Preparing teeth to receive a removable partial denture

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The success or failure of a removable partial denture is dependent on many factors. To achieve success, the practitioner must develop and sequence a sound treatment plan based on clinical and radiographic evidence. These findings must be carefully considered in prosthesis design and mouth preparation. Particular attention must be given to the proper placement of guiding planes and well-made rest seats and the use of surveyed crowns on abutment teeth. This article describes the rationale, importance, and clinical procedures for abutment preparation for removable partial dentures.
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The success or failure of a removable partial denture (RPD) is dependent on many factors, which include the condition of the patient's mouth, the management of periodontally compromised teeth, and the long-term prognoses of such teeth.[1,2] In addition, the practitioner must consider the effects of the framework design, clasp configuration, and denture base extension.[3-5] During the clinical phases of treatment, the practitioner must establish excellent guiding planes,[6,7] properly contoured rest seats, and well-designed crowns (if applicable).[8] The practitioner also must make accurate impressions and casts, and must provide clear instructions to dental laboratory personnel.[9,10] The completed framework must be meticulously fitted to the teeth and soft tissues, prosthetic teeth must harmonize with the remaining natural teeth, and denture bases must display proper contour and tissue coverage. In turn, the practitioner must provide the patient with appropriate verbal and written instructions regarding the use, maintenance, and wearing of the RPD. Finally, the dentist must establish an appropriate follow-up schedule.

The design philosophies of RPDs have progressed considerably since the first published description in 1711. The development of the surveyor circa 1915[8] contributed immeasurably to current concepts of RPDs. The first instrument specially developed for surveying RPDs was designed by Weinstein and Roth, and it was made available commercially in 1921.[11] In 1940, Applegate[12] wrote on the use of the paralleling surveyor in modern partial denture fabrication: "Perhaps no step in the construction of a clasp-retained partial denture has more direct bearing upon the ultimate result than that of surveying the model of the dental arch for which the appliance is to be made." The path of insertion, tilts of a cast, shapes and tapers of clasps, fulcrum line, and design of major and minor connectors are described in several manuals[13] and have been known for many years.

This article is limited to the preparation of the patient's teeth when the decision has been made to fabricate a RPD. It describes the rationale and sequence of steps for tooth preparation and concludes by describing important considerations in design, fabrication, and placement of cast restorations (surveyed crowns)[14,15] when used on abutments. Six steps of mouth and tooth preparation are given in chronological order: (1) establish occlusal plane; (2) recontour proximal surfaces of posterior teeth; (3) recontour proximal surfaces of anterior teeth; (4) recontour facial and lingual surfaces of teeth; (5) fabricate rest preparations; and (6) smooth and polish all altered surfaces.

I. ESTABLISHMENT OF OCCLUSAL PLANE

When a tooth is lost in an arch, the remaining teeth have a tendency to drift. This is particularly troublesome when a posterior tooth is lost and is not replaced. The remaining posterior teeth, in attempting to close the space, tip mesially rather than move in an upright position. This tipping can result in the mesial portion of the occlusal surface being out of contact with the opposing occlusion and the distal portion being in supraocclusion. Teeth also tend to extrude when occlusal contact with the teeth of the opposing arch is lost. When the occlusal plane is not in harmony with the dental arches, placement of artificial teeth and creation of a harmonious, functional occlusion becomes difficult or impossible to accomplish.[15] The dentition

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in the arch opposing the RPD, and the teeth in the arch being treated, must be returned to as normal an occlusal plane as possible, which is defined in the Glossary of Prosthodontic Terms as "the average plane established by the incisal and occlusal surfaces of the teeth…it is not a plane, but represents the planar mean of the curvature of these surfaces."[16]

Clinical treatment options

1. The first consideration is to determine whether the occlusal plane can be corrected by judicious reshaping of enamel by removing up to 2 mm of enamel. Care must be taken to maintain normal occlusal anatomy and not expose the dentine.

2. When more than 2 mm of enamel must be removed to bring the protruding teeth in line with the occlusal plane, the tooth should be restored. Remove enough tooth structure for a cast restoration to have adequate thickness and be in line with the occlusal plane after the restoration is placed.[15]

3. An extruded tooth may be shortened considerably without danger of pulp exposure. Endodontic therapy will be necessary if pulp exposure occurs.

4. Crown lengthening may be required to create sufficient occlusogingival height of the clinical crown to make a preparation with adequate retention.

5. A restoration may be required to restore teeth in infraocclusion to the desired plane of occlusion.

6. Malaligned teeth may be corrected by orthodontics, recontouring, or placement of a restoration.[15]

7. Endodontic therapy and reduction of the tooth to approximately 2 to 3 mm above the gingival level will allow otherwise hopelessly extruded or mobile teeth to be used as overdenture abutments. Teeth used in this manner can contribute outstanding vertical support to a RPD. A third molar that is malformed or too weak for clasping may be prepared in a dome shape and covered with a denture base and used as vertical support. This will prevent the RPD from having a distal extension base supported only by soft tissue.

8. When the preceding considerations are not feasible or practical, the offending teeth should be extracted. Removal of teeth is always a last resort.

II. RECONTOURING PROXIMAL SURFACES OF POSTERIOR TEETH

Proximal recontouring must always precede the preparation of rests. When the rest seat is prepared first, a sharp marginal ridge and even loss of part of the rest preparation may result. Any sharpness is difficult to reproduce in the definitive cast, the refractory cast and the RPD casting. Fitting the framework to the mouth is more difficult. A sharp marginal ridge is the first place to look for interference, which prevents the framework from seating. This defect can be found by using disclosing wax (Kerr Corp, Orange, Calif.).

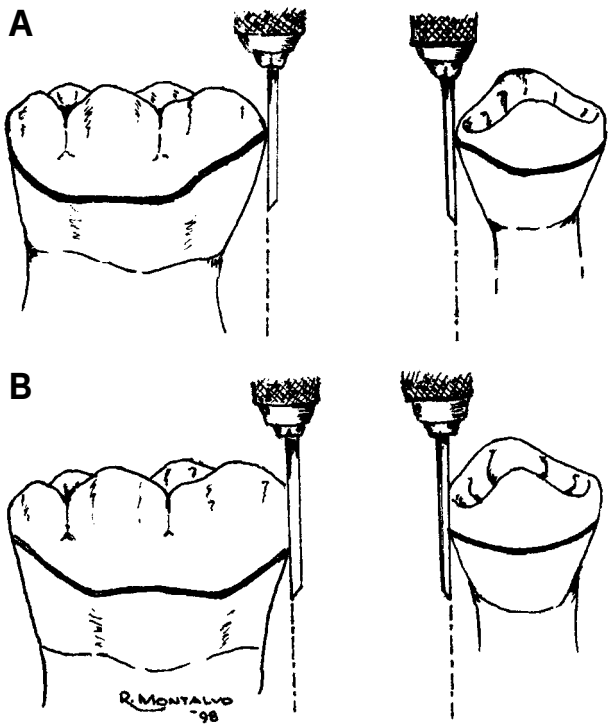

Fig. 1. Survey lines near occlusal surface of tooth may be lowered by recontouring. **A,** Survey line high on interproximal of molar and premolar tooth. **B,** Judicious removal of some surface enamel may lower survey line considerably.

Recontouring the proximal surfaces of posterior teeth reduces proximal undercuts, which permits the minor connectors to be placed closer to the proximal surface of the teeth. Recontouring reduces the gingival embrasure space and lessens the possibility of food entrapment between the tooth and minor connector or proximal plate. Removing a small amount of proximal enamel can often greatly reduce the undesirable undercut (Fig. 1). Guiding planes are vertically parallel surfaces on abutments and other teeth oriented so as to contribute to the direction of the path of placement and removal of a RPD.[16] Guiding planes may be prepared on any axial surface of a tooth but most often are on mesial, distal, and lingual surfaces.[17] Posterior proximal recontouring is also used to create proximal guiding planes[4] that provide a more definitive path of insertion and removal, making the clasps more retentive. Proximal guiding planes aid in stabilizing the abutments against lateral forces and in stabilizing the RPD against horizontal forces.[18-20] They reduce wedging stresses and provide some retention.

