Rubber bands of known thickness can be cut in pieces and the pieces held with cotton pliers.
- having the patient close into soft boxing or tray wax placed over the preparation and then examining the thickness of the wax

Note: In general, over reduction of the occlusal surface will be a far better error to make than under reduction.
Reducing the Occlusal Surface of Bicuspids
The midtooth depth cut will essentially divide bicuspids in half at the cusp tips. By the time the interproximal surfaces have been opened and the midtooth depth cut made, little remains of the occlusal surface.

Each cusp can be reduced in one cut, but bur placement and angulation should be done in the same manner as just described for molars.

Reducing the Incisal Surface of Incisors and Cuspids
The midtooth depth cut for incisors and cuspids dramatically demonstrates that the recommended incisal reduction of approximately one-third of the tooth length is not an overstatement, but in fact is the level at which the labial and lingual depth cuts meet (Figure 8-22). The depth cut also tends to keep the incisal edge of the preparation properly located labio-lingually for support and proper placement of the restoration.

X-Section at MidTooth Depth Cut

NOTE: 1) That proper labio-lingual position of incisal edge is maintained by depth cut.
2) When reduced enough to provide adequate thickness at incisal edge, nearly 1/3 of tooth length will be removed.

Incisor 3/4 View
figure 8-22
Incisal edge reduction is accomplished by placing the bur in the depth-cut groove, angled slightly toward the lingual and cutting the incisal edge off following the incisal contour (Figures 8-23A and 8-23B).
Reducing the Lingual Surface (Anterior and Posterior Teeth)

Introduction

The next step in reducing teeth is to perform a second plane lingual reduction. The procedures used for anterior and posterior teeth differ.

Lingual Reduction in Posterior Teeth

For posterior teeth, lingual reduction is simply planing off the second plane of the axial wall (Figure 8-23).

! For mandibular posterior teeth this wall may no longer exist (although, it should).

! For maxillary teeth, the bur is placed into the remaining portion of the depth cut, and the wall is reduced at that angle following cusp configuration. Since this is a centric holding cusp, adequate reduction should be verified as previously described for occlusal reduction.

Note: Err on the side of overpreparation if any error is to be made. Under preparation leads to a wide occlusal table in the restoration or to having a thin area in the casting that is subject to perforation when doing occlusal adjustments.

For occlusal coverage in porcelain, 2 mm of space is advisable.
Lingual Reduction in Anterior Teeth

For anterior teeth, lingual reduction necessitates a bur change to a football- or wheel-shaped diamond.

1. Similar to the porcelain jacket crown, the lingual surface is reduced prior to the labial surface to encourage adequate reduction of the lingual surface.

1. Using the depth cut as an initial guide to depth of reduction, reduce the lingual surface while preserving the parallel lingual axial wall and the relative labio-lingual position of the incisal edge (Figure 8-24).

![Figure 8-24](image)

1. After removal of the tooth structure to the depth indicated by the depth cut guide, check the actual reduction with the teeth occluded. For full porcelain coverage 1.5 mm clearance in the CO contact area is indicated; 1 mm is indicated for metal coverage of the contact area (Figure 8-25).

![Figure 8-25](image)

1. The lingual porcelain-metal finish line of the restoration can be placed above or below
the CO contact area, but not at it. Since this can be difficult to judge clinically, give yourself as much clearance as is reasonably available (Figures 8-26 and 8-27).

Anterior Teeth

Porcelain/metal finish line OK at A or B, not at C.

figure 8-26
Reducing the Labial/Buccal Surface

Introduction

The next step in reducing teeth is to perform a second plane reduction of the labial/buccal surface (occlusal/incisal one-third to one-fourth). This step is frequently overlooked in the mistaken attempt to incorporate the reduction in the parallel axial wall reduction. Failure to make this second plane reduction results in--

- the "halo effect" of opaque showing through the labio-incisal porcelain on anterior teeth (Figure 8-28)
- weakening the porcelain on posterior teeth
- widening the occlusal table (Figure 8-29)
- thin areas in full-metal crowns (Figure 8-30)
Inadequate Second Plane Labial Reduction. Opaque will show through or porcelain must be overcontoured.

Better Reduction

Widened Occlusal Table

Weak Metal or Porcelain

Better Level of Reduction

figure 8-28

figure 8-29
Second Plane Reduction of the Labial/ Buccal Surface

If the parallel axial wall reduction was accomplished as described, there should still be visible the remnant of the original labial depth cut. Simply place the bur into the depth cut and reduce the second plane at the indicated depth and angle. (See Figures 8-31, 8-32, and 8-33.)
Checking the Line of Draw/Path of Insertion

Introduction

The next step in reducing teeth is to check the line of draw/path of insertion.

Tips for Checking the Line of Draw/Path of Insertion

The following tips will assist you when checking the line of draw/path of insertion:
Intraoral photographic mirrors, or the large 1 1/2-inch mouth mirrors, greatly simplify checking line of draw (Figure 8-34).

Pencil or alcohol pen can be used to highlight the shoulder/chamfer area if desired.

If you have a tendency to undercut or significantly alter the parallel axial walls during final margin placement, this check should be delayed until after margin placement.

For most operators, the gingival margin will only be moved 1 mm or less apically, and this is a convenient, bloodless, and lower stress time to check alignment.

Most three-unit bridges (prepared in this fashion) will already draw with little or no modification of the preparations.

The more abutments involved in a bridge, the more the axial walls will need to be tapered. Thankfully, retention also increases as the number of abutments increases.

Severely divergent abutments will hopefully have been apparent prior to preparation and accommodations made.

An easily overlooked situation involving divergence of abutments is that of maxillary incisors paired with bicuspid. Always be skeptical of a bridge replacing a cusp (for
Establishing the Final Gingival Margin Configuration and Depth

Introduction

The eighth step in reducing teeth is to establish the final gingival margin configuration and depth. A discussion of margin configurations is found in Section D. Distinct continuous margins, accurately recorded in the impression, are more important than their configuration.

Tips for Establishing the Final Gingival Margin Configuration and Depth

The following tips will assist you in establishing the gingival margin configuration and depth:

- Any margin that can be placed supragingivally, should be placed supragingivally.
- Caries, aesthetics, retention, and previous restorations are the primary reasons for subgingival margin placement.
- It is generally taught that the gingival margin should never enter the sulcus by more than half the depth of the sulcus. In the average case this equals a depth of 1.0 mm or less, with less being favored.
- The final subgingival margin placement should be as atraumatic to the gingiva as possible.
- Packing a small length of retraction cord (dampened with water, Visine, or aluminum chloride solution) in the area of the sulcus to receive the subgingival margin works very well.
- Final margin placement should be accomplished with a slow-speed handpiece and friction grip contraangle attachment. If you have magnification available, use it.
- Considerable heat can be generated even at slow speed. Water spray coolant via the three-way syringe is important.
- If the roughed-in margin was placed at or near gingival crest height, apical placement with the slow-speed handpiece is quite easy. If the margin is in the range of 1 mm above the gingiva, bring it down with the high speed and finish with slow speed.
The lingual and approximately half of the interproximal margins should remain supragingival (if possible).

The labial and labial one-half of the interproximal margins are brought down to or near the level of the retraction cord. Be specifically aware of keeping the interproximal margin subgingival until it will no longer be visible when viewed at an angle. This is a frequent area of margin visibility, especially for porcelain veneers.

Although the Ultrapak knitted cord is uniquely resistant to entanglement in a diamond rotating at high speed, it will entangle on a bur operating at slow speed. Tuck it in firmly, including both ends to reduce entanglement.

Make a mental note of the relative relationship of the free gingival margin and roughed-in finish line prior to packing the cord. Even small cords often achieve remarkable gingival retraction. You may not need to place the margin as far apically as the level of the cord.

**Smoothing the Proximal Surfaces of Adjacent Teeth**

**Introduction**

The next step in reducing teeth is to smooth proximal surfaces of adjacent teeth. It is very difficult to cut an entire crown preparation and not touch an adjacent tooth. There is a significant risk of caries if the abraded enamel is left rough.

Smoothing and polishing proximal surfaces should be considered one of the routine steps of crown preparation. An approximating amalgam restoration, nicked or not, will benefit from some smoothing and polishing.

**Tips for Smoothing Proximal Surfaces of Adjacent Teeth**

The following tips will assist you in smoothing proximal surfaces of adjacent teeth:

- A 7/8-inch medium grit emery, paper-backed Moore's disc, followed by a large brown polishing cup (Brasseler, 204-100) works very well.

