University of Minnesota
School of Dentistry

Fixed Partial Denture

Self-guided Instructional Material
for Dental Students

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### I. Module Information

*Fixed Prosthodontics* is a branch of prosthodontics concerned with the replacement and/or restoration of teeth with artificial substitutes that are not readily removed from the mouth. A *Fixed Partial Denture (FPD)* is a restoration that is luted or otherwise securely retained to natural teeth, tooth roots, and/or dental implant abutments that furnish the primary support for the prosthesis.

In this module, we are going to learn how to prepare teeth to receive a 3-unit fixed partial denture on posterior teeth (Fig. 1) and anterior teeth. Preparing multiple teeth to receive single crown restorations is no different than preparing multiple teeth to receive a *fixed partial denture*, except that the latter requires an understanding of something called *path of insertion* (Fig. 2).

The goal of this module is to apply the concept of path of insertion and demonstrate the preparation of multiple teeth to receive a FPD that has one common path of insertion. This is a sharp contrast to having several individual teeth preparations that do not share the same path of insertion as seen often among beginners of this module.

This module also introduces one to the *dental surveyor*. This instrument will serve as a guide in producing preparations that share a common path of insertion. However, the learner should realize that there are other uses for and purposes of the dental surveyor that are not discussed, as they are beyond the scope of this module.

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**Table: Fixed Partial Denture**

<table>
<thead>
<tr>
<th>Restoration / Teeth #</th>
<th>Ideal FPD Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPD-Full Gold Crown (FGC) / 29-x-31</td>
<td>Estimated Set Up Time: 30 mins</td>
</tr>
<tr>
<td>Extensions: FPD-Porcelain Fused to Metal (PFM) / 9-x-11 FPD-Porcelain Fused to Metal (PFM) / 12-x-14</td>
<td>Estimated Completion Time: 6 hours</td>
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**Prerequisite:** Users of this module should be familiar and knowledgeable in preparing Full Crown Restoration (single tooth restoration).
II. Set-up of the Articulated Teeth

Since this is a simulated exercise, all tooth preparations should be done on a Frasaco ® Model mounted on a dental simulator.

1. Locate your typodont with a full complement of teeth.
2. Remove tooth #30
3. Cover the socket of tooth #30 with wax (Fig. 3).
4. Mount the typodont in the simulated patient head.
5. Prepare your instruments (handpiece, burs, instruments, etc.)

Clinical Relevance

People lose their teeth for several reasons. Generally, teeth are lost because of (1) caries, (2) periodontal disease, (3) trauma and sometimes (4) iatrogenic causes. The probable consequences brought about by tooth loss are of great importance. These consequences generally include loss of function, esthetics and even a patient’s confidence and self-esteem. Other specific dental consequences may include drifting or tipping of adjacent teeth and supraeruption of antagonist teeth into the edentulous space. These local events may lead to pathologic changes in the dentition that require treatment. The changes may also be seen as adaptations that stabilize the dentition. In the latter case, no treatment may be necessary. Therefore, one should know when intervention is necessary.

Treatment interventions for patients who have lost teeth include dental implants, removable partial dentures (RPD) and fixed partial dentures (FPD). Each treatment modality has unique indications and contraindications as well as advantages and disadvantages. One should carefully examine each patient in order to provide a sound diagnosis and appropriate treatment recommendations.
III. Preparing Teeth for Fixed Partial Dentures

The following steps are the recommended treatment approach for beginners. These steps include the (a) use of the dental surveyor to select and analyze the path of insertion, (b) simultaneous preparation of the abutment teeth, (c) use of the dental surveyor to evaluate the path of insertion of tooth preparations, and (d) modification of the preparations at the established path of insertion.

Instructor’s Note

Listed below are the definitions of key terms used in this module. Please be familiar with these terms before you proceed with the tooth preparations.

a. Dental Surveyor
   • A paralleling instrument used in construction of a dental prosthesis to locate and delineate the contours and relative positions of abutment teeth and associated structures.
   • For an FPD, it is used to determine the presence of undercut and to determine path of insertion.

b. Undercut
   • The portion of the surface of an object that is apical to the height of contour in relationship to the path of placement or insertion.
   • For an FPD, any irregularity in the wall of a prepared tooth that prevents the withdrawal or seating of a wax pattern or casting.

c. Path of Insertion or Placement
   • The specific direction in which prosthesis is placed onto abutment teeth.

d. Abutment Tooth
   • That part of a structure that receives thrust or pressure.
   • A tooth, a portion of a tooth, or that portion of a dental implant that serves to support and / or retain prosthesis.