Clinical treatment options

1. Place the surveyed and designed diagnostic cast on the surveying table at the correct tilt. Use it as a reference for correct orientation of the handpiece in the mouth.[20]

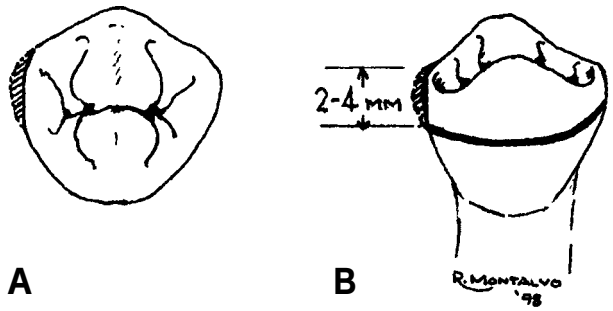

Fig. 2. Reduction of proximal surfaces of posterior teeth. **A,** Reduction must follow facial-lingual contour of individual tooth. **B,** Reduction occlusal-gingivally must be parallel to path of insertion.

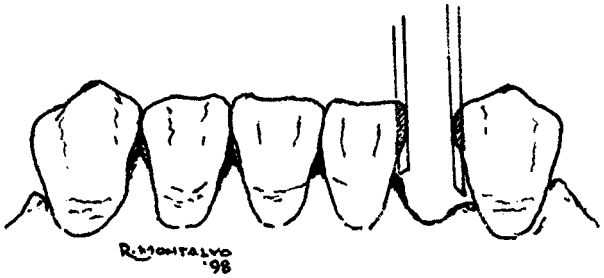

Fig. 3. Proximal surfaces of anterior teeth may be reduced to permit using a slightly larger replacement tooth on RPD and to reduce unsightly large gingival embrasures.

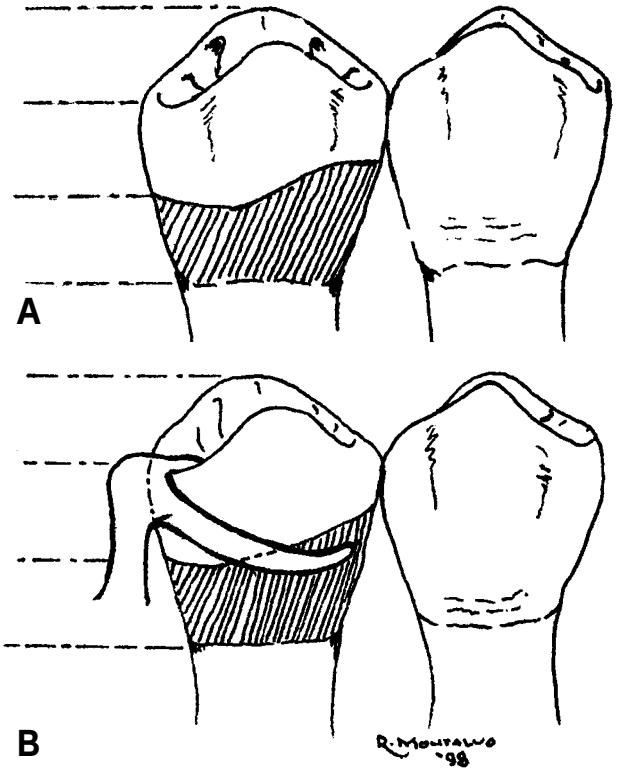

Fig. 4. Facial and lingual surfaces of teeth may be recontoured to place retentive portion of clasp arm in gingival one third of tooth. **A,** Crown of premolar divided into thirds showing undercut *(shaded portion)*. **B,** Proper position of circlet clasp with bracing portion of clasp in middle third and retentive tip in gingival third.

2. With a smooth cut carbide fissure bur or a cylindrical diamond rotary instrument (diamond bur) in the handpiece, use gentle, light, sweeping strokes to extend the preparation from line angle to line angle, following the normal proximal facial-lingual contour of a tooth (Fig. 2, *A*). At the same time, create a parallel surface that is 2 to 4 mm in occlusogingival height (Fig. 2, *B*).[15]

The proximal guiding plane preparation is flat occlusogingivally but curves buccolingually (Fig. 2, *A* and *B*). Avoid use of any instrument that causes deep striations or scratches in the enamel that will be difficult to remove. Do not use crosscut fissure burs or coarse diamond burs for this procedure.

III. RECONTOURING THE PROXIMAL SURFACES OF ANTERIOR TEETH

Anterior edentulous spaces tend to close rapidly after removal of teeth by a combination of drifting and tipping, especially in younger patients. Judicious recontouring of teeth adjacent to the edentulous space, which is smaller than normal, can provide for a more esthetic replacement of the missing tooth (Fig. 3).

Clinical treatment options

1. Use a cylindrical smooth cut carbide fissure bur such as a no. 57 or 52, or a fine diamond instrument (bur) of a comparable shape, to recontour the proximal surfaces. Original facial-lingual contour of the proximal surfaces should be maintained (Fig. 3).

2. Tipped teeth require the greatest reduction to reduce unsightly large gingival embrasure spaces.

3. Combination of tooth reduction and tilting the cast in the surveyor to change the path of insertion may often establish a more esthetic result.

IV. RECONTOURING FACIAL AND LINGUAL SURFACES

This procedure is performed almost exclusively on posterior teeth, although it is occasionally necessary on canines and other anterior teeth. When anterior teeth are recontoured, the same principles apply. The retentive tip of a clasp is ideally located no higher than the juncture of the gingival and middle third of the clinical crown. Although the retentive undercut is usually on the facial surface of the tooth,[6,20] the same rule applies when the retentive undercut is on the lingual surface

(Fig. 4). Minor recontouring of facial surfaces will frequently permit more ideal placement of the bracing portion of the retentive clasp arms (Fig. 5). Mandibular posterior teeth are usually inclined lingually with a resultant high lingual survey line.[19,20] Minor recontouring can frequently improve the position of the survey line to allow placement of the reciprocal clasp arm in its proper position (Fig. 6).

When it is not possible to recontour the tooth sufficiently for proper placement of the reciprocal arm, lingual plating[21] may be used to provide the necessary reciprocation. Unless the tooth is recontoured, a large undesirable undercut will be present to trap food (Fig. 6, *A*). Recontouring will reduce the amount of undercut and will result in less torque on the tooth (Fig. 6, *B* and *C*). Occasionally, mandibular posterior teeth have been severely worn or the occlusal surface adjusted in such a manner as to leave a flat occlusal surface that meets the lingual surface at an acute angle. The bracing arm of the clasp cannot go to place because it contacts a flat horizontal surface (Fig. 7, *A*) rather than an inclined plane (Fig. 7, *B*) preventing the partial denture from seating in the mouth.[21] This condition is rare but must be recognized and corrected by recontouring (Fig. 7).

Ideal contours can always be established by placing surveyed crowns, (see page 548, restoring abutments with cast restorations). The best method for increasing the retentive undercut on a tooth is by placing a properly contoured cast restoration. However, there may be instances in which recontouring the enamel to increase retention is indicated.[22] This must be performed cautiously as the recontouring must not penetrate the enamel (Fig. 8). Lower survey lines at proximal buccal and lingual line angles to allow the clasp shoulders to be properly placed. Smooth irregularities on the buccal and lingual surfaces to allow close adaptation of the clasps to the tooth surfaces.

Clinical treatment options

1. Lower the survey line on facial surfaces of teeth with a smooth tapered cylinder-shaped carbide bur with a rounded end or a similar shaped fine diamond bur. Care should be taken to preserve the general original tooth shape and maintain smooth contours. The preparation should incline slightly toward the occlusal surface from the repositioned height of contour to permit the retentive clasp arm to slide smoothly to place (Fig. 5, *A*). The recontouring to lower the survey line for a reciprocal arm should be parallel to the path of insertion.[6,20,23] Avoid changing the contour in the gingival third of the tooth to avoid damage to the marginal gingiva (Fig. 4).

2. Lower the survey line on the lingual surfaces of posterior teeth (Figs. 6 and 7) by reducing the tooth with a cylindrical diamond bur similar to the one illustrated in Figure 6, *B* or a similarly shaped fluted carbide bur (not crosscut). The reduction must be parallel to the path of insertion[6,21] of the RPD. A relatively small amount of reduction may lower the survey line considerably, produce the desired guiding plane, and reduce the large amount of space between the lingual plate and the tooth at the gingival level (Fig. 6, *A* and *C*).