- The medium grit 3M polishing disc is flexible and works very well if it will reach. Frequently the 1/2-inch diameter is too small to reach the gingival aspect of posterior teeth.

- Place the disc on the mandrel, abrasive side in and paper side out, even for the mesial
surface of posterior teeth. If you do not do this, you will not be able to angle the disc to reach the gingival portion of the tooth.

For the Moore's disc, place a mirror handle against the paper back and run the disk briefly while applying pressure with the mirror handle (Figures 8-35 and 8-36). This will "break the back" of the disc making it flexible enough to adapt to those hard to reach places like the mesial of second molars.

Follow the disc briefly with the large brown polishing cup (with water spray) and you will have done a lot to assure the integrity of the approximating tooth surface (Figure 8-37).
Smoothing Line and Point Angles of Preparation

Introduction

The last step in crown preparation is smoothing the line and point angles of the prepared tooth. All of the line and point angles should have been blended or smoothed with a diamond by this time.

Tips for Smoothing the Line and Point Angles

The following points will assist you in smoothing the line and point angles:

1. Pay particular attention to the occluso-axial angles. They are a frequent area for a casting to bind when sealing.

2. Use the brown polishing cup (still mounted from the previous step), light pressure, and water spray.

3. Do not smooth the bur marks on the axial walls; they add retention (Figure 8-38).
figure 8-38
Section D--Finish Line Configuration

Overview

Although finish line configuration is an area of generalized agreement, it is also an area of confusing terminology, contradictory research results, and dogma. After eight years of reviewing both incoming and completed cases at the dental laboratory level, the author is convinced that the presence of any accurately recorded margin is more important than its configuration.

Although the technicians may be required to make adjustments in their techniques to accommodate some configurations, they are capable of accurately reproducing virtually any margin in metal, if the margin is there in the first place.

For aesthetic restorations, the presence of another material, usually porcelain, and the need to accommodate its properties, complicates the entire matter. If the technician is given 1.0 mm of axial reduction, and an identifiable margin, a mechanically acceptable restoration can be fabricated. Given another 0.5 mm of axial reduction (1.5 mm total) and a clear margin, a very sound and aesthetic restoration can be produced.

Clinicians generally carry in their minds a good concept of the margin configuration taught at school. They vary tremendously in their ability to--

1. produce that configuration on a tooth
2. record the margin in the impression

Margin Configurations

Introduction

Surveys indicate that approximately six or seven different margin configurations for porcelain fused to metal restorations are taught in U.S. dental schools. If you are reasonably successful and comfortable with the configuration you were taught, you should stay with that design and concentrate your efforts on refining your ability with that design. If you are not happy with the design you were taught, strongly consider using some form of the chamfer configuration. It is the easiest to produce, readily identifiable, and can be accurately reproduced.

General Considerations
The following considerations may provide you with some valuable information to use in choosing a margin configuration:

1. The shoulder with bevel, deep chamfer with bevel, and "disappearing metal margin" are the configurations most frequently associated with problems.

2. In reviewing the basic finish line configurations available, the terminology rapidly becomes cloudy (Figure 8-39).

3. From an engineering, stress, and just plain fit standpoint, all point and line angles should be rounded. You can therefore eliminate the figure 8, the shoulder with 90° internal line angle from the discussion.

4. At what point one configuration becomes another is not always clear. (At what point does a shallow or long chamfer become a chamfer, a deep chamfer, or a shoulder with rounded internal line angle?)

5. One person's feather edge is another person's chisel, is another's shallow chamfer.

6. Some generalities seem to be reasonably well accepted, even though each of them can be argued.
Chapter 8
Fixed Prosthodontics

Figure 8-39

Feather Edge

Chisel or Knife edge

Bevel Sloped Shoulder (X) Degree Shoulder

Chamfer

Shoulder

Bevelled Chamfer or Shoulder

Deep
Shallow/Long

Rounded
Square

figure 8-39
The feather edge is discouraged as being indefinite, produces a weak restoration if improperly contoured, and is conducive to overcontouring of the restoration. It is probably the configuration of choice for Maryland Bridge retainers on posterior teeth.

The feather edge is described as having the best closing angle configuration in that as a crown is seated, the gap measured horizontally between axial wall and casting closes rapidly.

If one compares a feather edge and shoulder margin (Figure 8-40), both possessing an equal vertical discrepancy between crown margin and actual finish line, the feather edge margin will have closed the gap between the casting and axial wall, making the vertical discrepancy of less consequence. Whereas, the shoulder margin presents an open gap directly to the axial wall equal to the amount of vertical discrepancy.

An error involving a vertical discrepancy in which the crown margin fails to fully reach the actual finish line, but closes the gap at the axial wall is probably the most forgiving error that can be made in finish line discrepancies.

For metal restorations the chisel, steep bevel, and shallow chamfer are all attempts at compromises between the strengths and weaknesses of the feather-edge configuration.

For aesthetic restorations, the beveled shoulder or beveled deep chamfer are the most direct attempts at retaining this closing angle phenomenon while accommodating the increased axial reduction required for aesthetic material.
For the average operator, who does not place enough crowns to maintain proficiency, the beveled shoulder configuration rapidly deteriorates to an indistinct shoulder with an imaginary bevel configuration.

The beveled shoulder or beveled deep chamfer has traditionally been the primary configuration taught at the graduate level.

The dividing line between displaying metal or encroaching on the epithelial attachment, while still retaining enough of a bevel to be of value, is a fine one. "Traditional prosthodontic thought" by proponents of the beveled shoulder has been that if the marginal adaptation between crown and tooth are excellent, some encroachment on the epithelial attachment could be tolerated and/or adjusted to by the sulcus.

This thought has some validity. However, the excellent gingival response to even some fairly poorly developed porcelain margins placed 0.5 mm subgingivally is bringing about some rethinking of margin placement.

Adding fuel to this rethinking is the increasing popularity of insoluble resin cements and dentin bonding agents. (This is not advocating poor margins filled in with resin cement.)

At the other end of the spectrum from the "shoulder bevelers" are the folks maintaining that the sulcus does not have room for all this hoopla, the closing angle effect is never realized for angles less than 70°, and even then, only for an exact fit with vertical displacement only.

The deep chamfer, shoulder, and sloped shoulder are the advocated preparations here.

The most abused preparation in this group is the "disappearing metal margin" (Figure 8-41). As originally presented, the configuration was advocated for porcelain fused to base metal. The shoulder sloped at approximately 135° with a rounded internal line angle, and 90° cavosurface line angle. The metal at the gingival margin is tapered from approximately 0.5 mm at the internal line angle out to nothing at the cavosurface margin. Thus, tooth, metal, and porcelain all meet at the cavosurface margin. The term seems to have evolved to be applied to any degree of shoulder inclination displaying the tapered configuration of metal thinning to nothing at the cavosurface margin.
This configuration has not been well applied for the most part, and it receives a great deal of criticism in prosthodontic literature.

For most, the decision needs to be made to either put a metal collar at the margin or to put a porcelain margin, but not to waffle in the middle.

In spite of major advances in the ability to use porcelain margins, they remain technically demanding at both the clinical and laboratory levels.

Probably the safest approach is to consider the metal collar as your standard and use the porcelain margin in those cases where the metal cannot be adequately hidden.

In evaluating the character of the sulcus to determine metal versus porcelain margins, it is fortunate that most Native Americans have gingiva of sufficient thickness to accommodate a metal collar without greying or show through. Prominent cuspids are the most frequent exception.

On probing the labial sulcus, if the periodontal probe is visible through the tissue, awkward to insert, or causing noticeable blanching, consider the porcelain margin.

A 3 mm sulcus with average thickness tissue will easily allow a metal collar. A sulcus 2 mm (or under) should probably get a porcelain margin. The sulci between 2 and 3 mm puts most of us back in the waffle mode.
Most 2 to 3 mm sulci, with average tissue, will accept a metal collar. However, consider the risks of the metal showing. Consider whether it is an anterior or posterior tooth, maxillary or mandibular tooth, high lip line or low lip line. Think about what the patient is like. Will you hear about "your mistake" every time the patient everts the entire buccal mucosa to expose the visible margin at the distal of #31, or will the patient tell you that you did a good job with a stainless steel crown on #8?

Suggested Margin Configurations

Introduction

Margin configuration is an area of debate. Research papers discuss metal distortion during various firing cycles and measure margin discrepancies in microns; whereas, what is observed clinically and at dental laboratories are discrepancies measured in tenths of millimeters—not microns.

In fairness to the patient, be honest with yourself. If you cannot see the margin in the impression, it is not there. The laboratory cannot make it be there in anything approaching micron accuracy and neither can you. Modify the preparation and/or take the impression over again (even if it means reappointing the patient).