A. Use of Dental Surveyor to Analyze Path of Insertion

The goals of this procedure are to (1) analyze tooth morphology and (2) determine the single path of insertion, for abutments that are to receive a fixed partial denture. This can be accomplished with a diagnostic cast and with the help of a surveyor.

1. Diagnostic Cast
   a. Make an alginate impression of your simulated patient with missing tooth # 30
   b. Pour your impression in dental stone (Microstone®)
   c. Trim your diagnostic cast neatly
   d. Position your cast on the dental surveyor
2. Ready your dental surveyor
   a. Familiarize yourself with this instrument
      i. Dental surveyor and survey table (Fig. 4a)
      ii. Survey rods (Fig. 4b)
      iii. Survey rods used for this module (Fig. 4c)

3. Place the diagnostic cast on the survey table (Fig. 5)
4. Attach the analyzing rod.
5. Begin the analysis. This involves tilting the survey table while the cast is oriented against the analyzing rod. This procedure helps with the following:
   a. Determining the contour of the abutment teeth and the adjacent teeth
      i. Locate convexities of the teeth
      ii. Locate anatomical undercuts
   b. Identifying the long axis of the abutment teeth
   c. Identifying the occlusal plane of the arch
   d. Determining the desired path of insertion for an FPD
6. See Instructor’s Note Below:

### Instructor’s Note

Using the Dental Surveyor to Analyze the Cast and Determine the Path of Insertion

To set up your cast for analysis, secure the cast on the survey table and position the survey rod within the vertical arm of the surveyor. Once set, look carefully at the anatomical contour of your abutment teeth (see A). Notice the degree of convexity. Teeth vary in contour. Some are flat while others are more convex. Next, determine the occlusal plane. This can be done by looking at the cusps and incisal edges of all the teeth in the arch and visualizing a straight line connecting these points (see B). Use an occlusal plane as your reference, and position the analyzing rod perpendicular to the occlusal plane both anterioposteriorly and from right to left (see C). This line is represented by your survey rod (see D). The location at which the analyzing rod is tangent to the convexity of the abutment tooth is called the “height of contour”. The area apical to the height of contour forms a triangle is called an area of undercut. (see E) This area must be removed during preparation of any tooth that is to receive a full coverage restoration.

When determining the “path of insertion”, the goal is to establish that path at a line perpendicular to the occlusal plane. This direction facilitates FPD wax pattern fabrication, casting, restoration insertion and removal without interfering with adjacent teeth. However, tooth alignment varies from patient to patient. In situations where you cannot establish a path of insertion that is perpendicular to the occlusal plane, you may consider using the long axis of the abutment teeth (see F) as the path of insertion. OTHER ORIENTATIONS OF PATH OF INSERTION CAN BE USED AS LONG THAT PATH ELIMINATES UNDERCUTS ON THE ABUTMENT TEETH AND THE ADJACENT TEETH.

After preparation, the adjacent tooth contour can create an undercut relative to the determined path of insertion. If this is the case the adjacent tooth must be recontoured to facilitate an unobstructed path of insertion (see G).
7. Remove the analyzing rod from the surveyor and replace it with the carbon marker and carbon rod holder. Use the carbon marker to draw a vertical line along the mesiodistal center of each abutment tooth. Position the carbon rod cervical to each abutment and raise the vertical arm of the surveyor scribing a line on the abutment tooth. These lines represent the direction of the path of insertion (Fig. 6).

8. Place your typodont in simulated patient head.
9. Examine your abutment teeth (Fig. 7). Use the information obtained from cast analysis on in the dental surveyor. Take note of the following:
   a. contour of the abutment teeth and teeth adjacent to abutments
      i. convexities of the teeth
      ii. anatomical undercuts
   b. long axis of the abutment teeth
   c. occlusal plane of the arch

B. Simultaneous Preparation of Abutment Teeth

The goal of this procedure is to prepare the two abutment teeth simultaneously while establishing a single path of insertion. This procedure is similar to the procedure of preparing an individual tooth for a full crown in that the path of insertion is established while the abutment tooth is prepared. However, when preparing multiple teeth for a FPD, the path of insertion is established as each of the abutment tooth is prepared.
10. On your typodont, visualize the path of insertion you wish to create during abutment preparation by using a perio probe. This path of insertion should be identical to the path you selected during your cast analysis with the dental surveyor (Fig 8a and 8b). In this particular case, the path of insertion is oriented perpendicular to the occlusal plane.