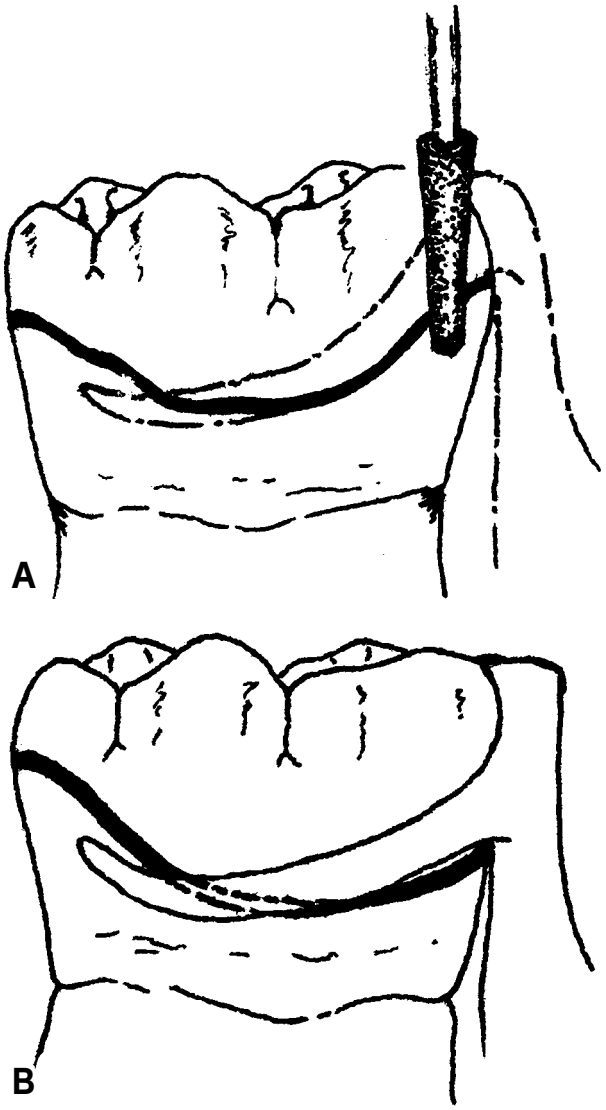

Fig. 5. Judicious facial and lingual contouring can be used to allow placement of clasp lower on tooth. **A,** Tapered cylindrical diamond rotary instrument used to reduce the enamel to lower survey line on mesial-facial surface of tooth. **B,** Bracing portion of clasp can be lower on tooth and remain in full contact with tooth surface.

3. A survey line at or near a flat occlusal surface at the juncture of the lingual and occlusal surfaces of a tooth usually causes problems (Fig. 7). Reposition it by using a cylindrical smooth cut fissure bur or diamond bur to judiciously remove enamel, lowering the survey

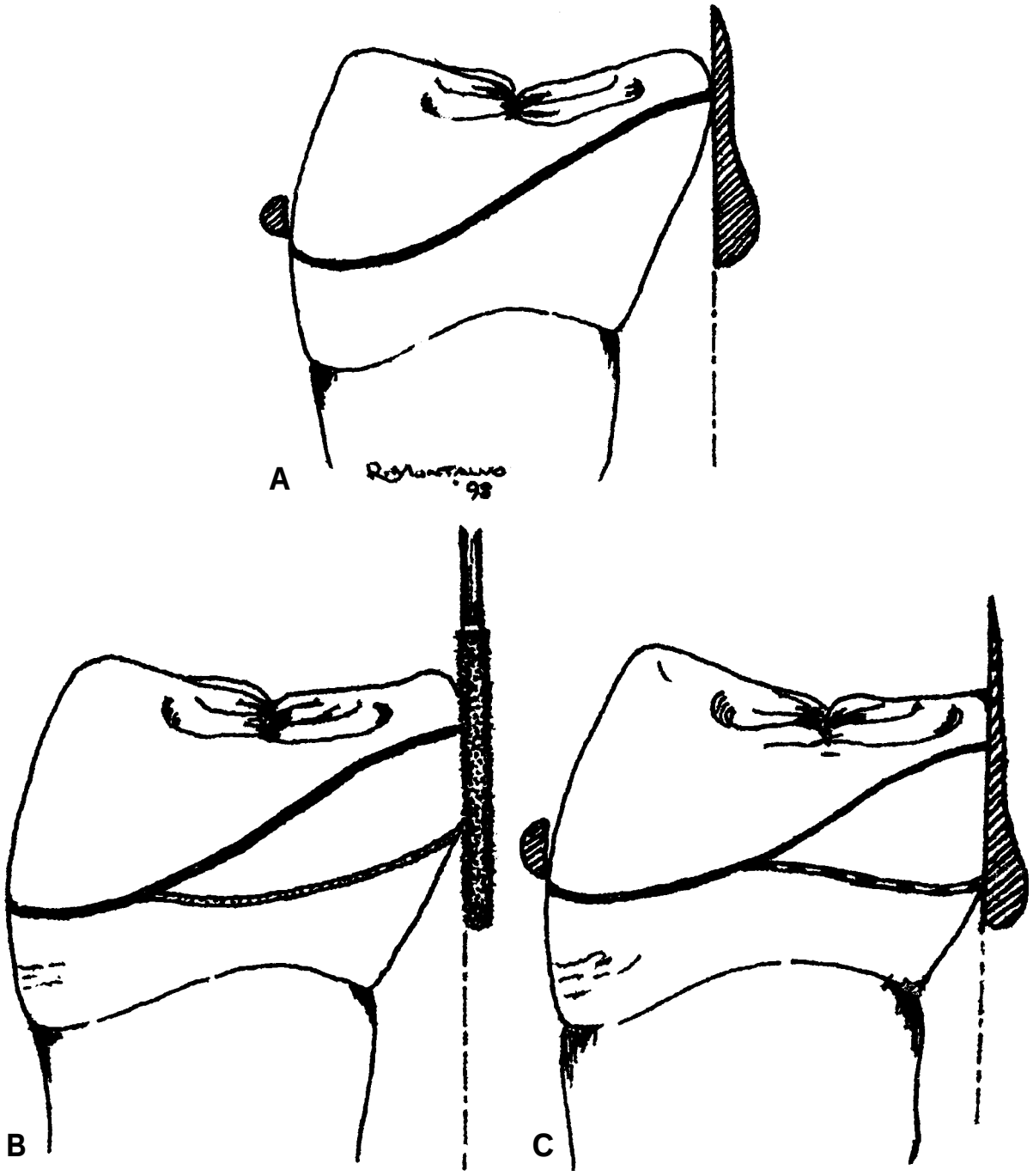

Fig. 6. Mandibular molars and second premolars are tipped lingually and present problems such as high survey lines with concomitant unusually large spaces adjacent to the gingiva to trap food. **A,** Lingual plate could be used to stabilize tooth but creates large space to trap food. **B,** Survey line being lowered by reducing tooth with cylindrical-shaped diamond rotary instrument. **C,** Reduction of tooth to lower survey line creates guide plane, reduces amount of space between lingual plate and tooth, and permits lingual plate or reciprocal clasp arm to remain in contact with tooth while retentive clasp arm is seated.

line to some extent, but primarily rounding the sharp edge that would prevent the clasp arm from seating (Fig. 7, *B*). Use a sweeping mesial-distal movement to reduce the height of contour and round the cusp.