Open margins account for the vast majority of crown and bridge failures. The following discussion includes some recommendations to help you avoid open margins.

Recommendation for Full Metal Crown

The following choices are recommended for full metal crowns:

- shallow or long chamfer as developed by flame-shaped diamond
- chamfer as developed by round-end diamond
- chisel as developed by diamond of your choice

Recommendation for Porcelain Fused to Metal (PFM) Crown

The following choices are recommended for PFM crowns--

- with metal collar: gently sloped shoulder or deep chamfer on labial, blending to
chamfer on interproximal and lingual

with porcelain margin: very gentle to no slope shoulder on labial, blending to chamfer on interproximal and lingual (The labial shoulder for a porcelain margin should be extremely smooth and benefits from final finishing with a brown point and water spray.)

Suggested diamonds are discussed later.

**Recommendation for Diamonds for PFM Crown**

The following diamonds are highly suggested (and are capable of developing any of the suggested PFM finish configurations) for metal or porcelain margins:

- 5856-016 round-end diamond (This diamond is used for the rough-in preparation. It develops an excellent chamfer.)
- 35005-series of KS modified shoulder diamonds
- 10839-series of tissue protective end-cutting diamonds

**Note:** The KS or end-cutting diamonds can be used to develop the entire margin. Also, they can be used only for the labial margin and will blend easily into the chamfer created by a round-end diamond.

- 0874-009 RCB diamond (This diamond is perhaps the best one available for placing a bevel on a deep chamfer or shoulder.)

**Note:** Brasseler nomenclature for burs has been used because of the author's familiarity with that brand. Use any quality brand that has a helpful representative in your area.

**Advantages and Disadvantages of Beveled Shoulder/Beveled Deep Chamfer for PFM Crown**

This PFM configuration is discussed in detail because of its unique advantages and disadvantages:

- Most operators cannot develop this configuration accurately unless they cut enough crown preparations to maintain proficiency.
- Even for proficient operators, infringement on the epithelial attachment is common.
However, the author remains convinced that this configuration (properly developed) provides the best adaptation to the tooth and is the most "forgiving” of minor marginal discrepancies.

**Indications for Beveled Shoulder/Beveled Deep Chamfer for PFM Crown**

For those operators interested in the beveled shoulder/beveled deep chamfer for PFM crowns, the following are indications for its use:

- any place the patient will accept metal display at the gingival margin, e.g., mandibular bicuspids
- teeth with buildups requiring the ferrule effect of extending crown margins 1.5 to 2 mm onto sound tooth structure apical to the buildup
- short teeth with questionable length for retention
- any teeth with apically deep interproximal alloys (After sound tooth structure is identified at the gingival floor of the proximal box, a bevel is frequently the best configuration for the box area. Unless there are strong indications against it, bevel the entire tooth and employ only one margin configuration for the entire crown.)

**Recommendation for Porcelain Jacket Crown (PJC), Bonded Porcelain Jacket Crown (BPJC), and Porcelain Veneer**

The porcelain jacket crown, the bonded porcelain jacket crown, and the porcelain veneer all require the very gentle to no slope shoulder in that cloudy area of nomenclature that could be called a deep chamfer. They vary in depth of cut, but not by much. Veneers currently receive 0.50 to 0.75 mm when possible.

**Margin Discrepancies**

**Introduction**

Although the goal is to create a crown with no discrepancies between restoration and tooth, both horizontal and vertical discrepancies do exist.

**Types of Discrepancies**

The author's experience with both temporary and permanent restorations indicates that--
The beveled or feather-edge configuration with **vertical discrepancy** only is very forgiving (Figure 8-42A).

The **horizontal discrepancy with a step up from crown to tooth but no vertical discrepancy** (small hat on a large head) seems to resist decay, but it frequently is associated with periodontal recession to a level below the defect (Figure 8-42B).

The **horizontal discrepancy with a step down from crown to tooth but no vertical discrepancy** (large hat on a small head) is very similar to an amalgam overhang, resulting in inflamed gingiva, periodontal pocket formation, and a fairly high incidence of caries (Figure 8-42C).

If an open margin is added to any of the above conditions, caries will be present in almost all of the cases following dissolution of the cement (including glass ionomer cement) (Figures 8-42D through 8-42F).

It is hoped that insoluble resin cements and bonding agents might aid in reducing errors shown in Figures 8-42D through 8-42F to those errors shown in Figures 8-42A through 8-42C.
figure 8-42D

figure 8-42E
Section E--Variations in Tooth Preparation Sequence

Overview

The porcelain fused to metal (PFM) restoration accounts for the majority of crown and bridge restorations in the IHS. If one adopts the preparation sequence presented for that restoration as his standard (or basic sequence), then it is easy to visualize preparations for other restorations as modifications of the standard rather than different entities.

Using Full Metal Crowns

Introduction

The full metal crown could be used to present the standard preparation sequence just as well as the PFM crown. Its primary difference is in the depth of reduction to accommodate the properties of porcelain. The sequence remains the same, and variations are made primarily to accommodate one's preference in finish line configuration.

Finish Line Configuration

The full metal crown requires approximately 0.3 mm of metal near its finish line. Using the finish line terminology presented in Section D, the chamfer or the shallow/long chamfer are the two configurations best qualified to meet this criteria and allow normal tooth contours, i.e., good emergence profile and restoration not overcontoured.

Note: The author prefers the shallow or long chamfer configuration for its better closing angle properties. The distinction between knife edge and shallow or long chamfer also seems minor and in favor of the long chamfer.

Preparation Procedure with Variations for Full Metal Crown

The standard preparation procedure with variations for a full metal crown are as follows:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1    | Open the interproximal embrasures.  
      | **Note:** For posterior teeth with deep interproximal alloys, find the tooth structure at the gingival floor of the proximal box. |
| 2    | Establish depth cuts. |
3. Reduce **occlusal** surface.

4. Reduce the axial wall (parallel walls, cervical 2/3 to 3/4 of tooth).

   **Note:** If a chamfer configuration of gingival margin is desired, the 5856-016 bur is retained and the depth of axial reduction is varied as appropriate. If you choose a long chamfer gingival margin configuration, it is counterproductive to rough the preparation in with a round-end bur (5856-016 Brasseler), producing a full chamfer, and then attempt to change the configuration back to a shallower configuration (Figure 8-43). It is easier to change burs at this time (5862-012 Brasseler) and produce the desired margin configuration directly. The 5862-012 is a flame-shaped supercoarse diamond. **It is critically important that the tip of the flame-shaped bur be kept projecting just beyond the finish line.** A definite sharp margin is created with the bur in this position. If the tip of the bur is allowed to engage the tooth structure, the margin becomes very jagged and indefinite (Figure 8-44).

5. Reduce the second plane lingual surface (nonparallel wall, occlusal 1/4 to 1/3 of tooth).

6. Reduce the second plane labial or buccal surface (nonparallel walls, occlusal/incisal 1/4 to 1/3 of tooth).

7. Check the line of draw/path of insertion.

8. Establish final gingival margin configuration and depth.

9. Smooth proximal surfaces of adjacent teeth.

10. Round off/smooth line and point angles of preparation.

---

**figure 8-43**

Full Chamfer must be-

beveled or

moved apically to produce a Long Chamfer
Using the Porcelain Jacket Crown and Bonded Porcelain Jacket Crown

Introduction

The porcelain jacket crown (figure 8-45) has long been known for its excellent esthetics. Its use has declined, however, due to its high rate of breakage if the preparation did not meet almost flawless standards. Luting agents other than resin cements appear to have contributed significantly to the problem encountered with porcelain jackets.
The remarkable bond of resin cement to etched and silanated porcelain has:

- significantly decreased fracture risk
- decreased the required tooth reduction
- improved aesthetic capabilities

As the use of resin cements and bonding agents becomes standard for all crown and bridge procedures, the term **bonded** porcelain jacket will probably be considered redundant. At the present time, it is usually used as a reminder that specific procedures involving porcelain etching and silanation, bonding agents, and resin cements are integral elements of the restoration.

### Preparation Procedure with Variations for PJC and BPJC

The following is a variation of the procedures presented in Section D. This procedure is effective for preparing both porcelain jacket crowns and bonded porcelain jacket crowns.

**Note:** The standard preparation sequence is followed with emphasis that Steps 5 and 6 not be reversed and that Step 10 be thorough. Variations in thickness of the restoration should be gradual and not abrupt.