11. Appreciate that there must be one common path of insertion for both abutment teeth.

12. Perform initial proximal reduction on the mesial of the more anterior abutment tooth, #29. Orient your bur in a position that will allow axial reduction of the mesial wall 3 degrees from the desired path of insertion (Fig. 9a).

13. Proceed with the proximal reduction on the distal of the more posterior abutment tooth, #31. Orient your bur in a position that will allow axial reduction of the mesial wall 3 degrees from the desired path of insertion (Fig. 9b).
14. Examine your initial proximal reduction. Make sure that you have maintained proper bur orientation during the proximal reduction phase of preparation. Again, you must reference your desired path of insertion and the occlusal plane (Fig. 10):
   a. Occlusal plane
   b. Path of insertion (line perpendicular to the occlusal plane)
   c. 3 degree taper of the abutment teeth

15. Use your mouth mirror to verify the development of the path of insertion (Fig. 11). At this point you are only checking the mesial and the distal aspects of the fixed partial denture abutment to ensure that they draw. Because you are evaluating draw, it is imperative that you do not change angulation of the mirror as you view the preparations. Only bodily movement of the mirror is acceptable (Fig. 12).
16. You should be able to see the margins created on the mesial and distal areas of the abutment teeth at an angle of view coincident with your desired path of insertion. (Fig 13).
17. Continue with the proximal reduction. Reduce the mesial surface of the more posterior abutment (Fig. 14a) and the distal surface of the more anterior abutment (Fig. 14b). Three degrees of taper relative to the desired path of insertion should be achieved.

**Instructor’s Note**

Preparing teeth to receive a fixed partial denture requires establishment of one common path of insertion for the abutment teeth. In order to achieve a common path of insertion, one should look at the abutment teeth not as individual entities, but rather as one unit. Realize that just like individual crowns, an FPD is one restoration regardless of the number of abutment teeth involved in the restoration. Therefore, the final goal for a full crown preparation is the same as the goal for fixed partial denture.

Since a fixed partial denture is one unit, simultaneous reduction of the abutment teeth is highly recommended. This is a prudent approach that ensures that the path of insertion is always taken into consideration. Initial tooth reduction should include the gross reduction of axial walls, which facilitates the removal of anatomical undercuts and establishes the 3 degrees of taper of each axial wall relative to the path of insertion. Fine reduction, which includes creation of the proper depth and contour of the margins, can be done once the path of insertion has been established.

The creation of the one common path of insertion takes effort on your part. You should always check the path of insertion after each step of tooth reduction. Use your mouth mirror at an angle of view that is parallel to the desired path of insertion. Check the more posterior abutment to see if you can clearly identify the margin. Next, move the mouth mirror bodily without changing the angulation to view the more anterior abutment tooth (Fig. 12). If you do not see the preparation margin of the anterior abutment without changing the angulation of the mouth mirror, one of two things has occurred. 1) You may have positioned the mouth mirror at an angle inconsistent with the path of insertion when viewing the posterior abutment, or 2) you may not have established a path of insertion that is common to both abutment teeth. If the latter is found to be the case, further axial reduction along the desired path of insertion in indicated. Please note that a change in the angulations of the bur will be necessary (Fig. 13).
18. Again, examine the proximal reduction. Make sure to keep the tapered bur parallel to the desired path of insertion. Again, take note of the following. (Fig. 15):
   a. Occlusal plane  
   b. Path of Insertion (line perpendicular to the occlusal plane)  
   c. 3 degree taper on the abutment teeth

![Fig. 15. Remember your orientation]

19. Use your mouth mirror to verify the development of the path of insertion (Fig. 16). You should be able to see the preparation margins created on the proximal areas of each of the abutment tooth at view angle consistent with the path of insertion. Essentially, you are ensuring that both preparations share a common path of draw (Fig. 17).