4. To create a retentive undercut, a cast restoration should be considered. However, a retentive undercut may be created in the enamel when none is present, if the opposing facial and lingual surfaces of the teeth are

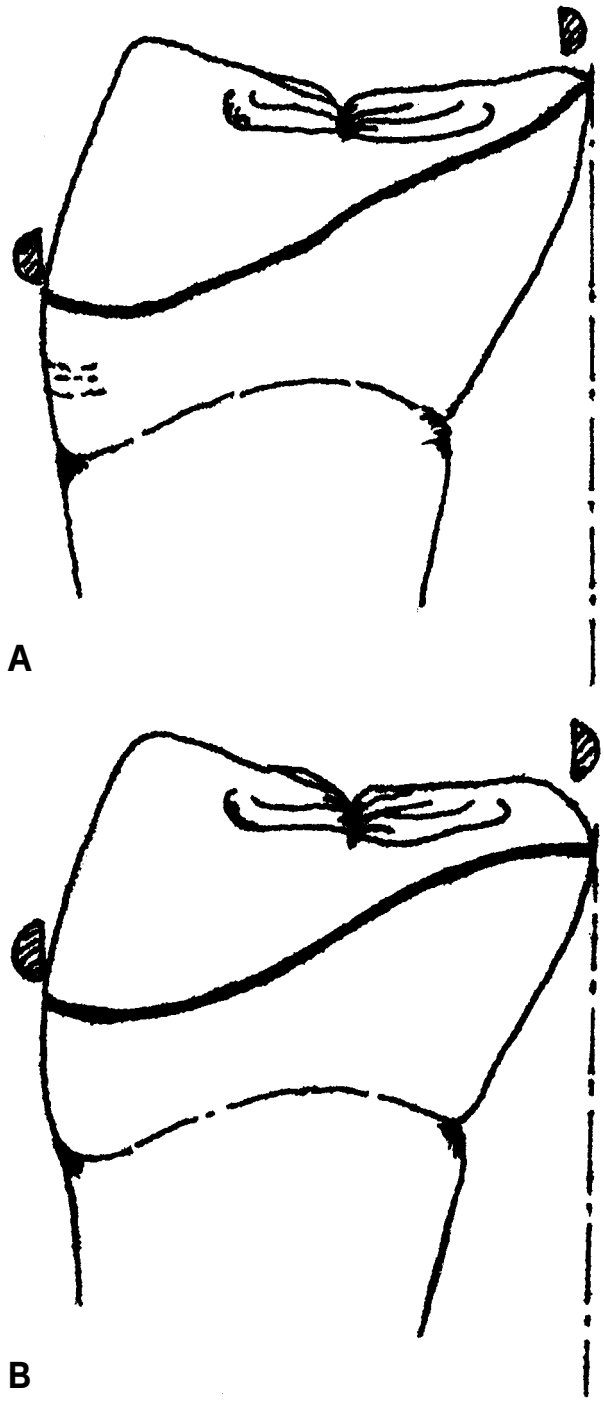

Fig. 7. Posterior teeth worn flat or improperly reduced to adjust occlusion. **A,** Survey line close to occlusal surface causes difficulty in seating RPD because lingual clasp arm cannot open. **B,** Rounding occlusal-lingual line angle allows clasp arm to open as it is seated in mouth.

nearly parallel to each other. The following procedure is contraindicated when pronounced occlusal convergence or relatively extreme sloping of either surface is present.

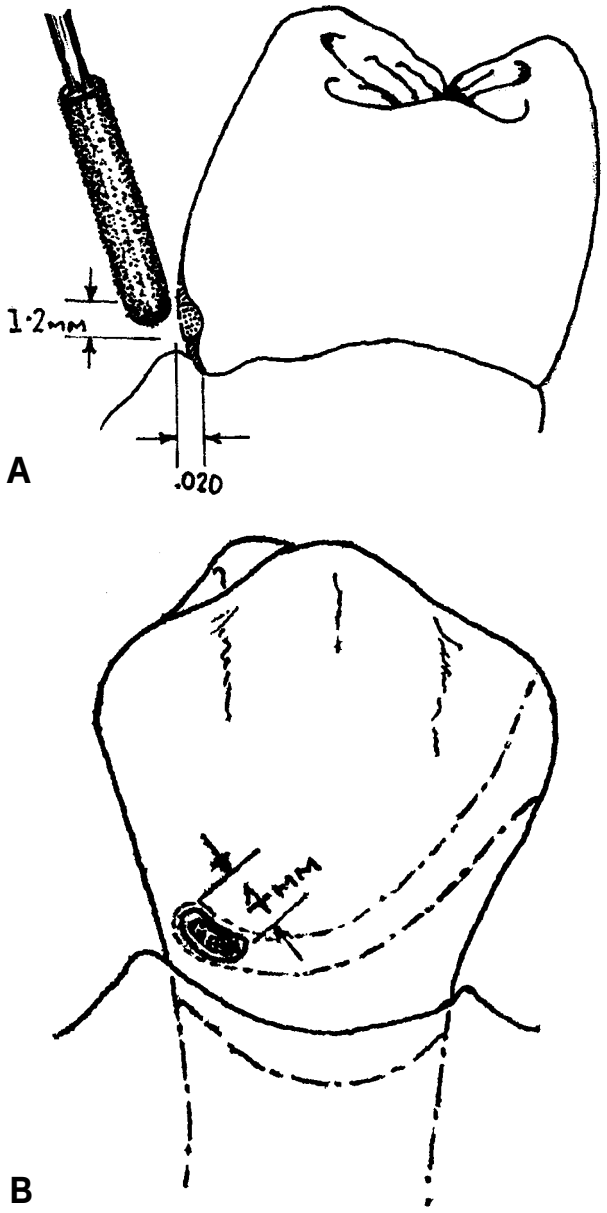

Fig. 8. Preparation being made in tooth to create undercut. **A,** Cylindrical diamond rotary instrument with rounded point used to slightly recontour tooth enamel to create depression for retention to be engaged by clasp tip. **B,** Depression should be approximately 4 mm long, between 1 and 2 mm deep, just wide enough to be covered with tip of clasp, and curved to follow contour of gingival margin.

a. Use a small round-ended tapered diamond bur (Fig. 8, *A*) to create a slight concavity or depression near the line angle of the tooth as close to the gingival margin as possible. The depression should be approximately 0.010 of an inch in depth, when compared with a vertical line paralleling the path of insertion.[20] Make the cut up to 4 mm in length mesiodistally and 1 to