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
</table>

---

8-69

Chapter 8
Fixed Prosthodontics
July, 2003
Chapter 8
Fixed Prosthodontics

Using Porcelain Veneer

Introduction

The porcelain veneer is another member of the bonded restoration concept that is changing dentistry. Like the Maryland Bridge, they are somewhat detail demanding. Unlike the Maryland Bridge, they only need to support themselves. They are very rewarding restorations to place.

Porcelain veneers started as a prepless preparation concept and have evolved to a definite preparation that frequently involves some dentin. Dentin/enamel bonding agents are a must have item. Like the 3/4 crown, the veneer involves significant amounts of detailed finish lines.

Significant Features

The following describes some of the important features of the finish lines on porcelain veneers (Figure 8-46):

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open the interproximal embrasures.</td>
</tr>
<tr>
<td>2</td>
<td>Establish depth cuts.</td>
</tr>
<tr>
<td>3</td>
<td>Reduce incisal/occlusal surface.</td>
</tr>
<tr>
<td>4</td>
<td>Reduce the parallel axial walls (cervical 2/3 to 3/4 of tooth).</td>
</tr>
</tbody>
</table>
| 5    | Reduce the second plane nonparallel lingual surface.  
| **Note:** The lingual surface should be cut prior to the labial surface to encourage full depth reduction of the lingual surface and decrease the rate of porcelain fracture. Once the labial surface is reduced, most operators are reluctant to fully reduce the lingual surface. |
| 6    | Reduce the second plane nonparallel labial or buccal surface (occlusal/incisal 1/4 to 1/3 of tooth). |
| 7    | Check the line of draw/path of insertion. |
| 8    | Establish final gingival margin configuration and depth.  
| **Note:** Apply same rules of margin placement as for porcelain veneers. |
| 9    | Smooth proximal surfaces of adjacent teeth. |
| 10   | Round off/smooth line and point angles of preparation.  
| **Note:** Sharp angles concentrate stress. Brittle materials (i.e., porcelain) fracture in these areas. |
Incisal Finish Lines A, B, and C:

- A or B - must be used if veneer extends tooth length
- A - very useful, convenient, easiest to prepare, author's preference
- B - more difficult to prepare, requires relatively thick tooth, extension of
lingual finish line further gingivally results in "taco shell" preparation increasingly used to deal with occlusion

- C - originally intended to protect veneer from excursive occlusal (actually increases failure when occlusal contact does occur); cannot be used if veneer is intended to lengthen tooth

! Interproximal Finish Lines D and E:

- D - gingival aspect must be kept near gingival crest and extended lingually far enough to avoid being visible (often described as dogleg or elbow)

- E - debate over opening or retaining interproximal contacts has increasing support for the improved aesthetics achieved by opening the contacts

Note: In cases with well-aligned teeth, stripping the contact with metal finishing strips can be sufficient opening.

! Labial Finish Line Placement F:

If the desired shade change involves three shades or more on a shade guide, place the margin subgingivally. If the desired shade change is less, place the margin at or just above the free gingival margin.

Variation of Preparation Procedure

Some amount of labio-lingual malalignment of teeth can be compensated for with veneers by adjusting the depth of preparation and shaving the lingual surface of lingually displaced teeth. However, orthodontics and/or complete coverage of the tooth may be indicated. The described sequence assumes relatively normal tooth alignment:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decide if the interproximal embrasures will be opened or not.</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Do not actually open them at this time. Aesthetics are generally improved by opening. For nonrestored well-aligned teeth, the opening can be as simple as stripping the contact area with Compo-Strips (ESPE-Premier). This amount <strong>can</strong> be done at this time.</td>
</tr>
<tr>
<td>2</td>
<td>Decide what incisal edge treatment will be used (A, B, or C).</td>
</tr>
<tr>
<td>3</td>
<td>Place depth cuts.</td>
</tr>
</tbody>
</table>
**Note:** The single, midfacial-depth cut, supplemented with pen marks or bur scratches at gingival crest height, is still recommended (Figure 8-47). An intentional perforation to the dentin near the gingival crest will end the suspense over how thick the enamel is in this region. The small perforation can be made without water spray by using intermittent cuts with very light pressure.

<table>
<thead>
<tr>
<th>4</th>
<th>Make the incisal reduction as follows:</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>If you are using incisal form C in Figure 8-46, no incisal reduction is necessary.</td>
</tr>
<tr>
<td>•</td>
<td>If you are using incisal form B in Figure 8-46, make the flat part of the cut.</td>
</tr>
<tr>
<td>Note:</td>
<td>The lingual chamfer is formed later as a continuation of the interproximal finish line.</td>
</tr>
<tr>
<td>•</td>
<td>If you are using incisal form A in Figure 8-46, simply cut a flat plane at the incisal edge.</td>
</tr>
<tr>
<td>Note:</td>
<td>If the interproximal surface was not opened previously with a Compo-Strip, you may have two little tags of enamel at the point angles. Leave them until later (Figure 8-47).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>Prepare the gingival margin as follows:</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>If the desired shade change by the veneers involves three steps or more on a shade guide, locate the margin subgingivally.</td>
</tr>
<tr>
<td>•</td>
<td>If the margins are to be subgingival, prepack the sulcus with retraction cord.</td>
</tr>
<tr>
<td>•</td>
<td>The level of the free gingival margin should be recorded prior to prepacking.</td>
</tr>
<tr>
<td>•</td>
<td>Depending on the character of the sulcus and cord size used, it is not always necessary to prepare the tooth to the level of the cord.</td>
</tr>
<tr>
<td>•</td>
<td>Margins limited to 0.5 mm below the free gingival crest allow easier access for finishing and less risk of damage to the tooth or gingiva.</td>
</tr>
<tr>
<td>•</td>
<td>Prepacking for margins located at, or above, the free gingival margin is a matter of operator preference.</td>
</tr>
<tr>
<td>•</td>
<td>The diamond (835KR-008, 835KR-010, KS1) is placed in the mid-facial depth...</td>
</tr>
</tbody>
</table>
**Steps 3 and 4 Illustration**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 6    | Prepare the interproximal margin as follows:  
  - As the interproximal area is entered, the handpiece should be gently rotated to allow the tip of the bur to extend interproximally and continue to form a 0.5 to 0.8 mm chamfer.  
  - The gingival portion of the interproximal finish line is kept near the gingival crest and extended lingually far enough to avoid being easily seen.  
  - As the finish line is brought up toward the contact area, it is curved back out to the labial.  
  - At the contact area, the finish line cut is either brought labial to the contact or used to open the contact, as previously discussed.  
  - The interproximal cut then joins the incisal edge. For incisal configuration B, the interproximal and lingual chamfers are made continuous. For incisal configurations A and C, no further extension is necessary. |
| 7    | Perform labial reduction.  
  **Note:** With the combination of the midface depth cut and the margins cut to depth, it is easy to follow the contour of the tooth and remove the remaining labial enamel to the desired depth. |
| 8    | Check the path of insertion.  
  **Note:** Ensure there is a path of insertion without undercuts, especially with incisal configuration B. |
| 9    | Round and smooth sharp line and point angles.  
  **Note:** Accurate porcelain margins require a smooth continuous finish line. Use of the slow speed handpiece is highly recommended. |
Enamel Tags

Alcohol Pen or Bur Scratch

Intentional Dentin Exposure

Figure 8-47
Section F-- Resin Bonded Fixed Partial Dentures

Overview

Introduction

Resin Bonded Fixed Partial Dentures are also known as Maryland bridges, Acid – Etch Retainer bridges, and Resin Bonded bridges. In this chapter, all terms may be used interchangeably.

The text by Simonsen, Thompson, and Barrack remains the best reference to this style of bridge retainer. This section of the manual is intended only to supplement that text.

Historical development

The earliest examples of resin bonded fixed partial dentures include the following:

- Composite resin pontic (Simonsen, 1978)

In these examples, composite resin was used to bond a pontic tooth to the etched surface of an adjacent tooth. This technique had the following advantages and disadvantages:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed at Chairside</td>
<td>Color change</td>
</tr>
<tr>
<td>Low Cost</td>
<td>Fracture</td>
</tr>
<tr>
<td>Short Term Temporary</td>
<td>Debonding</td>
</tr>
</tbody>
</table>

The next step in the evolution of this appliance was the use of a perforated casting framework to cover the lingual surfaces of the abutment teeth. (Rochette, 1973)

- Tapered holes in frame add Macro-mechanical retention

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esthetic</td>
<td>Complicated Fabrication</td>
</tr>
<tr>
<td>Conservative</td>
<td>No bonding between metal-resin interface</td>
</tr>
<tr>
<td></td>
<td>Time consuming bond and finish</td>
</tr>
</tbody>
</table>

Today, Resin Bonded FPD make use of bonding agents that bond the restoration and teeth both
chemically and mechanically.

Methods of bonding attachment
- Macro-mechanical retention
- Micro-mechanical retention
- Chemical retention
- Mixed retention

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal enamel reduction</td>
<td>Limited applications</td>
</tr>
<tr>
<td>No pulpal involvement</td>
<td>Esthetic limitations</td>
</tr>
<tr>
<td>Minimal periodontal involvement</td>
<td>a. graying of teeth</td>
</tr>
<tr>
<td>Simplified impression</td>
<td>b. Changes in pontic size</td>
</tr>
<tr>
<td>Anesthetic optional</td>
<td>Possible debonding</td>
</tr>
<tr>
<td>Esthetics</td>
<td>Alloy visibility</td>
</tr>
<tr>
<td>Less time required</td>
<td></td>
</tr>
<tr>
<td>Reversible?</td>
<td></td>
</tr>
<tr>
<td>Lower cost</td>
<td></td>
</tr>
<tr>
<td>Predictable results with Resin–bonded Bridges</td>
<td></td>
</tr>
<tr>
<td>Proper patient selection</td>
<td></td>
</tr>
<tr>
<td>Correct enamel modification</td>
<td></td>
</tr>
<tr>
<td>Correct framework design</td>
<td></td>
</tr>
</tbody>
</table>

**Indications/Contraindications for Maryland Bridges**

**Indications**
- Periodontal Splinting
- Replacement of missing teeth
- Prosthetic splinting
- Combination with Removable Partial Denture
- Changes in Occlusal table
- Strengthening Natural Teeth

**Contraindications**
- Sensitivity to base metal alloys
• Changes in facial esthetic of abutments
  – Long spans
  – Inadequate enamel for bonding
• Poor quality enamel
• Short clinical crowns
• Narrow embrasures
• Incisors with thin buccal lingual dimensions
• Pathologic occlusion (i.e.- bruxism)
• Malocclusion
• High caries rate or high caries risk

General considerations for Maryland Bridge Construction

Non-noble alloys are currently being used for the following reasons:
• Higher strength
• Thinner framework
• Multiphasic alloys (alloy etching and improved microretention, and bonding)

The thickness for the metal framework should follow the following parameters:
• Porcelain substructure- 0.3mm
• Connector- 1.0mm
• Proximal line angle- 0.6mm
• Lingual surface- 0.6mm

Retention of the metal framework is accomplished by one of the following surface treatments:
• Macroscopic retention
  o uses a meshwork pattern or crystal sprinkled on the die on the interface surface.
• Electrolytic etching
• Sandblasting
• Silicoating
• Tin-Plating

Macroscopic retention has the following advantages and disadvantages:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any alloy can be used</td>
<td>Mesh is difficult to adapt to abutment</td>
</tr>
<tr>
<td>Try in and bond at one appointment</td>
<td>Potentially thicker</td>
</tr>
</tbody>
</table>
Electrolytic Etching of the Metal framework consists of the following steps:

- Complete clinical try in and adjustments.
- Return the frame to lab.
- Clean the interface with air abrasion (Al₂O₃).
- Cover polished surface with wax.
- Etch and clean according to manufacturer’s directions. This surface should not be handled or contaminated prior to cementation.

Sandblasting to create the uniform surface irregularities and fresh oxide later for chemical and mechanical bonding is accomplished in the following manner:

- Non-precious metals (Ni-Cr, Co-Cr)
- Sandblast with Al₂O₃ (50µ) at a pressure of 60 –80 p.s.i.

**Tin-plating**

- provides an oxide layer for chemical bonding
- Noble and semi-noble metals do not form an oxide later as readily as non-precious metals. (Au or Pd alloys)
- Sandblast with Al₂O₃ to create uniform irregularities and a fresh oxide later for Tin-plating.
- Tin-plate the bonding surface with an electroplating device according to the manufacturer’s instructions.

**Anterior Maryland Bridges**

Remember that although the original Maryland Bridge had no real preparation, today it requires a tooth preparation similar to the “Three Quarter Crown” of yesteryear. Success is dependent on the resistance and retentive form. It is not the completely reversible restoration from which it evolved. Ideally the preparation is all within Enamel!

**Anterior restorations**

- Occlusion
- Vertical overlap
- Size of Space, (Diastema)
- Existing Restorations (enamel?)
- Short teeth
- Thin teeth (shade)
- Length of span

**Design Concepts**

- Proximal wrap-around
• Gingival margin
• Incisal margin
• Cingulum rest
• Proximal guideplane
• Proximal grooves

Steps to anterior abutment preparation

• Establish the lingual clearance
• Reduce lingual height of contour (football diamond).
• Create incisal finishing line
• Develop cingulum rest seat
• Establish interproximal finish line
• Place proximal retentive grooves
• Round off sharp line angles

Steps to anterior abutment preparation – Details

• Establish lingual clearance

<table>
<thead>
<tr>
<th>Mean lingual enamel thickness (mm)</th>
<th>Incisal third</th>
<th>Middle third</th>
<th>Gingival third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary Central</td>
<td>0.65</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Maxillary Lateral</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Mandibular Incisors</td>
<td>0.55</td>
<td>0.45</td>
<td>0.3</td>
</tr>
</tbody>
</table>

• Reduce lingual height of contour
Lingual reduction is accomplished by using a football diamond at 0.6 – 1.0 mm in intercuspal position, lateral, and protrusive excursions. The lingual height of contour is reduced using a round-end tapered diamond to make a single plane, 0.3 –0.4 mm reduction on the cingulum wall. The preparation should keep maximum coverage while preserving the proximal contact with the contiguous tooth. Use a knife-edge or light chamfer finish line in enamel. Stay 1.0 mm supragingivally and do not pass the C.E. J.

• Create incisal finishing line
The Incisal Finish line is created using a round–end tapered diamond, a light chamfer, and maximum coverage, while minimizing the display of metal (graying) on the incisal edge.
Develop a cingulum rest seat using an inverted cone creating an L-shape, ledge, notch or flat plane perpendicular to the long axis of the tooth at 0.5mm deep and 2 to 3 mm long.
• Develop cingulum rest seat
  Rest Seats give the following properties to the preparation:
  – Resist gingival displacement
  – Add rigidity to the casting
  – Accurate and reproducible alignment and seating

• Establish interproximal finish line
  Create and establish an interproximal finish line. Carry the finish line to the labial surface as far as possible without compromising esthetics keeping it parallel to the planned path of insertion

• Place proximal retentive grooves
  Place the proximal retention grooves using a 169L carbide at 0.5mm deep and parallel to the path of insertion.

  Proximal grooves
  – Substituted for the wrap-around design
  – Offer resistance to lingual displacement without facial metal display
  – Pre-designed path of insertion

• Round off sharp line angles.

Posterior Resin bonded Fixed Partial Dentu

As with anterior Maryland bridges, ideally the preparation is all within enamel.

Considerations for Preparation Design
  • Single path of insertion
  • Interocclusal clearance
  • Resistance and retentive form
  • Direct loading parallel to the long axis of the abutment teeth.

Steps to Posterior Abutment Preparation
  • Establish interproximal guide plane
  • Reduce lingual height of contour
• Develop occlusal rest seat
• Place proximal retentive grooves
• Round off sharp line angles

Considerations of Posterior Restorations
• Occlusion
• Existing restorations (enamel?)
• Length of teeth
• Esthetics
• Length of span

Design of Posterior Resin Bonded FPD
• Proximal wrap around
• Occlusal rest
• Gingival margin
• Occlusal margin
• Proximal guide plane
• Connector area
• Proximal grooves

Establish interproximal guide planes 2.5 to 3.0mm occlusal-gingivally with 6°-15° occlusal divergence parallel to the planned path of insertion.

Factors that affect the retention
• Surface area
• Resistance to torque
• Occlusal rest
• Retentive grooves

Surface area
Any area not in an undercut, with no undesirable esthetics on a bondable surface should be covered. Stay 1.0 mm below the incisal edge to avoid darkening of anterior teeth (graying).

Reduce the lingual height of contour using a round-end tapered diamond in a single plane at 0.3 to 0.4mm of reduction, 1.0mm from the occlusal edge and 1.0 mm supragingival not involving the C.E.J. Use maximal coverage with a knife-edge or light chamfer finish line while preserving the contiguous tooth.

Note: Teeth with high survey lines need to be modified to lower the survey line for the restoration.
The proximal wrap

- 180° wrap is not critical, what is critical is to resist buccal and lingual movements of the pontic tooth without the aid of the adhesive.
- Proximal wrap increases the surface area of the enamel for bonding.

The occlusal rest seat is developed using a #6 round bur to create a spoon shaped rest 0.75 to 1.0mm deep, 1.5 to 2.0 mm wide (buccolingual), and 1.0 to 1.5 mm long (mesiodistal) to resist gingival displacement. The rest is in the proximal ridge adjacent to the edentulous space and is inclined toward the center of the tooth. One rest should be on each side of the edentulous space. Proximal grooves are placed with a 169L parallel to the planned path of insertion at 0.5 mm depth and 1.0mm above the gingival margin between the lingual line angles and contact points. Placing these too far lingual or too shallow will affect the retention and longevity of the restoration.

Resistance to torque is provided by the "wrap around" design and proximal grooves, proximal guideplanes, and the single path of insertion.

Round all sharp line angles.

Cementation

Sample luting agents include:
- Comspan
- Panavia
- C & B Metabond
- All Bond

Note: manufacture’s instructions must be followed closely to assure the desired and maximal clinical properties.

Cementation of the Resin Bonded FPD

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rubber Dam (isolation)</td>
</tr>
<tr>
<td>2.</td>
<td>Pumice teeth (non-flavored, non-fluoridated)</td>
</tr>
</tbody>
</table>
### Step-by-Step Procedure for Fixed Prosthodontics

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Condition the tooth, Etched (37% phosphoric acid 30 –60 seconds)</td>
</tr>
<tr>
<td>4.</td>
<td>Rinse 45 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Place bonding agent according to the manufacture’s recommendation (both the restoration and the tooth).</td>
</tr>
</tbody>
</table>
| 6.   | Cement the restoration  
  - Assuring complete seating.  
  - Verify closed margins  
  - Hold restoration until polymerization complete |
| 7.   | Remove excess cement and finish the margins |
| 8.   | Follow-up and recall  
  - Verify bond and margins  
  - Verify occlusion |

### Common causes of Failure
- Inappropriate patient selection
- Incomplete tooth preparation
- Improper bonding
- Improper occlusion.
Section G-Dowel Cores

Overview

This section discusses the principles, indications, preparations, and construction of a dowel core. This can act as a quick reference and review for clinical construction of endodontically broken down teeth.

Patient Selection

Introduction

Untreated caries has a devastating effect on the tooth and the occlusion. Given the amount of decay and advanced state of the decay, the IHS practitioner must often make decisions as to the restorability of given teeth on a quick basis. Is the tooth worth endodontic therapy, dowel core (post and core), and a final restoration (often a crown)? What factors can help the practitioner make a clinical evaluation of restorability and longevity? The more extensive the damage, the more extensive the time and techniques for treatment and restorability and often the more decreased the chance for success over the long term.

General guidelines

The following guidelines can help assist you in determining if a tooth is restorable:

- Does the oral hygiene warrant extensive surgical and restorative procedures to save the tooth? Is recurrent decay historically a problem? (People can change but seldom do.)
- Does active and advanced caries warrant removal?
- Is decay below the level of the height of crestal bone? Will crown lengthening involve adjacent teeth? To crown lengthen a tooth the tooth on either side will have bone lowered to give an even profile. How will this affect the esthetics and caries rate?
- Does the remaining root have adequate length? Length = crown length + 4mm of apical seal.
- Is the remaining root tapered or straight? Taper will affect the ability to place a post to length while maintaining adequate diameter around the post. Tapered roots are also less resistant to lateral forces. (i.e. the third molars that “pop” right out).
- Is the root curved? Can adequate length be achieved above the curve?
- Does the remaining tooth have sufficient bulk to accept a dowel core? The thinner the root the greater the chance of root fracture and the greater the chance of perforation in preparation.
- Is acceptable esthetics conceivable without extensive periodontal procedures? You may save the root/tooth for #9 but the margin of the crown will be 4mm above #8. If the
patient has a high lip line an implant or bridge may be more esthetic.

**Mechanical Guidelines**

- Intact endodontically treated central incisors are three times as resistant to fracture as those restored with dowel cores. (Lovdahl and Nicholls). In a moderate sized anterior tooth which is intact except for the endodontic access and one or two small proximal lesions placement of a dowel core is more likely to weaken instead of strengthen it.
- If a dowel is used, the extension into the root must at least equal the length of the crown or two-thirds of the root, which ever is greater.
- A minimum of 4 mm of gutta-percha must remain after adequate length is obtained.
- A tooth with a dowel that is three-quarters the length of the crown or shorter has less chance for success than a tooth that has no dowel at all.  
  **Note** - 97.5% of dowel cores are successful if dowel length equals or exceeds the length of the crown.
- The remaining tooth structure should allow for 2.0 mm of vertical encirclement, “ferrule effect” to prevent root fracture and crown dislodgment. If the “ferrule effect” is not possible the tooth should be extracted.
- Endodontically treated teeth should not be used as abutments for distal extension partials. (Four times the failure rate of endodontically treated teeth that are not abutments.)
- If previously treated with endodontics, is the seal adequate and has the obturation been exposed for more than a few days? If so success diminishes while time and extensive care increase.
- Is the placement of a fixed bridge more predictable and less extensive?
- Keep it simple. Simple procedures have higher success rates.

**Custom Dowel Core versus Prefabricated**

**Introduction**

The dowel core is a procedure to gain increased axial wall height while trying to improve resistance form. Retention is **not** the reason to do a dowel core. The ferrule is responsible for retention. A dowel increases resistance to lateral forces applied to the crown from 15% to 48%. Non-corrosive metals such as gold, stainless steel, titanium, and chromium-containing alloys are preferred metals. New fiber-reinforced and composite material posts are being introduced into the market with improved esthetics.

Pre-fabricated posts are generally passive (cemented) or active (threaded). Threaded posts are more retentive but introduce increased stress within the remaining tooth structure. Anterior teeth and premolars generally receive the greatest benefits from the cast post. The cast dowel provides a combined dowel and core with good margins and anatomical shape. Molars on
the other hand have angled canals that require more complicated lock and key dowel core systems. The use of prefabricated post and amalgam cores provides excellent strength and resistance and simplified clinical procedures.

**Preparation of a Dowel Space**

**Introduction**

The tooth should be evaluated for adequate ferrule effect, root length, apical fill, and lateral wall prior to committing to a dowel core. Concerns with fixed abutment and removable abutments should all be addressed.

**Preparation**

After local anesthesia the tooth is prepped for the final restoration, generally Porcelain fused to metal crown. Unsupported dentin is removed and an approximate 1.0-mm contrabevel is added to the incisal or occlusal preparation. The gutta-percha should be warmed with an endodontic condenser and the removal can be started with a #6 gates glidden in the “crown down” procedure (“crown down” procedure uses decreasing sizes of gates glidden drills to remove the gutta percha from the coronal section to the desired depth). After the initial canal orifice is cleaned, a Peeso reamer should be used to complete the preparation of the canal. Safety instruments (Peeso reamers) are available with safety tips to keep the instrument within the canal proper. This will limit perforations.

Once the predetermined depth is reached, a radiograph should be exposed to determine if adequate depth is achieved and adequate seal remains. Graduating with 0.2 mm increases (decrease the chance of perforation) the canal should be enlarged to the desired depth and size (less than one-third the mid root dimension). A smooth canal without undercuts should be attained.

Using the acrylic lubricant, die lube, or Vaseline a paper point is used to coat the walls of the canal. A prefabricated plastic dowel pin (burnout pin) is inserted and adjusted to seat fully without wall engagement. The pin should be measured to ensure full seating. Dispense the powder and liquid (GC America resin or Duralay) into two separate dappen dishes. Using a disposable brush dip the brush into the liquid and then the powder to form a small amount of acrylic. Now apply the acrylic until the post is adequately covered and insert the plastic post into the prepared and lubricated canal. Seat the pattern firmly and hold until the resin has a doughy consistency. Pump the pattern in and out of the canal to assure removal. After set, observe the pattern and repeat above steps until an accurate duplicate of the canal space is formed. Ensure that the margin along the bevel is completely closed. Now add more bulk to the coronal portion to recreate the ideal crown preparation. Using carbides and sandpaper disc trim
the pattern to ideal proportions and smooth. After complete set re-evaluate the pattern for accuracy. Remove lubricant from the pattern surface. The pattern is now ready for investing and casting.

**Prefabricated Patterns and Post**

Because of the many varieties of prefabricated posts they will be discussed only in general. The instructions with each kit should be familiar to clinic personnel. The appropriate size post should be selected and adequately prepared. When adjusting the post do **NOT** cut off the end of the post intended to be seated in the canal space. This will give unwanted stress distribution and could lead to root fracture. Most kits provide drills with the kit. Gates and Peeso reamers can be used and the final post space completed with the appropriate drill from the kit.

Select the appropriate “post” from the kit and adjust to length. The “post” should have good adaptation to the wall. It should not wobble in the preparation. When trimmed and seating is assured the “post” can be cemented with the appropriate cement.

**Cementation of the Custom Dowel**

After adequate isolation, the temporary should be removed and the post space cleaned to remove all temporary cement and debris. Carefully seat the post and adjust using disclosing spray (i.e. occlude), rouge, or disclosing silicone (i.e. fit-checker) to evaluate fit. The dowel should fit to place without binding or pressure. Evaluate the margins and assure complete seating of the dowel core. Some advocate the use of a channel created by a bur in the lateral wall of the dowel to allow the cement to escape. When acceptable, clean the dowel and cement with appropriate cement (I personally do not recommend resin cements). Assure complete seating of the dowel core. The use of an ultrasonic condenser can help assure complete seating of the dowel core. Allow 24 hours before further preparation to allow for complete cement setting.

**Note:** If using a noble metal and resin bonding is desired the dowel should be cleaned and tin-plated to assure adequate bonding.
Section H—All Ceramic Restorations

Overview

The demand for high esthetic prosthetics continues to grow. To meet this need the dental community continues to seek new and improved methods and materials. Each of these materials has individual limitations and techniques for success. An overview of all-ceramic restorations is provided but each provider should familiarize himself with the selected ceramic and its individualities.

Ceramics have excellent tissue compatibility and esthetics. Ceramics exhibit high compressive strength. Tensile strength is 10–20 times lower than compressive strength and fracture is evident in shear. A ceramic’s strength is adversely affected by flaws, scratches, defect number, and size. Ceramics propagate cracks whereas metal blunts them. Ceramics are brittle and must be supported.

The porcelain jacket crown was developed in 1886. In 1965 Mclean and Hughes developed an inner core of alumina porcelain containing 40% to 50% of alumina crystals to improve material characteristics. Later, platinum foil was included to further improve the porcelain crown. In the 1980’s Dicor, a castable ceramic became widely used. It proved to have a high failure rate in the posterior. Today the latest generation of materials utilizes high strength ceramics with composite materials to reinforce the ceramic. Today’s materials include Procera, In-Ceram, Empress I and Empress II.

<table>
<thead>
<tr>
<th>Ceramic</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Powder- Slurry</td>
<td>Vita</td>
</tr>
<tr>
<td>Castable</td>
<td>Dicor, Cerestor, Cerapearl</td>
</tr>
<tr>
<td>Pressable</td>
<td>IPS Empress, Empress II, Optimal Pressable</td>
</tr>
<tr>
<td>Infiltrated</td>
<td>In-Ceram</td>
</tr>
<tr>
<td>Machinable</td>
<td>Procera, Cerac II, Cerac III</td>
</tr>
</tbody>
</table>

A short overview will be given for familiarization
**Dicor**

**Description of Dicor**
Dicor is a castable glass. The glass was Cerammed (reheated) to grow crystals to improve strength. Colorants are added to give appropriate shade. This crown is not in wide use today due to failures.

**Procedure for Dicor**
An impression is made using any adequate impression material. The crown is waxed to full contour and the lost wax technique used. After “burn-out” the glass was cast into the mold. The ceramic cooled and was then re-heated to allow crystal growth to improve strength (ceramming). Colorants were added and the crown/inlay was returned for delivery. Later Dicor cores were constructed and veneered with conventional porcelain similar to Procera and In-ceram. The system is not in wide use today.

**Procera**

**Description for Procera**
Procera is a dense (99.9 % pure) sintered aluminum oxide ceramic core. It had 7 to 10 years of clinical success. Procera can be cemented with any conventional cement or bonded. The anterior coping is 0.4mm if high esthetics is needed. In anterior and posterior regions the normal 0.6mm coping is available. Procera can be used for limited three-unit bridge applications with a minimum connector height of at least 3mm and maximal edentulous space (pontic) of 11mm in length. The laminate is available at 0.25 mm thick. Procera has no glass phase. The inner surface is rough due to manufacture that is similar to the etched porcelain. The core can not be etched.

**Procedure for Procera**
For Procera an impression is obtained using any material that provides adequate accuracy. The laboratory creates a die that is placed in the Procera scanner. The three-dimensional contours of the die are measured and recorded as data points. This data is sent to the manufacturing lab. The pre determined cement space is programmed. An oversized coping is constructed and used to press a coping. This coping is returned to the dental lab for porcelain veneering. The case is returned to the provider for delivery.

**IPS Empress I**

**Description for IPS Empress I**
IPS Empress I is an injection-molded leucite-reinforced ceramic with control glass crystallization. IPS Empress I had about 8-12 years of clinical experience. Manufacturer recommends Variolink resin cement. The material does not have sufficient strength for bridges.
The material can be etched for bonding. Temperature is used to control the formation of the reinforcing phases.

**Procedure for IPS Empress I**
The impression is taken with any adequate impression material. A die is produced and a traditional wax crown is constructed. The wax pattern is invested and burned out. IPS Empress I high-leucite ingots are heated to a plastic state and pressed into the mold made by the lost wax technique. The crown is stained and completed and returned for delivery.

**IPS Empress II**

**Description for IPS Empress II**
IPS Empress II is injection molded Lithium disilicate (probably should have a different name since it is a different material). It has 2-3 years of clinical service. It is recommended by the manufacturer that resin bonded cements be used (Variolink recommended by manufacturer). IPS Empress II can be used for limited anterior and premolar three-unit bridges. The connector height and width is determined from a chart according to the position in the mouth (i.e. central incisor versus a premolar).

**Procedure for IPS Empress II**
IPS Empress II using the Lithium disilicate uses the same lost wax technique and pressure as Empress I. However, Empress II uses a fluorapatite layering ceramic and is returned for delivery.

**In-Ceram**

**Description for In-Ceram**
In-Ceram uses an Alumina Slip Cast technique to create a glass infiltrated alumina coping. Alumina is slip cast and sintered to form a core. The core is then covered with glass and fused to allow infiltration. In-Ceram has been used successfully for 5-10 years of clinical service. Manufacturers recommended that the crowns and bridges be cemented with glass ionomer cement and inlays be cemented with Panavia 21 or Variolink. In-Ceram is recommended for limited three-unit anterior bridges. In-Ceram is not etchable and has a core thickness of 0.5mm.

**Procedure for In-Ceram**
An impression is made using any adequate impression material. The laboratory creates a plaster die that can absorb moisture as the fine alumina particles are “stacked” onto the die. The core structure is sintered to form a core. Glass is painted onto the alumina structure. This is re-fired to allow the glass to infiltrate the alumina. The coping is the refined and veneered with conventional porcelain and returned for delivery.
Other In-Ceram Ceramics
In-Ceram- Alumina and Zirconia (not currently released yet on the market at the time of printing).
In-Ceram- Magnesium aluminous spinel (aluminum and magnesium oxide core).

<table>
<thead>
<tr>
<th>In-Ceram Material</th>
<th>Flexural Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>500</td>
</tr>
<tr>
<td>Zirconia</td>
<td>700</td>
</tr>
<tr>
<td>Spinell</td>
<td>350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Ceramic</th>
<th>Flexural strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dicor</td>
<td>Castable</td>
<td>100-200 MPa</td>
</tr>
<tr>
<td>Empress</td>
<td>Pressable</td>
<td>100-200 MPa</td>
</tr>
<tr>
<td>Empress II</td>
<td>Pressable</td>
<td>200-400 MPa</td>
</tr>
<tr>
<td>In-Ceram</td>
<td>Slip Cast</td>
<td>&gt;400 MPa</td>
</tr>
<tr>
<td>Procera</td>
<td>Machinable</td>
<td>&gt;400 MPa</td>
</tr>
</tbody>
</table>

General Preparation for All Ceramic Crowns

Introduction

General considerations for porcelain crowns, joints, and veneers include smooth rounded preparations with a lack of sharp angles, crevices, or sharp anatomy.

- The margin should be prepared as a shoulder with rounded cervical line angle.
- Moderate depth chamfer design can be used with some systems.
- Rounded smooth contours with a lack of sharp angles.
- Rounded inner angles and edges.
- Defined marginal reduction generally 1.0 mm.
- Incisal/Occlusal cutting depth 1.5 to 2 mm with relatively flat surface topography.
- Uniform circular preparation without grooves
- The shoulder preparation should have an angle of 90-120 degrees.
- Flat chamfers, tangential preparations and bevels are contraindicated.

General Cautions

- Increased risk of pulpal involvement due to extensive reduction.
- Increased loss of tooth structure.
- Metal dowels and amalgam can show through.
- Avoid all sharp edges and corners.
• Avoid tapered margins, feathered-edges, and beveled shoulders.

Note- marginal gingiva preparation, axial height, retention, and resistance form are defined as conventional crowns.

These are general conditions and preparations should follow guidelines for the desired material.

<table>
<thead>
<tr>
<th>Material</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empress</td>
<td>Excellent fit, Very Esthetic, Etchable</td>
<td>Weaker than others, New equipment, No bridges</td>
</tr>
<tr>
<td>Empress II</td>
<td>Excellent fit, Good strength, Bridges possible, Etchable</td>
<td>Opacity</td>
</tr>
<tr>
<td>In-Ceram</td>
<td>High Fracture Strength, Good marginal adaptation, Good esthetics, Good clinical performance (5-10 years)</td>
<td>Collar can be opaque, Min core thickness of 0.5 mm, Not etchable or bondable, Labor intensive, Technique sensitive</td>
</tr>
<tr>
<td>Procera</td>
<td>Good fitting, Esthetic, Bridges achievable, Reduced fabrication cost, Any conventional cement</td>
<td>Turn around time (new lab in U.S may help), Not etchable, Coping 0.4 to 0.6mm</td>
</tr>
</tbody>
</table>

Warning- Contrary to popular belief, resin cements are not a cure for open margins. Resin cements have no appreciable dissolution in saliva but they do leak. Open margins should be remade as with conventional crown and bridge.

<table>
<thead>
<tr>
<th>Product</th>
<th>Material</th>
<th>Recommended Cement</th>
<th>Bridge Compatible</th>
<th>Coping</th>
<th>Process</th>
<th>Years of Clinical use</th>
<th>Manufacture Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procera</td>
<td>99.9% sintered aluminum</td>
<td>Any</td>
<td>Yes</td>
<td>0.6 mm any area 0.4mm</td>
<td>Scan CAD/CAM</td>
<td>7-10 yrs</td>
<td>Veneer Crown Bridge</td>
</tr>
<tr>
<td>Material Type</td>
<td>Oxide Type</td>
<td>Resin Bond</td>
<td>Veneer</td>
<td>Crown</td>
<td>Bridge</td>
<td>Inlay</td>
<td>Onlay</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>------------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>Empress I</td>
<td>Leucite reinforced ceramic</td>
<td>Resin bond Variolink</td>
<td>No</td>
<td>N/A</td>
<td>Lost wax pressable</td>
<td>8-12 yrs</td>
<td>Veneer Crown Inlay Onlay</td>
</tr>
<tr>
<td>Empress II</td>
<td>Lithium disilicate</td>
<td>Resin bond</td>
<td>Yes (anterior and premolar 3 unit)</td>
<td>Chart calculator</td>
<td>Lost wax pressable</td>
<td>2-3 yrs</td>
<td>Veneer Crown Bridge Inlay Onlay</td>
</tr>
<tr>
<td>In-Ceram</td>
<td>Glass infiltrated alumina</td>
<td>Glass Ionomer (C and B) Panavia 21 and Variolink (inlay)</td>
<td>Yes (3 unit ant bridge)</td>
<td>0.5 mm Slip cast</td>
<td>5-10 yrs</td>
<td>Veneer Crown Bridge Inlay Onlay</td>
<td></td>
</tr>
</tbody>
</table>
Section I – Implants

Overview

Implants continue to increase in popularity. With the increased number of implants being placed it is imperative that Indian Health Service be prepared to meet the needs of recall and maintenance. This section is intended to provide guidance for identification, recall evaluations, and maintenance of the fixture and restoration(s).

General Policy

If a patient comes into a Health Care Facility with a problem implant, the person should be referred back to the provider that placed the implant. If the provider is in another state and a return visit is not possible the patient should phone the provider and ask for a local referral office. Only if all other options fail should a provider become involved with care. Implants rarely appear as an acute problem and palliative treatment can be used until the person returns to the restorative or surgical office.

Basic types of Endosseous Implants

External hex/ Butt joint
1. Branemark by Noblepharma
   a. Mark III
   b. Mark IV (Stargrip)
2. 3-I by Implant Innovations
3. Steri-OSS HL by Steri-OSS (now Noblepharma)
4. Steri-OSS replace by Steri-OSS/Nobelpharma
5. Swede Vent by Dentsply (Paragon)
6. Impla Med by Sterngold Impla Med
7. Restore by Lifecore
8. Interpore Hex by Interpore Intl.
9. Crossmark by Osteo Implant
10. Bud by Great Lakes Orthodontics
11. Minimatics by Minimatics
12. Maestro System by Biohorizons
13. Threadlock by Calictek
14. Imtec by Imtec
15. Restore by Lifecore
16. Hextrac by Osteomed
17. Star-Vent by Park Dental Research
Spline and Similar
1. Spline by Sulzer Calicitek
2. Star-Lock by Park

Internal Hex/ Bevel joint
1. Spectra System by Dentsply (Paragon Implant Company)
   a. Screw Vent
   b. Micro Vent
   c. Bio Vent
   d. Core Vent
   e. AdVent- Paragon
2. Friatec by Frialit (two stepped)

Butt Joint
1. Integral by Calcitek
2. Steri-OSS std by Steri-OSS
3. ImplanTatum by Omni Intl.

Internal Hex joint
1. HA-Ti by Mathys AG
2. Mini by 3-I Platform
3. Frialit by Friadent (deep internal hex with parallel walls)
4. Frialit-2 by Friadent

Internal Octagon joint
1. Omnilock by Calcitek
2. Swiss Plus by Swiss Plus

Internal Bevel joint
1. ITI by Straumann (8 degree)
2. Astra by AstraTech (11 degree)
3. Sustain by Lifecore
4. Bicon system

Polymer Butt Joint
1. IMZ by Interpore Intl. (now owned by Steri-Oss)

Internal Lug Connection
1. Steri-OSS Replace Select by Nobelpharma (Steri-Oss)
Transitional Implants
   1. IPI (Immediate Provisional Implant) by Steri-OSS

Note- Names of Implants Systems Change as the Manufactures are purchased and consolidated by other manufactures. This has been a frequent event over the last decade.

The list above is not all-inclusive or complete. The information and products on the market change daily and will continue to do so. Some implants are out of production but may have a 100,000 or more fixtures already in service. These implants still need service, maintenance, and new prosthetic components replaced.

Endosseous Implant Identification

Fortunately identification of the specific type of implant is not necessary for routine maintenance. It is advisable to contact the surgeon that placed the implant(s) and record the information in the record for future reference before any urgent conditions occur. If identification is necessary the above list can be used to help narrow the field. The best source is the surgeon. Any interface color should be noted. If not available, a radiograph may be helpful in identifying the implant. Recommend that the patent acquire the information and carry the information with them. Dental practitioners retire and move and information is much more difficult to acquire at a later date.

Contacting the surgeon

Give the surgeon what information is available to you. (i.e. external hex that is blue in color). Request the Type of Implant, Manufacturer, Coatings, Diameter, and Length.

Sample: Replace by Steri-OSS, HA coated, threaded, 5.0 diameter X 13 mm length.

This information is necessary to order restorative components (i.e. screws, abutments, etc). Types of coatings are necessary to predict grafting outcomes and procedures and the type of procedure necessary for removal.

Maintenance

Do’s
   • Evaluate oral hygiene and the debris around the implant.
   • Evaluate the color of the tissue around the implant where it emerges from the gingiva.
The tissue should be pink and healthy in appearance.

- Note if any exudate comes out around the implant with palpation around the gingiva.
- The implant should have NO mobility. There is no periodontal ligament and no movement. If movement is seen the implant has failed and should be evaluated for removal. The patient should be referred back to the surgeon who placed the implant.
- Evaluate the radiograph for bone height, pocket formation, or atypical appearance.
- Use graphite or plastic scalers to clean calculus from around the implant.

**Don’ts**

- Don’t use any metal instrument on the implant. A scratch on the implant surface creates a flaw on the surface that looks more like a valley to bacteria.
- Only probe into the sulcus around the implant if there is a suspicion of a problem (i.e. pus, inflammation, or a complaint). Be sure to use a plastic probe. The implant does not have a “true” hemidesmosome attachment. Unnecessary probing disrupts the minimal “gingival seal” and allows direct access to the bone and could potentate an infection.
- Don’t use pumice and prophy paste can scratch the implant surface.