![Fig. 16. Use a mouth mirror to check for the development of path of insertion](Image139x121)

![Fig. 17. Margins are clearly identified when viewed along the path of insertion](Image270x256)
20. Next, proceed with the lingual axial reduction of the abutment teeth. Orient the bur by using appropriate references. One must now take into consideration the desired buccolingual orientation of the bur. Because the selected path of insertion was perpendicular to the occlusal plane, one must orient the bur perpendicular to the occlusal plane (Fig. 18a). If done correctly, this will ensure that each axial wall is 3 degrees from the path of insertion (Fig. 18b).

![Fig. 18a. Verify Orientation](image1.png) ![Fig. 18b. Lingual reduction](image2.png)

21. Use the mouth mirror to verify the development of the path of insertion. One should be able to see the margins created on the proximal and the lingual surfaces of each of the abutment tooth at an angle of view that is consistent with the path of insertion (Fig. 19).

![Fig. 19. Margins are clearly identified when viewed along the path of insertion](image3.png)

Clear margins seen at a view angle of determined path of insertion
22. Buccal reductions follow the same orientation as that of the lingual reduction. At the end of this step, one should be able to see the entire circumference of the prepared margin (Fig. 20). If prepared margins can be seen circumferentially on both abutments when viewed along the same angle, a path of insertion has been successfully created. If not, continue with the axial reduction until the entire circumference of the preparation margin can be seen at an angle of view consistent with the desired path of insertion.

23. Continue with the FPD preparations by reducing the occlusal surfaces according to the type of restoration desired and corresponding specifications (Fig. 21a). Note that this procedure does not affect the path of insertion. However, it is always good practice to intermittently verify your path of insertion as you continue with further preparation of the abutment teeth (Fig. 21b).
24. Check your preparation and make any modifications needed to idealize the preparation (Fig. 22).

Fig. 22. Modify preparations as needed

Clinical Relevance

Since tooth preparations for fixed partial dentures are done intraorally, one must use the mouth mirror to verify that all abutments share one common path of insertion. This is one reason the operator should practice the use of the mouth mirror during each step of tooth preparation. This will aid the operator in the development of clinical skills necessary to both establish and evaluate a path of insertion.

However, there are several situations in which it is difficult to verify path of insertion by using the mouth mirror. These situations may involve cases in which there are more than two abutments that are far apart in the same arch from one another and abutments that have noticeable differences in axial inclinations. In these situations, there are two techniques that may prove useful in the evaluation of path of insertion. The first involves the use of an intraoral photography mirror. This mirror is much larger than a mouth mirror, yet it can be placed intraorally to allow inspection of multiple abutment teeth simultaneously. The second technique requires the use of a dental surveyor and a stone model of the FPD preparations. To implement the technique, an alginate or VPS impression of the preparations is made and poured in quick setting stone. The resulting cast is then placed on the dental surveyor for extraoral evaluation of path of insertion. With both techniques, areas of preparation modification can be identified to create a common path of insertion shared by all abutment teeth.
C. Use of Surveyor to Evaluate One Common Path of Insertion

25. Make an impression of the preparations. Impressions may be made with alginate or vps putty material (Fig. 23a and 23b). The impression must capture all FPD abutments as well as any teeth adjacent to those abutments. The contours of the adjacent teeth are needed to ensure that their contours do not interfere with the planned path of insertion for the FPD.

![Fig. 23a. Quadrant impression using a putty material](image)

![Fig. 23. Impression captures FPD abutments as well as adjacent tooth](image)

26. Pour your impression with a Microstone® and slurry water, quick setting plaster or another fast setting stone. Once set, gently remove the cast from the impression to avoid breaking the abutment teeth. (Fig 24a and 24b).

![Fig. 24a. Pour impression with a quick setting stone](image)

![Fig. 24b. Remove the cast from the impression](image)
27. Prepare your cast for use on the dental surveyor. Remove any positive blebs from the axial walls of your preparations that may interfere with surveying of the cast. Trim the base and sides of the cast so that it is neat and can be easily positioned and secured on the survey table (Fig. 25a and 25b).