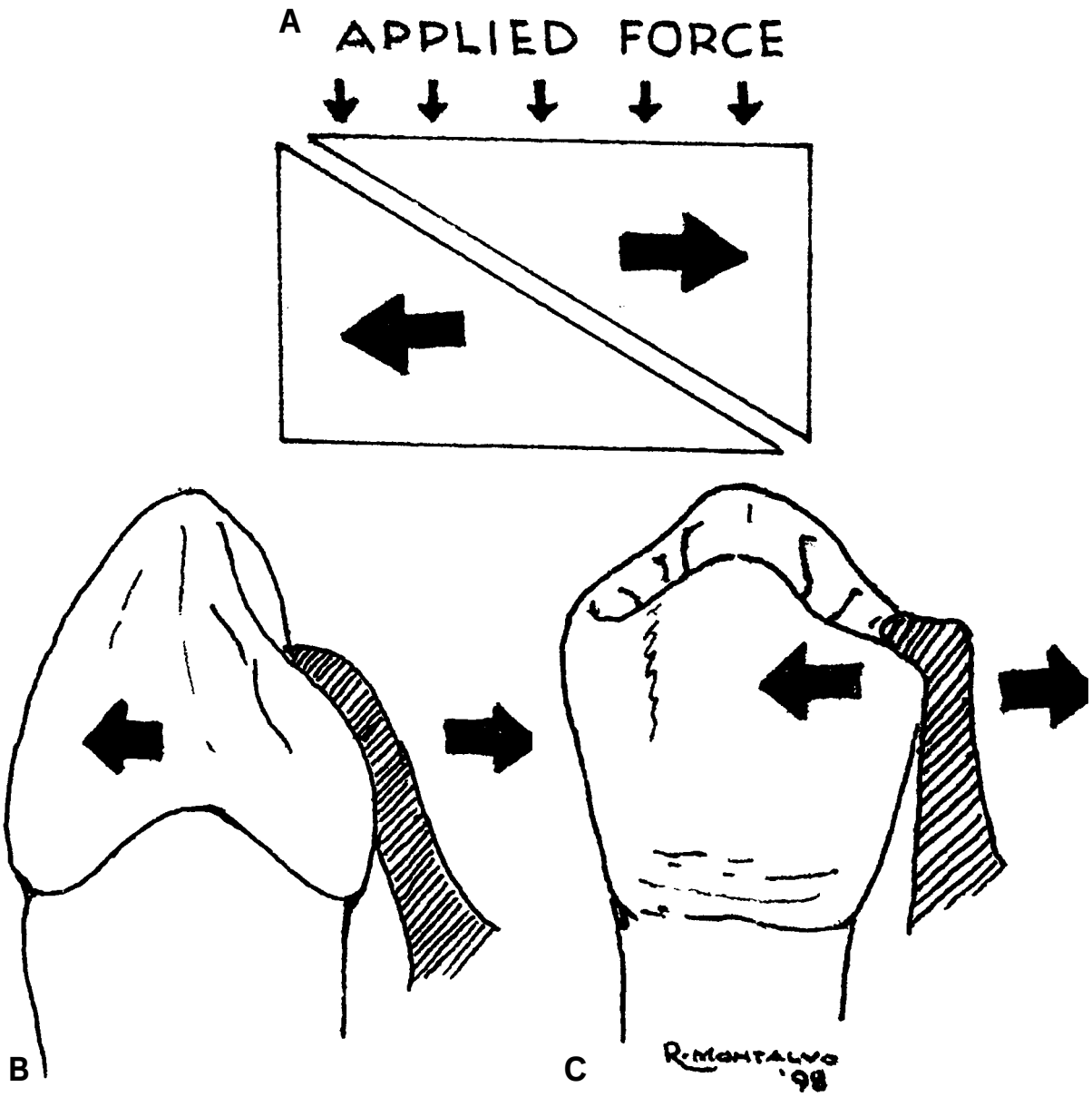

Fig. 9. Rests should not be placed on inclined planes when related to long axis of tooth. **A,** Inclined surfaces in contact with each other react to applied force by moving away from each other. **B,** Rest on inclined planes of unprepared canine force tooth and RPD in opposite directions under masticating stress. **C,** Improperly prepared rest on premolar reduced only marginal ridge for clearance with opposing occlusion but inclined plane of rest seat still remains. Tooth and RPD are forced away from each other.

2 mm in height occlusogingivally (Fig. 8), and it should follow the gingival contour.

b. Care must be taken not to create a ledge or shoulder in the enamel. The preparation should be small enough to be covered with the tip of the clasp.

5. A dimple-like preparation should be avoided if possible and only be considered as a last resort. If there is enough enamel to prepare a dimple-like depression, there is more than enough enamel to hollow grind and create a smooth, highly polished retentive surface for the retentive tip of the clasp. The patient should always be given instructions on how to keep the preparation clean.

V. FABRICATION OF REST PREPARATIONS (REST SEATS)

A preparation must be made for each rest before making impressions for the definitive casts.[22-24] A metal rest should never be placed on a tooth that has not been adequately prepared to receive that rest.

When a rest is placed on an unprepared or improperly prepared tooth, the action will be as if 2 inclined planes were placed opposing each other. This can be illustrated with 2 blocks (Fig. 9, *A*). When a force is applied to the top block, the blocks will slide in opposite directions. Likewise, as the pressure of mastication is applied on the RPD, the resultant force will cause movement of the RPD in one direction and the abutment in the opposite direction (Fig. 9, *B* and *C*). This movement occurs whether or not there is a clasp on the tooth. In fact, a retentive clasp arm on the tooth could amplify the problem. When forces of mastication are applied to the RPD, the tooth and framework are forced away from each other. When the force is removed, the flexible retentive clasp arm will pull the tooth back into its position in the framework. This repetitive movement may cause the tooth to loosen and eventually be lost. The preparation must be such that, when a force is applied to the rest through the RPD, the greater amount of force will be directed approximately along the long axis of the abutment. In addition, the force must draw the framework and the tooth (teeth) toward each other (Fig. 10).[19] Thus, the horizontal portion of the rest preparation on posterior teeth must be inclined slightly apically toward the center of the tooth (Fig. 11, *C*).

The rest acts as a stop to prevent injury to and overdisplacement of soft tissues under partial denture bases. The rest maintains the attached clasp assembly in its properly surveyed position. The rest functions as an indirect retainer for distal extension denture base partial dentures.[22] Additional rests may be positioned anteriorly or posteriorly to the axis of rotation to act as indirect retainers. The rest prevents food from becoming impacted between the clasp and the proximal surface of the abutment.[15] This is one reason the rest is placed in an adjacent position to the denture base. Rests can close a small space between teeth by bridging that space with back-to-back occlusal rests to restore continuity of the arch.

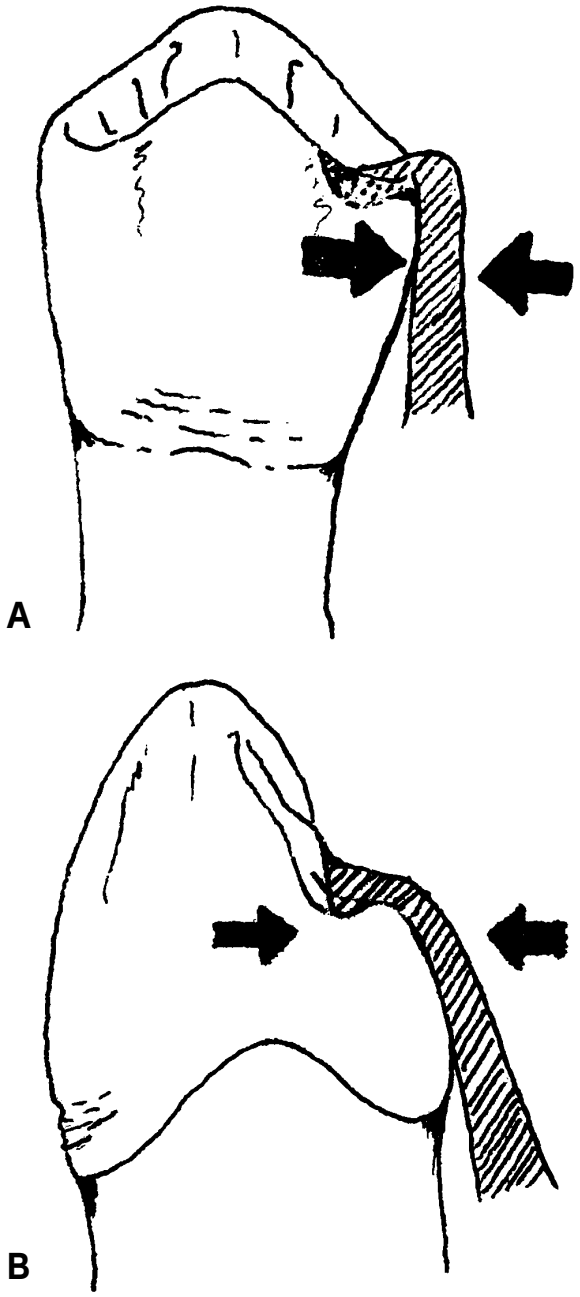

Fig. 10. Properly prepared rest seats change direction of applied force, by 180 degrees, to pull tooth and RPD toward each other to make them mutually supportive. **A,** Rest seat made with fossa deeper than marginal ridge will pull abutment and RPD toward each other, during mastication, to make them mutually supportive of each other and system will direct force more directly along long axis of abutment. **B,** Cingulum hook rest on maxillary canine will have same effect.

Rests in posterior teeth

The outline for an occlusal rest is basically triangular with the base of the triangle at the marginal ridge and the apex extending toward the center of the tooth.[23,24] The apex of the triangle should be rounded (Fig. 11, *A*). This shape follows the outline of the mesial or distal fossa of the occlusal surface of the tooth in which the rest seat is prepared (Figs. 11, *A*, and 12, *A*, and *C*). The length of a conventional rest varies from one third to one half the mesiodistal length of the tooth, approximately 3 to 4 mm. The facial-lingual width should be at least one half the distance between the cusp tips or approximately one third the facial-lingual width of the tooth (Fig. 11). The floor of the occlusal rest seat should be inclined slightly toward the center of the tooth and should be concave or spoon-shaped throughout (Fig. 11, *B* and *C*).

The angle formed by the inclination of the floor of the rest preparation and the vertical projection of the

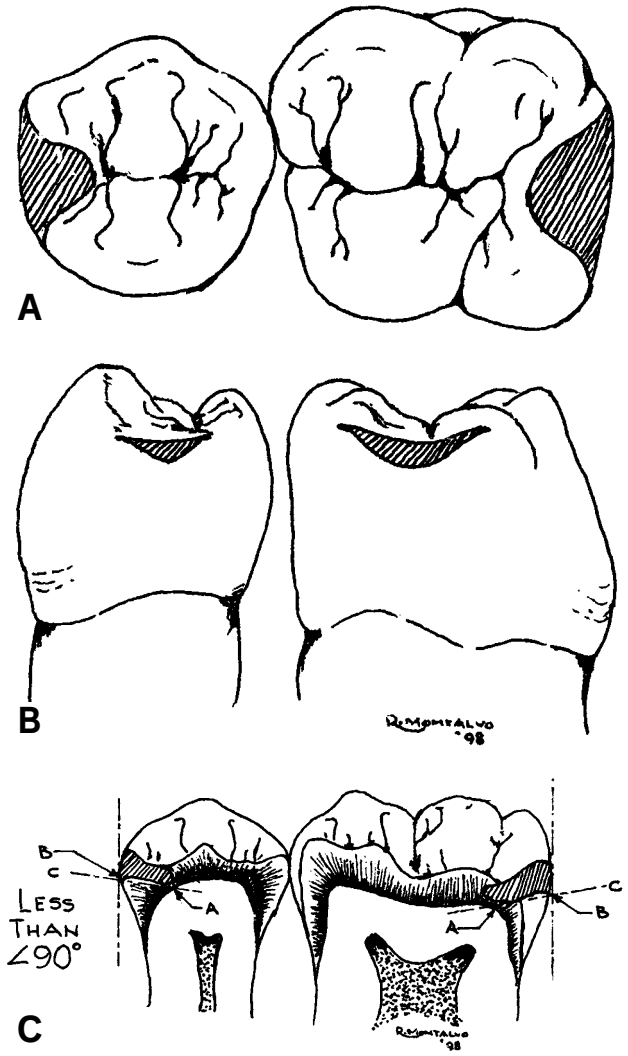

Fig. 11. Proper conventional rest preparations in posterior teeth. **A,** View from occlusal shows facial-lingual width of rest seats that should be as wide as possible but approximately one half distance between cusp tips of teeth and in length about one fourth mesial-distal crown length of tooth. **B,** Proximal view of preparations show spoon shape of rest seat, maximum depth of 1 to 2 mm, and that they flare at marginal ridge. **C,** Cross-section of teeth showing that deepest part of preparation is in the fossae (*A*) and that marginal ridge (*B*) is higher than fossae. Angle formed between inclination of floor of rest and vertical projection of greatest contour of proximal surface (*C*) must be less than 90 degrees.

greatest contour of the proximal surface of the tooth should be less than 90 degrees. Only when the angle is less than 90 degrees will occlusal forces be directed more nearly parallel to the vertical axis of the abutment and the framework and the tooth forced together for mutual support (Fig. 11, *C*).[19,20] The deepest part of the occlusal rest preparation should be in the center of the fossa of the tooth (Fig. 11, *C*).

Rests in posterior teeth clinical treatment options

1. Occlusal rests should be prepared with a no. 4 round bur or diamond bur of approximately the same size. For larger teeth, a slightly larger round bur may be used.

2. To ensure uniform, adequate reduction, the following procedure is helpful:

a. Start the bur in the floor of the fossa and make a cut about one half the depth of the bur. Extend the cut the same depth along the facial wall of the rest seat and over the marginal ridge (Fig. 12, *A*).

b. Repeat the procedure for the lingual wall of the fossa to make an inverted V-shape of the remaining marginal ridge (Fig. 12, *A* and *B*).

c. Observe the cuts from the proximal surface to determine the depth of the cut (Fig. 12, *B*).

d. When the cut is at the desired depth, remove the enamel left between the 2 cuts to form the base of the rest preparation. Blend the outside edges of the bur cuts with the contours of the occlusal surface to eliminate undercuts (Fig. 11, *B*).

e. Flare the cuts slightly as they cross the facial and lingual aspects of the marginal ridge (Fig. 11, *B*).

f. Verify the depth of the rest preparation by having the patient close on a small piece of red utility wax placed over the preparation. Remove the wax and measure the depth of the preparation with a thickness gauge made to measure wax. (The most critical dimension is the amount of reduction over the marginal ridge. The wax may also disclose undercuts in the preparation if any are present.)

g. Round the marginal ridge to eliminate any sharp angles.

Embrasure rests

The outline form of an embrasure rest seat (Fig. 13) must have through-and-through clearance wide enough to accommodate two 18-gauge round wires side-by-side if a double embrasure or crib clasp is to be used. If a single cast clasp arm is to be used, there must be through-and-through clearance sufficient to accommodate a single 14-gauge round wire. This preparation extends over the occlusal embrasure of 2 approximating teeth. The preparation should extend into the mesial fossa of one and into the distal fossa of the other adjoining tooth.[25] The lingual embrasure of mandibular teeth and the buccal embrasure of maxillary teeth must be opened and rounded. The outline form of the preparation should present smooth rounded curves. Sharp corners and undercuts should be avoided, and the preparation should not break the interproximal contact.

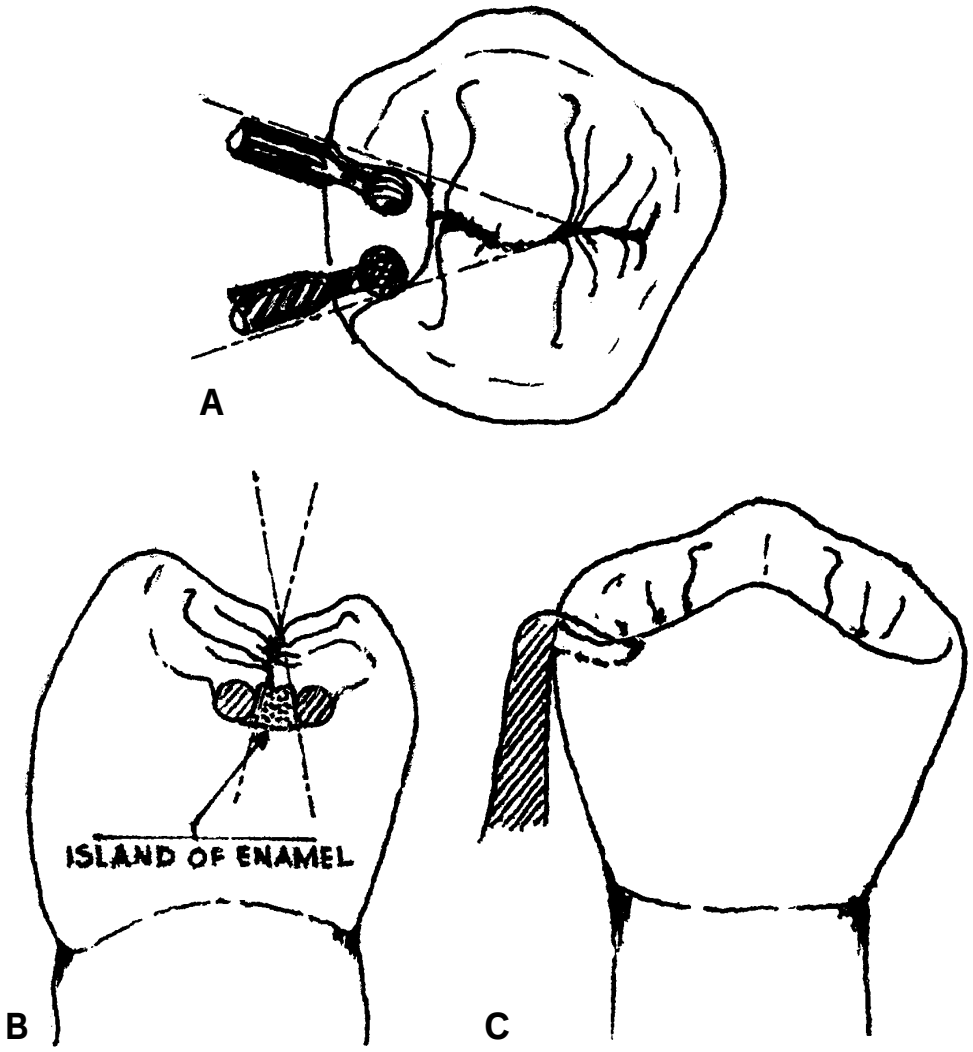

Fig. 12. Step-by-step conventional single rest preparation as made in posterior teeth. **A,** Occlusal view to show direction of successive cuts. **B,** Proximal view of tooth showing depth and location of first 2 cuts that start in fossa and continue over marginal ridge. Island of marginal ridge enamel remains as depth gauge. After depth is established, island of enamel is removed to make spoon shape of floor of preparation and preparation is flared to facial and lingual at marginal ridge. **C,** Lingual view of tooth to show relative depth of preparation.

Embrasure rest clinical treatment options

1. Reduce the marginal ridges of the approximating teeth adjacent to the mesial and distal fossae with a no. 4 round bur or equivalent sized diamond bur.

2. When the marginal ridges are uneven on the teeth to be prepared, they should remain uneven when the preparations are complete. A minimum clearance of 1 mm must be provided with the opposing occlusion.

3. The outline form developed for the rest must be consistent with that of the usual occlusal rest preparation for posterior teeth (Fig. 11).

4. Extend the rest preparations over the facial and lingual occlusal embrasures using the same bur or diamond.[26]

5. With the teeth in occlusion, guide the patient through excursive movements and carefully examine the space for the clearance of the rest.

6. Blend the sides of the rest preparations into the cuspal contour of the teeth.

7. An alternate method is to make a cut with a cylindrical diamond instrument held flat facial-lingually across the occlusal surface, along the distal incline of one tooth and the mesial incline of the other. This will provide ample space for the metal of the cast clasp (Fig. 13).

Long box rests

This type of rest is used almost exclusively for the rotational path of insertion RPDs[27] because the con-

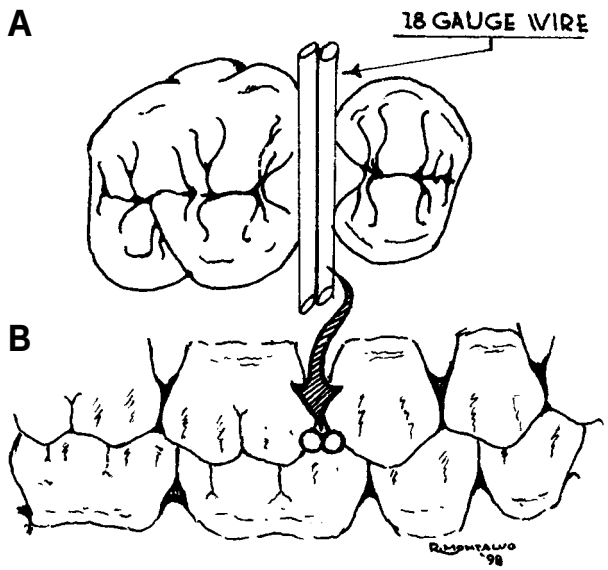

Fig. 13. Extent of preparation necessary to accommodate embrasure (crib) clasp between posterior teeth. **A,** Occlusal view showing that preparation must be wide enough to accommodate two 18 gauge wires side by side. **B,** Facial view shows depth of cut and width.

ventional clasp arms are replaced by specially designed rigid retainers that must fulfill the requirements for bracing and encirclement and must prevent rotation of the abutment. In their syllabus on RPD design, Kroll et al[28] wrote "the most critical elements in utilizing the rotational path are the rest seat preparations (Fig. 14) and the development and maintenance of intimate contact between the rigid retainers and their corresponding tooth surfaces. If the proper form of the rest seat cannot be achieved, the rotational path design is contraindicated."

The rests and clasps of conventional RPDs are seated simultaneously parallel to a single path of insertion. In the dual path design, 2 rests are seated parallel to 1 path of insertion and the other 2 rests are seated parallel to a different path of insertion There is little tolerance for error in making and registering the rest preparations. Box rest preparation must be deep enough to prevent rotation of the tooth but not deep enough to contact the dentine. The preparation should extend more than half the mesial-distal length of the occlusal surface of the crown to contribute to bracing and axial distribution of forces (Fig. 14, *A* and *B*). Facial and lingual walls of the preparation must be nearly parallel to each other to prevent the tooth from rotating and the floor must be at right angles to the long axis of the tooth. The outline of the preparation is usually asymmetric to provide an equivalent adequate encirclement. However, the outline may be a straight channel when the tooth is tipped considerably

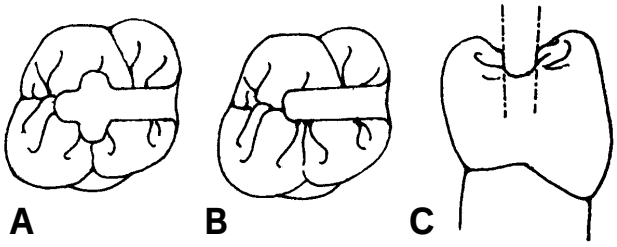

Fig. 14. Long box rests in posterior teeth. **A,** Dovetail rest preparation. **B,** Straight rest preparation. **C,** Proximal view of box preparations. Facial and lingual sides are nearly parallel to each other and must be parallel to path of insertion and removal in lateral tilts of cast.

in 1 direction to prevent further tipping of the tooth (Fig. 14, *A* and *B*).

Long box rest clinical treatment options

1. After the path of insertion has been determined on the diagnostic cast, it is meaningful to prepare the rests in the stone cast to get a feel for the angulations that will be required when preparing the tooth in the mouth.
2. Use a carbide bur or diamond rotary instrument (bur) to cut the rests. It must extend more than half the mesial to distal length of the crown of the tooth measuring from 1 marginal ridge.
3. Make the rest preparations 1.5 to 2 mm deep and the lateral walls nearly parallel to each other or slightly divergent toward the occlusal surface (Fig. 14, *C*).
4. Make the floor flat and at right angles to the long axis of the tooth.
5. The occlusal outline may be made asymmetrical (dovetailed) or it may be made straight for severely tipped teeth.
6. Slightly bevel the occlusal edge of the cavosurface.

Rests in anterior teeth—cingulum rest

The cingulum rest seat is usually prepared on the cingulum of a maxillary canine[24] (Fig. 15). Rarely does the mandibular canine have the anatomic contours or the thickness of enamel necessary for a cingulum rest preparation. The rest seat is an inverted U shape. The lingual surface of the tooth makes up the inner wall, while the outer wall of the U-shaped notch starts at the apex of the cingulum and inclines gingivally toward the center of the tooth to meet the inner wall of the preparation. Sharp angles should be avoided because they create problems in casting and fitting of the framework. The outline form should be in the shape of a crescent and form a smooth curve from one marginal ridge to the other. The deepest portion should be in the center of the tooth over the cingulum.

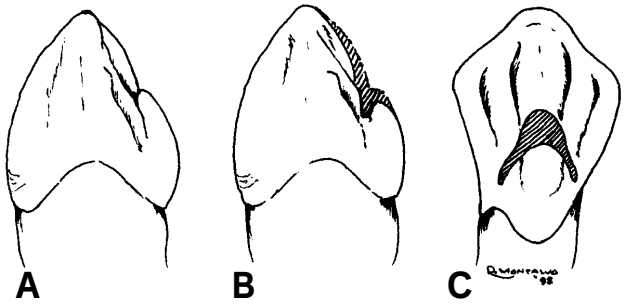

Fig. 15. Maxillary canine. **A,** Profile of canine seen from distal view. **B,** Reduction made in enamel for rest preparation in cingulum of maxillary canine. **C,** Crescent-shaped contour of preparation.

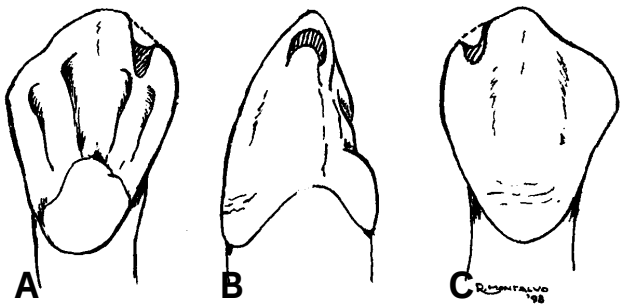

Fig. 16. Incisal rest preparation made on mandibular canine. **A,** Lingual view of preparation. It may extend down lingual surface to make room for metal. **B,** Preparation from proximal surface. **C,** Facial view of preparation.

Cingulum rest in anterior teeth clinical treatment options

1. An inverted cone carbide bur no. 37, inverted cone green stone, or a small knife-edged diamond wheel may be used to prepare the cingulum rest. Cut slowly and with extreme caution.

2. Start the preparation incisal to the cingulum. The flat side of the cutting instrument should follow the incline of the lingual surface of the tooth cutting toward the apex of the tooth. Continue cutting gingivally by moving the tool mesially and distally in an arc to form the notch. Care should be used not to create an undercut (Fig. 15, *B*).

3. Use a small knife-edged carborundum impregnated rubber abrasive wheel to remove sharp edges and polish the preparation.[26] The desired shape and sharpness of the knife-edged rubber wheel can be maintained by rotating it against a diamond disk.

4. Never attempt to round sharp edges of this preparation with a bur or stone.

Incisal rests in anterior teeth

Usually used on mandibular canines, the rest seat consists of a small inverted U-shaped notch on the incisal surface just inside the proximal corner of the tooth with the deepest part of the preparation toward the center of the tooth mesial-distally (Fig. 16). The notch should be rounded and carried slightly over the facial surface to provide positive seating. The enamel, lingual to the notch, may be prepared to accommodate some of the bulk of the minor connector (Fig. 16). Sharp points and angles must be avoided. Although the incisal rest seat may be used on a maxillary or mandibular canine, it is most often used on the mandibular canine. When a cast restoration is made for a canine tooth, a cingulum rest is the rest of choice.

Incisal rests in anterior teeth clinical treatment options

1. Use a small knife-edged diamond wheel or green stone to prepare a U-shaped notch 1.5 to 2 mm inside the proximal corner (Fig. 16). Move the cutting instrument in an inverted U-shaped motion and extend the cut to the facial and lingual surfaces of the tooth. Use it to partially prepare the lingual surface to accommodate the minor connector (Fig. 16, *A*).

2. Round the notch and remove any sharp points or angles (Fig. 16, *A*) with a small knife-edged carborundum impregnated rubber wheel. Caution should be taken to use light pressure and intermittent contact of the rubber wheel with the tooth; prolonged contact may create considerable heat and cause severe pain for the patient. The groove should continue to be polished and shaped with the same U-shaped motion, used to cut the notch or groove in incisal rest option (1) above, until the cut surfaces are repolished.

When extensive recontouring of the teeth is required, it is advantageous to verify the accuracy of the preparations by making an irreversible hydrocolloid impression and then pouring a cast. The cast can be poured with an accelerated mix of stone (use concentrated slurry water from the cast trimmer to accelerate the set). While the stone is setting, proceed with finishing and polishing the prepared surfaces of the teeth. When the cast is hard, place it on a surveyor and analyze the preparations. There may be some areas of the preparation that can be markedly improved by a small additional amount of recontouring.

VI. SMOOTH AND POLISH ALL GROUND SURFACES

All surfaces that have been prepared must be smoothed and polished. Scratches and roughness contribute to plaque accumulation. When proper instrumentation and procedures are used, the prepared surfaces can be returned to the same degree of smoothness and polish as existed before tooth preparation.

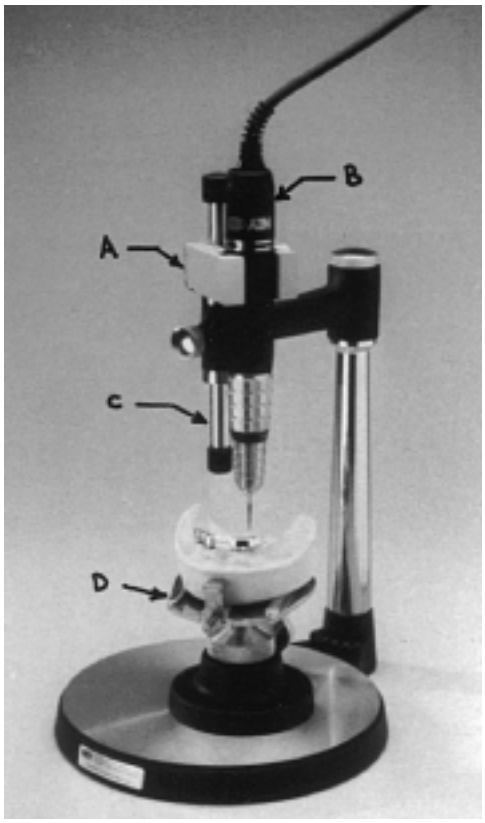

Fig. 17. Ney Surveyor. *A,* Handpiece attachment. *B,* Ney electric handpiece. *C,* Vertical spindle of surveyor. *D,* Surveyor table. (Photo courtesy of Ney Dental Inc.)

Clinical treatment options

1. When deep scratches are present in the enamel, they should be removed by lightly preparing the scratched surface with a fine diamond or white stone before attempting to polish them.

2. The most effective method of polishing enamel involves the use of rubber abrasive wheels or points impregnated with carborundum. Use them with light intermittent pressure and moderate speed as they can generate considerable heat, which may cause pulpal damage and can be painful for the patient.

3. For posterior rest preparations, use a dulled carbon steel bur of the same size as the bur used to make preparations. Run the bur in reverse to polish the otherwise inaccessible floor of the rest seat preparations. This will eliminate fine scratches and produce a good degree of smoothness.

4. Apply fluoride gel to the surfaces after polishing.

Restoring abutments with cast restorations (surveyed crowns)

A cast restoration may be required on an abutment, when the tooth has a large carious lesion or is weakened because of large restorations whether or not it has recurrent caries. An abutment may require a cast restoration because it has inadequate contours for clasping or required recontouring will expose the dentine. Teeth may be restored when they are in infra- or supra-occlusion to correct the occlusal plane. Regardless of the reason for placing cast restorations on abutments, the cast restoration should provide ideal contours for clasping the abutment.

Clinical treatment options

To ensure proper tooth preparation, it is important that all abutments involved in the RPD design that do not require cast restorations have been prepared to accommodate the RPD design.

1. After carefully studying and planning the reduction of the tooth on the diagnostic cast, prepare the tooth. The lateral walls of the preparation must be in line with the path of insertion of the RPD as much as possible. Frequently, more tooth removal is required than for a routine preparation so the ideal position of the survey lines and crown contours may be obtained. The preparation should include the removal of enough tooth structure to accommodate the rest seat. If possible, tipped molars should be prepared to align the axial surfaces with the path of insertion.

2. Make an elastomeric or agar impression of the entire arch containing the preparations and a complete arch impression of the opposing dentition.

3. Make a definitive cast with removable dies and an opposing cast with type 4 or 5 dental stone.

4. Make interocclusal records and use a face-bow to aid in mounting the casts in an articulator.

5. Wax the crown(s) with ideal contours, guiding planes,[29] and rest seats keeping in mind the need for retention, bracing, and support for the clasps of the RPD.

6. A surveyor (Fig. 17) must be used to verify the contours in relation to the path of insertion.[13] (Wax cutters are available for use in handpieces and milling devices in varying sizes with tapers from 0 to 4 degrees.)

7. Sprue, invest, cast, recover, finish, and polish the casting(s).

8. Both the wax crown and the casting can be machined with a handpiece and a bur or a stone by using a handpiece holder (Ney Dental Inc, Bloomfield, Conn.) attached to the dental surveyor[20] (Fig. 17) or self-contained milling devices, such as the Bachmann parallelometer instrument (Andres and Métaux SA, Biel, Switzerland; Métaux Précieux SA, Neuchâtel, Switzerland) or similar instruments.[29]

9. Precise guide planes can be perfected by this procedure. Milled surfaces must be carefully repolished before cementing them.[29]

10. Milling carbides and polishing stones for metal can be purchased in various sizes with tapers from 0 to 4 degrees.

11. Never cement a cast restoration until the contours, guiding planes, and the retentive undercuts have been verified with the castings on the definitive cast mounted in a dental surveyor. This verification must be made with the polished casting(s) on the surveying table at the tilt used for the design of the partial denture framework to make certain that the desired contours and undercuts have not been lost in the finishing and polishing process of the cast restoration.[29]

12. After the surveyed crowns and RPD have been fitted to the cast, they must be fitted to the mouth with disclosing wax or other disclosing medium.[30]

SUMMARY

Much has been written about removable partial denture design. The more significant aspect of treatment with removable partial dentures is the careful planning and execution of mouth preparations and their accurate reproduction through the fabrication process. The most thoughtful denture design cannot be successful without meticulous completion of clinical and laboratory procedures. Conversely, any rational, generally accepted design will most likely be successful with careful execution of the procedures.

The benefits of careful planning, designing, and executing mouth preparations are substantial. Properly prepared rest seats and accurately fitting rests will direct the forces of mastication so that the teeth and the partial denture will mutually support each other. Properly balanced and distributed forces can contribute to enhanced longevity of both the remaining oral structures and the restoration.

The principles presented in this article can result in saving considerable chair time in seating the framework and completed removable partial denture. They can provide more comfort for the patient by reducing repeated procedures and follow-up appointments. Finally, they can ensure a predictable, favorable prognosis for the restoration.

The artwork for this article was completed by Ralph Montalvo.

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