28. Place the cast on the survey table. Since the survey table is made to accommodate the size of the full arch cast, a tongue depressor can be used to stabilize a smaller quadrant cast (Fig. 26).
29. Orient the cast so that the FPD preparations are aligned with the desired path of insertion. Tilt the survey table as needed to make minor modifications in the orientation of the cast relation to the survey rod. Move the survey table around the base of the dental surveyor to evaluate the orientation of the axial walls of the preparations against the survey rod (Fig. 27a). Remember that the survey rod is the visual indicator of the path of insertion. Ideally, you should see a 3 degree taper from each axial wall to the survey rod (Fig. 27b). NO UNDERCUTS SHOULD BE PRESENT. Use the following criteria to evaluate your FPD preparations:

a. Abutments and Path of Insertion
   i. Is a path of insertion present for each abutment?
   ii. Do both abutments share the same path of insertion?
   iii. Do the abutments have more than one possible path of insertion? (typically seen in cases where the preparations are over tapered)

b. Common Orientation
   i. Is the path of insertion perpendicular to the occlusal plane?
   ii. Is the path of insertion parallel to the long axis of the teeth?

c. Modification of the adjacent teeth
   i. Do contours of teeth adjacent to the FPD abutments interfere with the path of insertion and, therefore, seating of the final restoration?
   ii. Would modification of adjacent tooth structure allow an uninterrupted path of insertion and seating of the final restoration?
   iii. If modification of adjacent tooth structure would allow seating of the final restoration, is the amount of reduction appropriate? Would further preparation of the abutments be a more realistic course of action?

Fig. 27a. Evaluation of axial walls in relation to path of insertion as represented by the survey rod

Fig. 27b. Ideal 3 degrees of taper from axial wall to survey rod
30. During the evaluation of the path of insertion on the dental surveyor, determine if increased taper is needed to allow proper path of insertion. (Fig. 28a). Also, determine if further tooth reduction is needed to remove areas of undercut on the preparations (Fig. 28b). Again, an undercut is any irregularity in the wall of a prepared tooth that prevents the seating or withdrawal of a wax pattern or casting. On the dental surveyor, an undercut can be identified when a triangle which forms within the negative space between the axial wall and the survey rod. The apex of the triangle always points towards the occlusal aspect of the preparation. The undercut can be removed by preparing the axial wall 3 degrees from the desired path of insertion (Fig. 28c).

**Fig. 28a.** Axial wall parallel to the survey rod must be tapered

**Fig. 28b.** Axial wall exhibits undercut when placed against the survey rod at the desired path of insertion; the undercut must be removed.

**Fig. 28c.** Axial wall with ideal taper and relation to the desired path of insertion.
D. Modifying Preparation at an established Path of Insertion

31. Return to the simulated patient and modify the preparations based on the extra oral analysis just performed. (Fig. 29). Refine and complete the preparations.

32. Evaluate the reduction performed on individual abutment preparations based on the requirements of the restorative material.

CONGRATULATIONS! You have finished the Fixed Partial Denture self-guided instructional material. You may now proceed to the extension portion of the module. In the next step, you will prepare teeth to receive other types of fixed partial denture restorations. You will need to apply what you have learned in this module as you progress through subsequent exercises of the extension portion. This is especially designed to develop your skills in the selection and creation of path of insertion. The extension will provide you with further practice of FPD preparations on anterior teeth and teeth in posterior maxilla. We hope you develop efficiency with these extensions. Good luck!

Instructor’s Notes on Instructional Material’s Extensions

The extension is designed to further enhance your dexterity in tooth preparation for fixed partial dentures. You will be provided with the basic guidelines for abutment preparation however, you should be able to use your own judgement to determine the appropriate path of insertion for each extension.
FPD-Porcelain Fused to Metal (PFM) / 9-x-11

PATH OF INSERTION

LONG AXIS

AXIAL TAPER

OCCLUSAL PLANE
Clinical Relevance

Establishing a path of insertion for anterior teeth is more involved than simply choosing a path of insertion that is perpendicular to the occlusal plane of the arch. Because of the normally proclined position of the anterior teeth, establishing an appropriate path of insertion requires studying the exact position of the abutment teeth relative to the overall occlusal plane. Most often, the path of insertion selected for anterior tooth preparations are based on the long axis of the abutment teeth. Using the occlusal plane as reference and establishing path of insertion perpendicular to the occlusal plane may resort to over reduction of the labial or facial surfaces of the abutment teeth.

FPD-Porcelain Fused to Metal (PFM) / 12-x-1
Prerequisite Reading:


References: