Rotational Path Removable Partial Dentures: Part 1. Replacement of Posterior Teeth

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Tooth-supported removable partial dentures, using rotational paths of placement, are described. Retention is obtained when a minor connector rotates into a proximal undercut. It is maintained in intimate contact with the tooth surface by its partial denture rest, other components of the prosthesis, and clasps located away from the path of rotation. Although conventional clasps are not totally eliminated, they may be confined to posterior abutments where esthetics are usually not affected. Factors that influence the practicality of the rotational path of placement include patient acceptance and coordination, the presence of proximal undercuts, the location and number of edentulous areas, and the arch form.
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When designing a conventional removable partial denture, a path of placement perpendicular to the occlusal plane is commonly chosen (Figs 1a and 1b). The perpendicular path is usually selected because (1) the contours of the abutment teeth surveyed in this position frequently present favorable undercuts; (2) guiding planes may be prepared more easily; (3) the path of placement is easily repeatable; and (4) many patients seat their prostheses under occlusal force, and clasp distortion is less likely because the path of placement approximates the direction of mandibular closure.

However, variations from such a path of placement may be necessary to compensate for the lack of proper tooth position or contours. A modified path of placement is established by changing the lateral or the anteroposterior tilt of the cast in the dental surveyor. Such changes, if they are slight, may be very helpful, but if they are severe, the patient may have difficulty placing the prosthesis. As noted

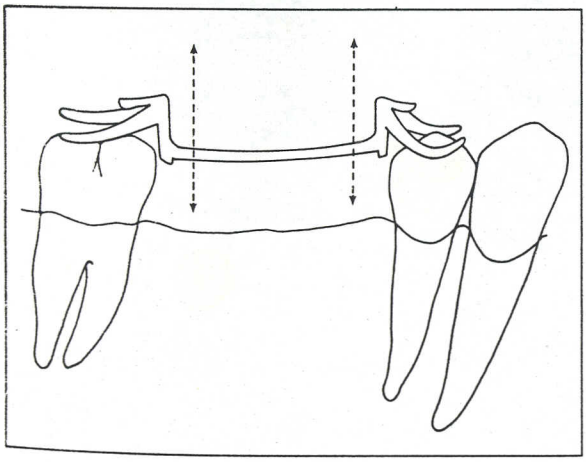

Fig 1a Partial denture framework being placed along a path perpendicular to the occlusal plane. Note guiding planes on the mesial surface of the molar and distal surface of the premolar.

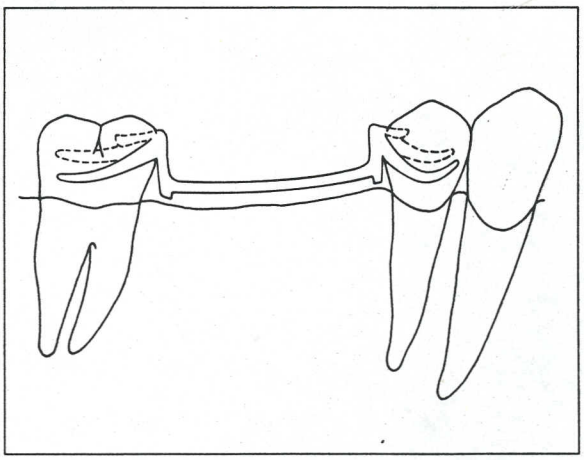

Fig 1b Partial denture completely seated along a straight path of placement.

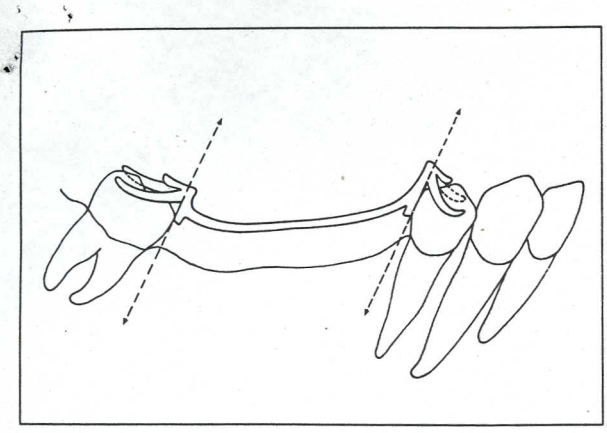

Fig 2 Partial denture framework being placed along a straight path that markedly deviates from the perpendicular. Rests will still seat simultaneously.

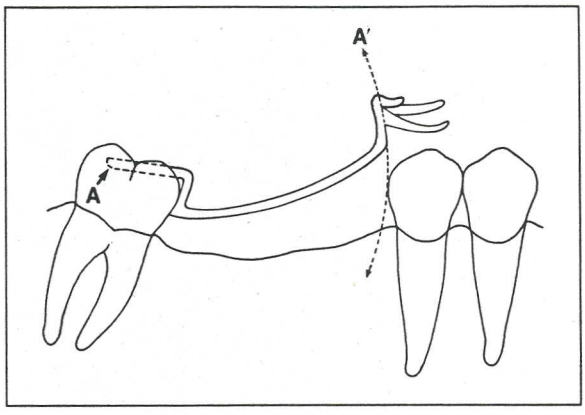

Fig 3 Placement of framework using a rotational path. (A, distal end of the molar rest around which the partial denture rotates into position along the arc, A'.)

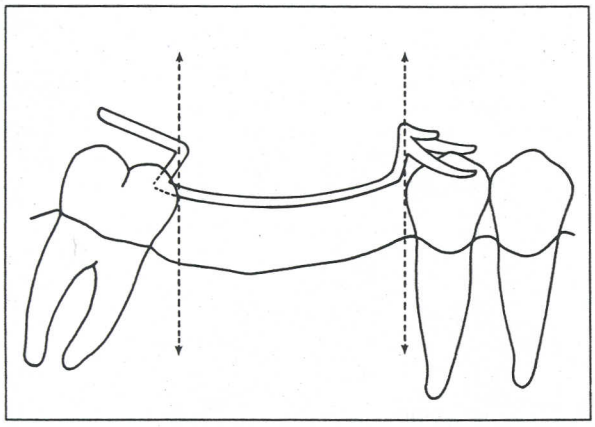

Fig 4 In a true rotational path design, the partial denture cannot be placed along any straight path. The distance between the gingival portions of the minor connectors is greater than the distance between the marginal ridges of the abutment teeth.

earlier, many patients tend to seat their dentures under occlusal force. If the path of placement differs markedly from the perpendicular, the clasp arms are more likely to be deformed.

A rotational path of placement used by Hollenback and reported by Humphreys[1,2] in 1935, differs substantially from the conventional straight path. The straight path seats all rests more or less simultaneously, even when the path of placement varies from true perpendicular (Fig 2). However, the rotational path seats one portion of the partial denture first, allowing one or more of the rigid components access to undercut areas adjacent to the edentulous spaces (Fig 3). Then, the entire prosthesis is rotated into its final position.

The rotational path cannot be reduced conceptually to a straight path of placement established by a severe tilt of the cast. In a true rotational path design, the partial denture cannot be seated along any straight path (Fig 4). One portion of the denture must be placed first to gain access to undercuts before the entire denture can be completely seated. Proper use of the rotational path makes it possible to eliminate undesirable or unesthetic clasp arms while still fulfilling the requirements of retention, stability, and support.

The rotational path design replaces conventional clasps with rigid retentive units that typically consist of a rest and its retentive component. This retentive component may be a minor connector, generally used on posterior teeth (Fig 5), or an extension from the minor connector, frequently used on anterior teeth (Fig 6). The rigid retentive components are placed or rotated into undercuts and maintained in intimate contact with the tooth by modified rests and conventional clasps. Because of the rigidity of the retentive units, the rotational path design should be limited to completely tooth-supported removable partial dentures.

Development of the Rotational Path Concept

Clasp design for rotational path removable partial dentures has evolved over a period of years. The Hart-Dunn attachment, described by Mann[3] in 1957, introduced a design for embrasure clasping of Kennedy Class II removable partial dentures. This design used a clasp assembly consisting of two rests and two clasp arms, known as "embrasure hooks," that engaged adjacent proximal undercut areas from the lingual aspect of an abutment tooth on the dentulous side of the arch. The embrasure hooks were placed first, then the extension base of the partial denture could be rotated into position. This design

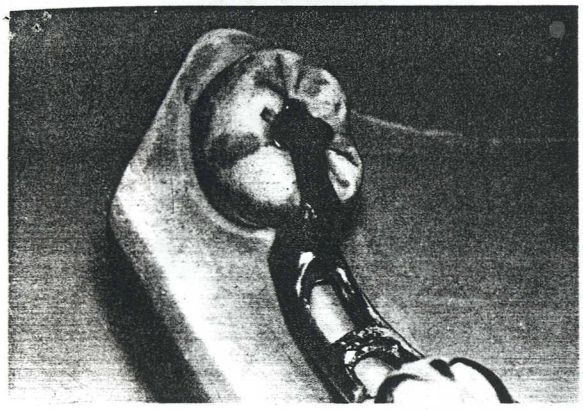

Fig 5 Minor connector that acts as a retentive component contacts the undercut area on the mesial surface of the tooth.

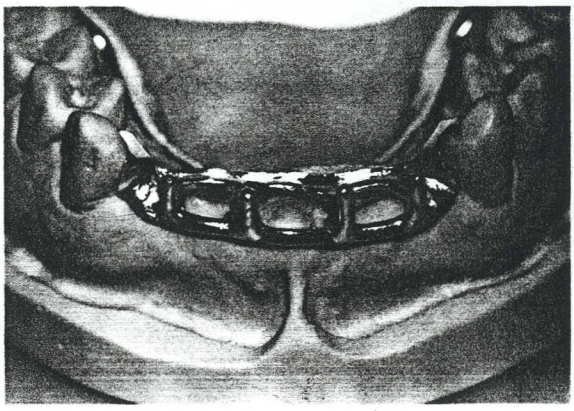

Fig 6 Extension from the minor connector contacts the undercut area on the mesial surface of the canine abutment teeth.

was further modified by Garver,[4] who realized the importance of the fulcrum line axis. He used an embrasure-type clasp along the horizontal axis of rotation, and included a clasp arm beneath a fixed partial denture pontic on the dentulous side of the arch, supported by an appositional rest on the occlusal surface.

Variations of the rotary path[5] have been used to solve certain clasping problems for tooth-supported removable partial dentures. These included a dual path of placement[6,7] that combined an initial straight path, followed by complete seating along a curved path. Others have elaborated on these suggestions by applying functional and mechanical principles.[8-10] Dividers were used in the surveying procedures, and rotational paths were separated into two categories.

Categories of Rotational Path Designs

There are two categories of rotational path designs based on the location of the framework rotational centers and their most appropriate clinical applications. Category I designs are primarily used to replace missing posterior teeth. The rotational centers of the framework are located at the ends of the long rests of the rigid retainers. The rotational centers on each side of the arch determine the axis of rotation for placement. The rotational centers are seated first, then the entire prosthesis is rotated into place (Figs 7a and 7b). Category II designs are primarily used to replace anterior teeth. Their rotational centers are located gingivally as rigid extensions of the minor connectors. The portion of the removable partial denture with the rigid retainers is

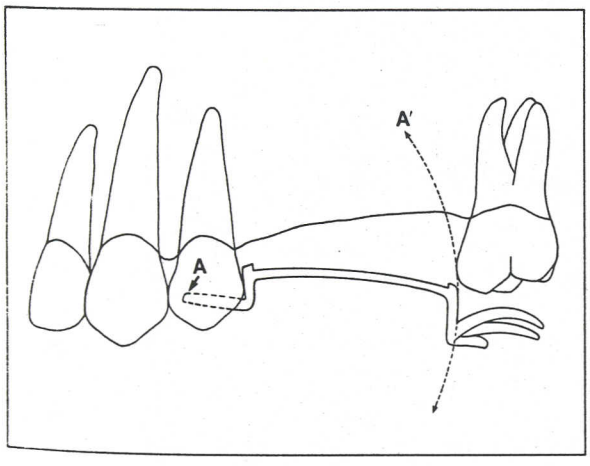

Fig 7a Category I design is used primarily to replace posterior teeth (A, rotational center on the long occlusal rest of the rigid retainer; A', arc along which the molar clasp will rotate into position.)

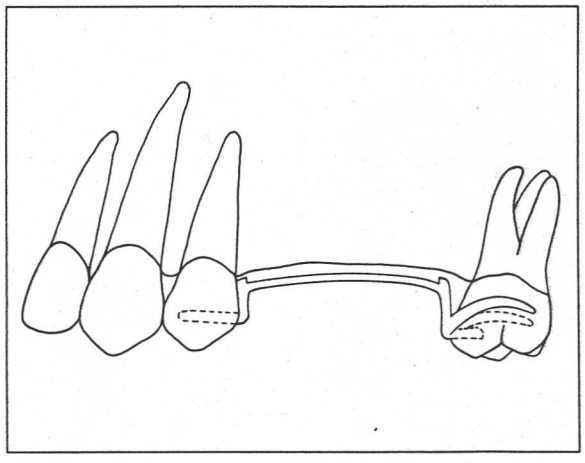

Fig 7b Category I partial denture framework completely seated. Note absence of clasp arms on the premolar and the intimate contact of the minor connector with the distal surface.

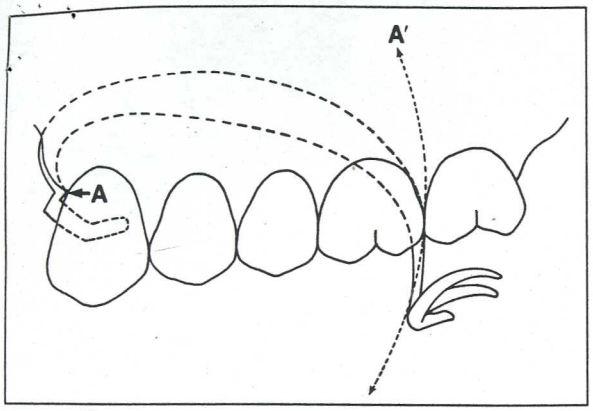

Fig 8a Category II design. Maxillary arch. (A, center of rotation located at the gingival portion of the mesial surface of the canine; A', arc that the molar clasp will follow when being placed.)

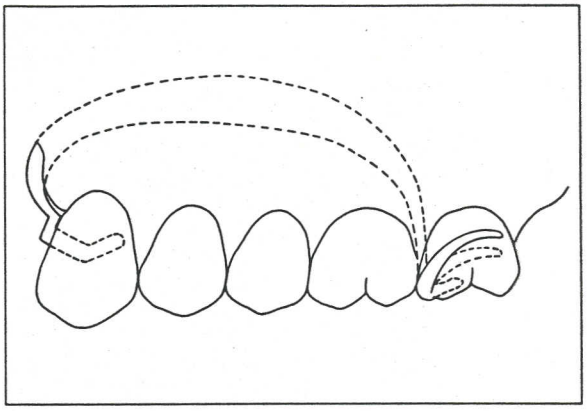

Fig 8b Partial denture framework completely seated.

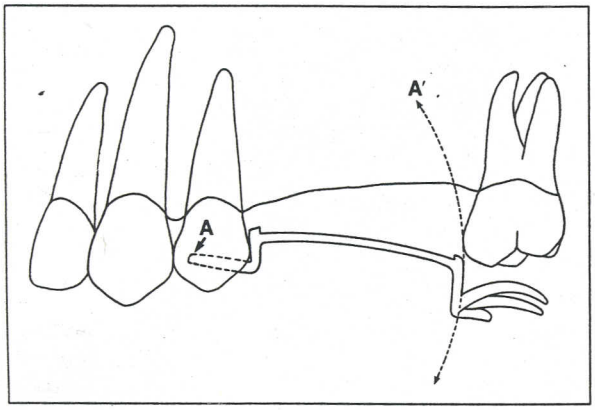

Fig 9a Anteroposterior (AP) path of placement. Rigid retainer placed first on premolar, followed by seating of the partial denture framework.

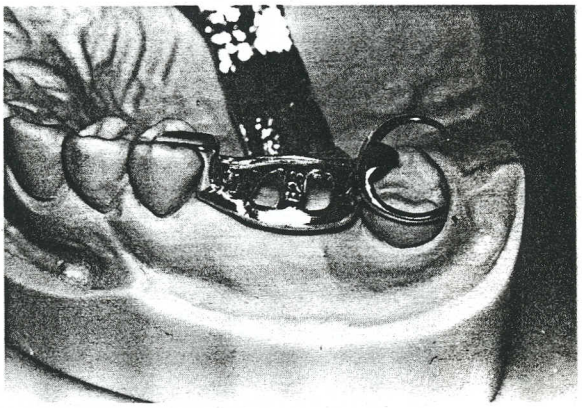

Fig 9b Maxillary partial denture framework with rigid retainer placed first on premolar.

first placed along a straight path to gain access to the rotational centers, then the prosthesis is rotated into place (Figs 8a and 8b). This article presents design considerations for Category I rotational path dentures. A subsequent article (Part 2) will discuss Category II designs.

Design Considerations for Replacing Posterior Teeth

Path of Placement

When posterior teeth are missing, the anterior or posterior portion of the partial denture is designed to seat first, depending on esthetic and periodontal considerations. If the anterior portion of the prosthesis is placed first (Figs 9a and 9b), the path of placement is termed anteroposterior (AP). Usually, the AP path is used in the maxillary arch for esthetic reasons, as this design eliminates clasps on the more anterior abutments (Figs 10a and 10b). If the posterior portion is placed first (Figs 11a and 11b), the path is termed posteroanterior (PA). In the mandibular arch, the PA path may be used to great advantage when molar abutments are tipped mesially (Figs 12a and 12b). Clasp arms on these molars are eliminated, thus resolving a common and difficult clasping problem. As a result, the amount of tooth coverage and subsequent plaque accumulation are reduced.

Rest Form of the Rigid Retainer

Rest seat preparations must be deep enough to allow a rest thickness of at least 1½ mm for base metal alloys and 2 mm for noble metal alloys, the same as for any conventional rest. This thickness is particularly important at the junction of the rest and

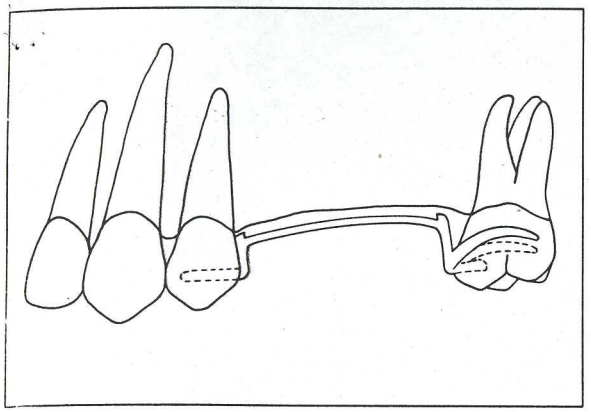

Fig 10a Partial denture framework shown in Fig 9a completely seated.

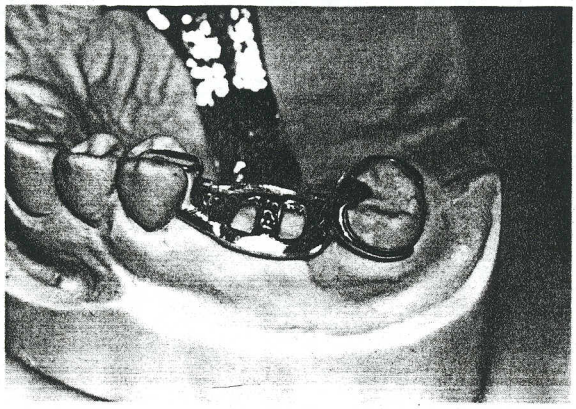

Fig 10b Maxillary partial denture framework completely seated. Note absence of clasp arms on the premolar.

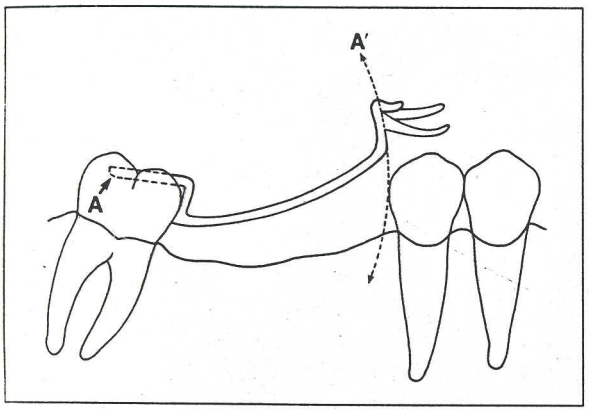

Fig 11a Posteroanterior (PA) path of placement. Rigid retainer is placed first on the molar, followed by seating of the entire partial denture framework along a curved path.

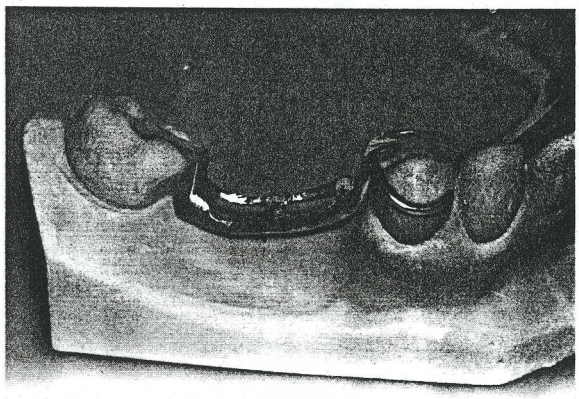

Fig 11b Mandibular partial denture framework placed first on the molar.

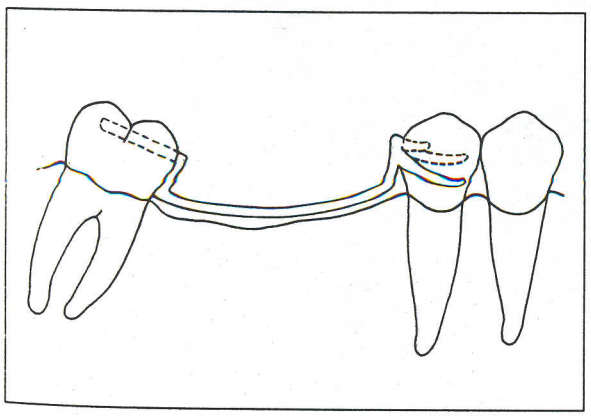

Fig 12a Partial denture framework shown in Fig 11a completely seated. Posteroanterior (PA) path may be used advantageously on mesially tipped molars, often resolving a common and difficult clasping problem. Note the occlusal rest on the molar extending more than half the mesiodistal width of the tooth.

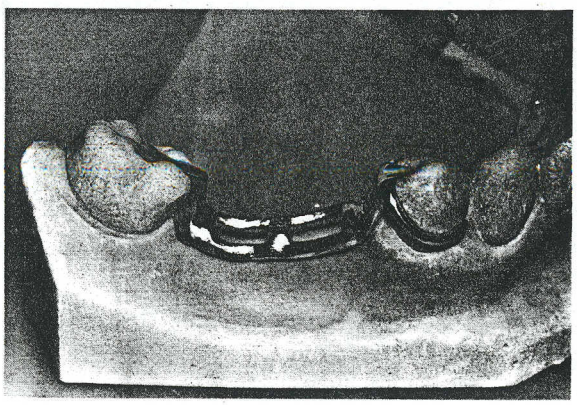

Fig 12b Mandibular partial denture framework completely seated. Note absence of clasp arms on molar.

the minor connector to prevent fracture of the rest. The rest should extend more than half the mesiodistal dimension of the abutment tooth, and its facial and lingual walls should be nearly parallel (Fig 13). This configuration provides bracing and vertical distribution of forces to the abutment tooth. The walls of the rest seats should be parallel bilaterally across the arch. This is especially critical in Category I mandibular partial dentures with a PA path when tipped molars are used for abutments. These molars are often tipped lingually as well as mesially, necessitating parallel facial wall preparations across the arch to permit seating of the rests (Figs 14a and 14b).

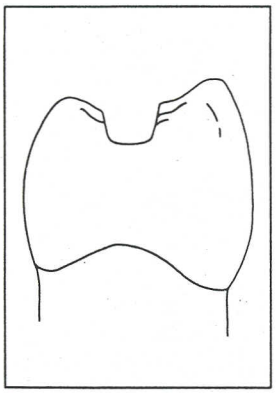

Fig 13 Rest seat preparation should allow for 1.5 to 2 mm thickness of metal. Facial and lingual walls are nearly parallel to provide bracing and vertical distribution of forces.

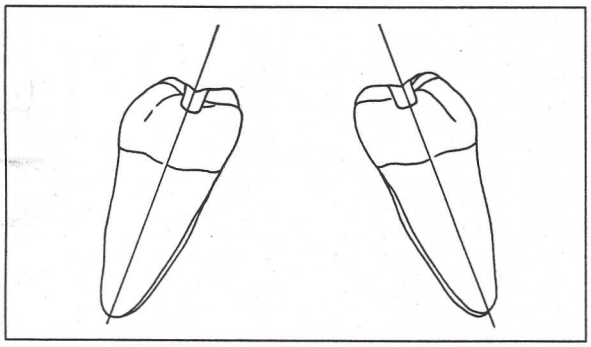

Fig 14a Molars are often tipped lingually as well as mesially. The walls of the rest seats should be parallel bilaterally across the arch to permit seating of the rests. In this diagram the facial walls would prevent placement of the rests since they create undercuts in relation to one another.

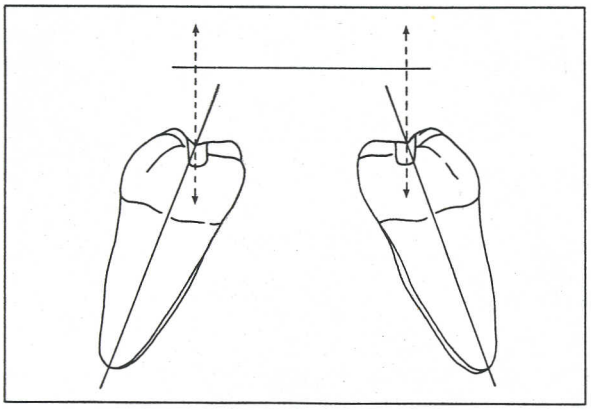

Fig 14b Rest seats on tipped molars properly prepared to permit placement of the rests.

Rest seat preparations should have an asymmetric outline, such as dovetails, that will provide the equivalent of adequate encirclement of a clasp (Fig 15). This design eliminates the possibility of the abutment tooth moving away from the clasp. An exception to this rule applies to molars that are severely tipped mesially. For these teeth, a straight channel rest, its floor perpendicular to the long axis of the tooth, exerts the least amount of tipping force under occlusal loading.[11] The channel rest permits slight movement of the tooth or rest when the partial denture is subjected to forces of mastication (Fig 16).

Intimate contact of minor connectors and rests with their corresponding tooth surfaces must be preserved. Finishing or adjusting the rigid retainer must be done with care to preserve this contact.

Surveying for Posterior Tooth Replacement

AP Path

The AP rotational path is used when esthetics is a primary concern. This is often true in the maxillary arch, where the anterior abutments are first premolars or canines and the display of metal clasps in a conventional design would be objectionable. If the contours of the more anterior abutment tooth permit the use of rigid retainers, the AP rotational path may be indicated.

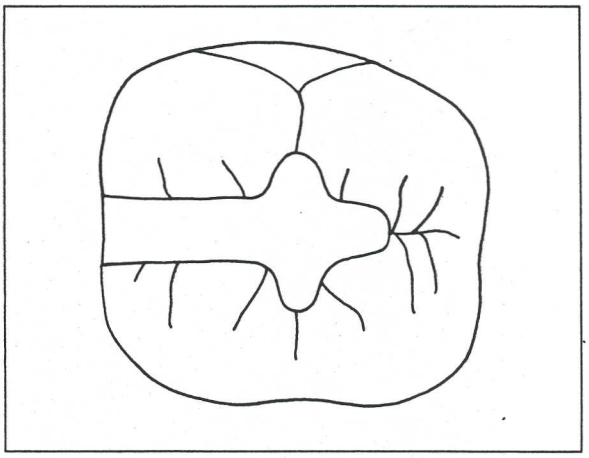

Fig 15 Proper rest seat preparation. A dovetail or other irregularity is acceptable. The asymmetrical outline prevents migration of the tooth.

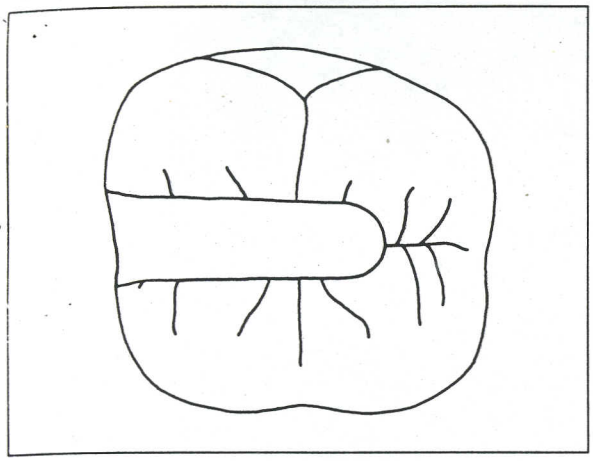

Fig 16 Channel rest seat preparation on severely tipped molars is preferred to permit slight movement of tooth or rest to minimize further tipping force.

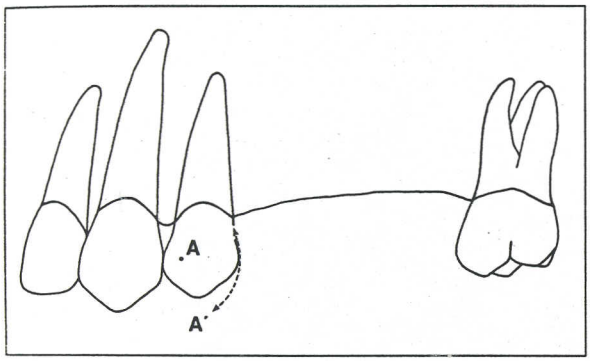

Fig 17a One point of a divider is placed on point A, (rotational axis around which the partial denture will be rotated into place) and the other point on the distal surface of the premolar near the gingiva. The divider is then rotated occlusally. If the divider binds on the distal surface, the undercut must be reduced. (A', arc that the minor connector of the rigid retainer follows in seating the partial denture).

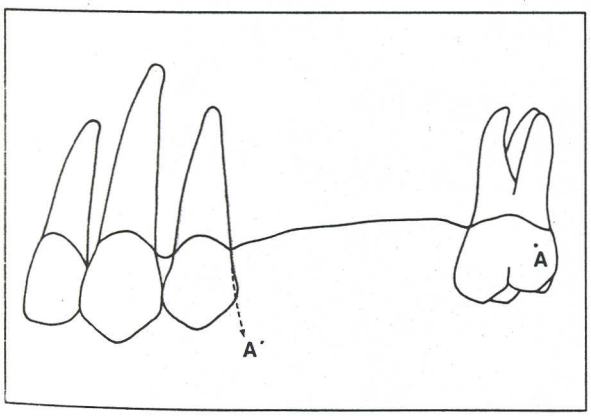

Fig 18a If the arc passes through the tooth, the retention will be adequate. (A, terminal of the retentive clasp arm around which the partial denture will tend to rotate when a dislodging force is applied; A', arc along which the minor connector of the rigid retainer will tend to move.)

In addition to a dental surveyor, a divider is helpful in determining the amount of blockout needed to eliminate interferences in placing the framework. One point of the divider is placed on the axis, around which the framework will rotate into position. The other point is placed at the most cervical portion of the same tooth. The cervical point of the divider is then rotated occlusally to determine if the undercut is too great for the minor connector. The cervical point of the divider should move occlusally without interference (Figs 17a and 17b). If binding occurs, the amount of undercut must be reduced.

To determine whether the undercut is sufficient for the rigid retentive component, one point of the divider is placed at the anticipated terminal of the retentive clasp arm. The other point is placed at the cervical third of the proximal surface of the tooth on which the minor connector (retentive component) will be positioned. If the point on the proximal surface binds when moving occlusally, the undercut is adequate (Figs 18a and 18b). Another method is

Fig 17b One point of the divider is placed on the rotational axis and the other point on the distal surface of the premolar.

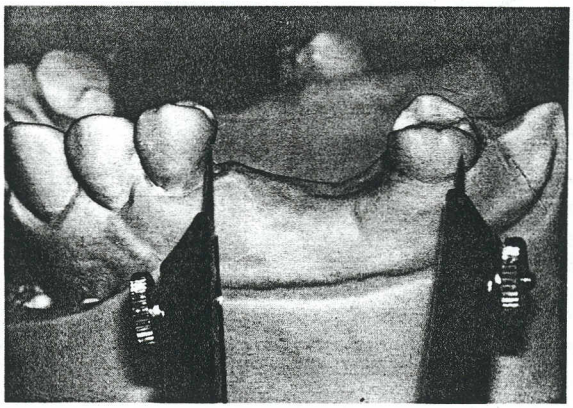

Fig 18b One point of the divider is placed on the molar at the retentive terminal of the clasp arm and the other on the distal surface of the premolar. The point of the divider on the distal surface of the premolar should bind when rotated occlusally.

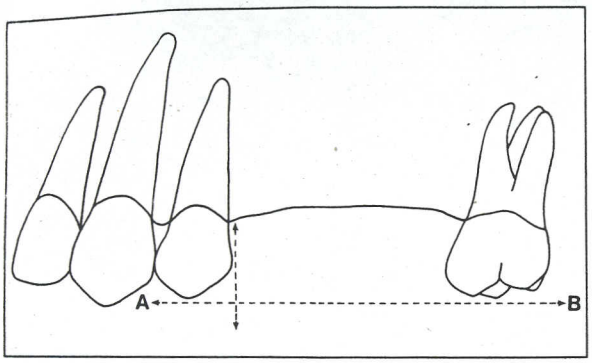

Fig 19 Premolar and molar teeth are positioned on the line A-B. The perpendicular line represents the analyzing rod. A small amount of undercut is present on the distal surface of the premolar.

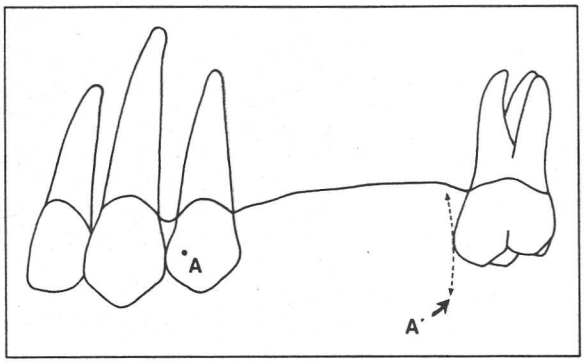

Fig 20 Necessary blockout may be seen between the arc and the mesial surface of the molar. (A, point on the axis of rotation; A', arc that the minor connector on the molar would follow upon complete seating the partial denture.)

to survey all of the abutments at the same horizontal level. Lack of sufficient undercut will be apparent in relationship to the analyzing rod (Fig 19).

To determine the amount of blockout necessary to coincide with the arc of rotation, one point of the divider is placed on the axis of rotation, around which the partial denture will rotate into its final position. The other point is extended to the marginal ridge of the posterior abutment on the same side of the arch, then rotated cervically (Fig 20). To determine the proper undercut on the tooth to be clasped, conventional surveying is done with a 0° tilt. The occlusal plane should be as parallel as possible to the base of the surveyor.

PA Path

The PA path of placement may be used when molar abutment teeth are to receive the rigid retainer. The surveying procedure is similar to the one described for the AP path. However, in the AP path, the rigid retainer is located on the more anterior abutment, usually a premolar, and a conventional clasp is placed on the posterior abutment. In the PA path, the rigid retainer is located on the more posterior abutment, and a conventional clasp is used on the more anterior abutment (Figs 12a and 12b).

Factors Affecting the Rotational Path

Multiple Edentulous Areas

As the number of minor connectors increases, so does the potential difficulty of rotating the partial denture framework into place. An adequate blockout of undesirable undercuts must be planned for all minor connectors. The further the minor connector is from the axis of rotation, the straighter the arc it must follow. The closer the minor connector is to the axis of rotation, the greater the curvature of the arc it must follow. This can be readily determined by using a divider to analyze all edentulous areas (Fig 21). If a lingual plate is used and posterior teeth are involved, all lingual embrasures must also be analyzed to determine the blockout necessary for the lingual plate to seat without interference. These blockouts will assume a curvature coinciding with the arc of placement. When using the rotational path design, a properly designed lingual bar is simpler to fabricate than a well-designed lingual plate.

Shape of the Arch

The shape of the arch may affect the proper placement of a rotational path prosthesis. Radii used to assess the amount of blockout required must be

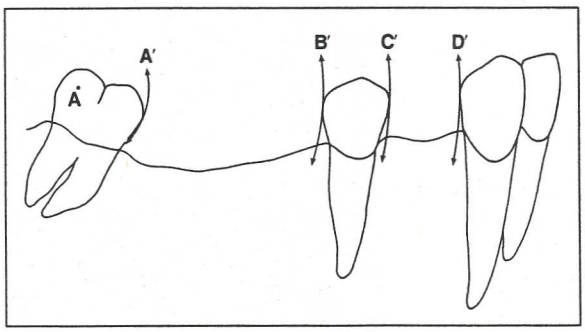

Fig 21 Multiple edentulous areas. The rigid retainer will be placed on the molar. (A, a point on the axis of rotation; A', B', C', D', amount of blockout necessary for each minor connector.) The further the minor connector is from the axis of rotation, the straighter the arc that it follows; the closer the minor connector is from the axis of rotation, the more acute the arc that it follows.

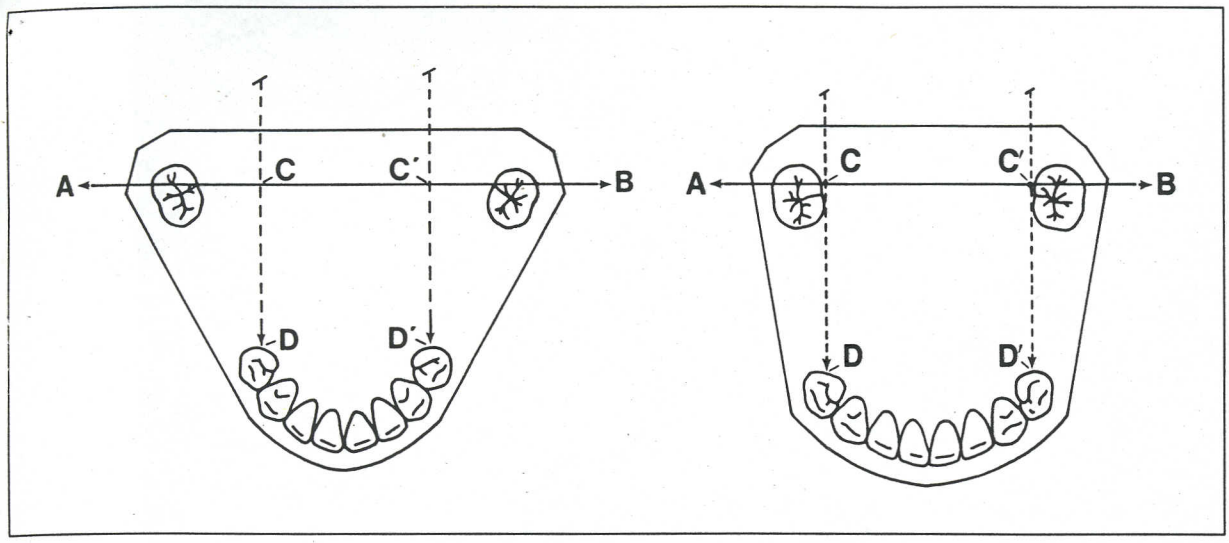

Fig 22 Distance between the mesial surfaces of the molars and the distal surfaces of the premolars is identical in both arches. For the tapered arch (left) the radius distance from C to D or C′ to D′ is less than in the square arch (right). More blockout at the distal surfaces of the premolars is required for the tapering arch.

extended perpendicularly from the rotational axis. A shorter radius requires more blockout than a longer one. A tapering arch has shorter radii requiring more blockout than a square arch (Fig 22).

Lingually Tilted Teeth

Lingually tilted mandibular teeth that may not interfere with the placement of a conventional removable partial denture may prevent placement of a rotating framework. The major connector may require excessive relief to prevent contact with the teeth during placement (Fig 23), which can create a food trap and become bothersome to the patient's tongue. Problems associated with lingually tilted teeth are accentuated by a tapering arch, as discussed above. Rotational paths should probably not be used in such instances.

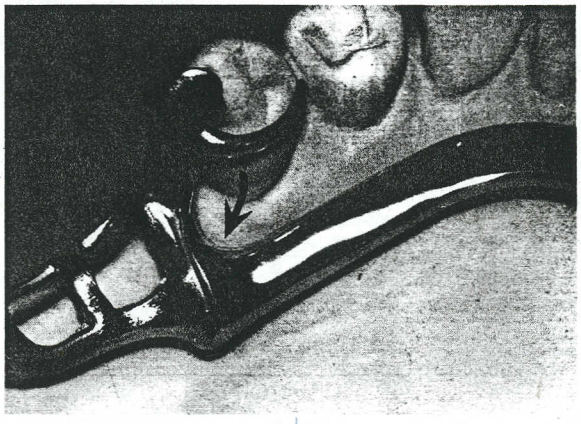

Fig 23 Arrow indicates arc of placement of major connector in region of second premolar. Lingually tilted teeth may require excessive relief which could be bothersome to the patient.

Vertical Height of the Retentive Clasp Terminal

The terminals of the retentive clasp arm, around which the partial denture tends to rotate when the prosthesis is displaced, must be properly located in relation to the retentive retainer to make this component functional. In the maxillary arch, if a steep anteroposterior occlusal curve is present and a molar clasped, the rigid retainer on the more anterior abutment may be nonretentive. As described earlier, the effectiveness of the rigid retainer may be determined easily on a diagnostic cast, using a divider (Fig 24), or by surveying the cast with the anterior and posterior abutments at the same hor-

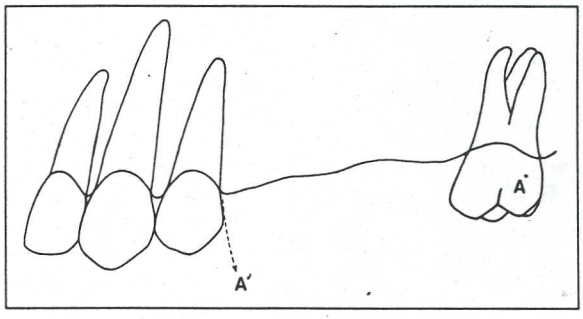

Fig 24 Since the arc does not pass through the tooth, the rigid retainer would not be retentive. (A, terminal of the retentive clasp around which the partial denture will tend to rotate when a dislodging force is applied; A′ arc along which the minor connector of the rigid retainer will tend to move.)

izontal level. The absence of an undercut for the rigid retainer will become apparent (Fig 25).

Multiple Rotational Paths

At times, more than one rotational path may be used to seat a single removable partial denture. This potential may be confirmed by constructing a template of the proposed design in autopolymerizing resin, using strips of carding wax or other suitable material to confine the resin (Fig 26). All undesirable undercuts must be blocked out. After the resin has set, the wax is removed and the resin template analyzed to be certain that it covers only the area of the proposed design. The template must be removed carefully to avoid fracturing the teeth on the stone cast. If the template cannot be removed easily, it may indicate that the proposed design should not be used. After removal, the template should be studied carefully to be certain that no elements will be added to interfere with its placement. The template may be trimmed (Fig 27) and sent to the laboratory as a guide in fabricating the framework.

Conclusions

Removable partial dentures with a rotational path of placement can be used to advantage in many different clinical situations. In particular, designs of this type may help overcome esthetic problems of conventionally designed removable partial dentures by eliminating the need for some clasps. Designs for rotational path removable partial dentures have evolved with time; they include modifications for use with resin-bonded fixed prostheses[12] and for Kennedy Class IV removable partial dentures.[13]

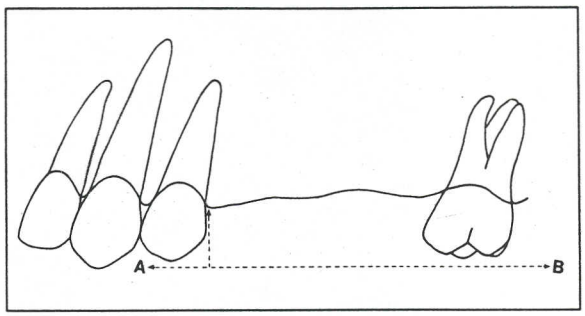

Fig 25 Premolar and molar teeth are positioned along line A-B. The analyzing rod is represented by the perpendicular line. It is apparent that no undercut is present on the distal surface of the premolar.

Although a typical rotational path removable partial denture allows little tolerance for error, several excellent articles have been published that analyze common problems and describe how they may be avoided.[14,15] By taking the time to understand the rotational path concept, the dentist and laboratory technician may learn to avoid problems and fully realize the benefits of the design.

Acknowledgments

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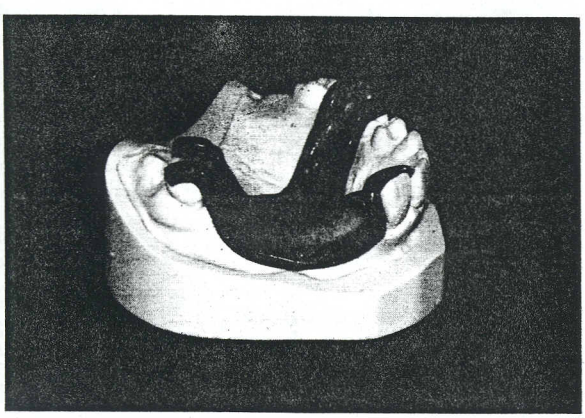

Fig 26 Wax is used to confine autopolymerizing resin to the proposed outline on a diagnostic cast.

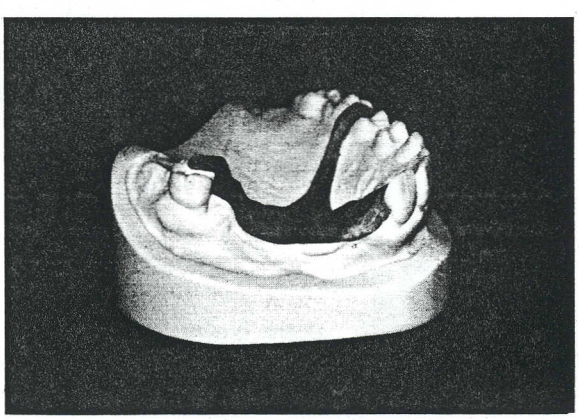

Fig 27 Trimmed resin template is used to confirm the rotational path of placement on a diagnostic cast. It may be used to verify the possibility of seating the framework and as a guide for the laboratory technician.

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Literature Abstracts

Factors Associated with Occurrence and Reversibility of Connective Tissue Attachment Loss

Experimental periodontitis was studied in four adult squirrel monkeys. Systemic administration of Metronidozole was begun 3 days prior to the initiation of the experimental disease and continued throughout the study. Oral hygiene was stopped after initiating periodontitis. Bactericidal sampling was done prior to the study and at 3, 7, and 14 days. Animals were sacrificed after all bacterial samples were taken and histologic sections made to evaluate periodontal destruction. Initially, subgingival plaque consisted of cocci. After the initiation of periodontitis, cocci were reduced and straight rods were the primary form. Levels of spirochetes and motile forms were low. There was significant loss of connective tissue attachment at 3 and 7 days, but this was reversed and repaired at 14 days.

Zappa UE, Polson AM. *J Periodontol* 1988:59;100-106. **References:** 79. **Reprints:** Dr Alan M. Polson, Department of Periodontology, Eastman Dental Center, 625 Elmwood Avenue, Rochester, NY 14620.—*Gary Dickinson, DDS, MS, Albuquerque, New Mexico*

Prevalence of Craniomandibular Dysfunction in Children and Adolescents: A Review

The literature relative to the occurrence of craniomandibular dysfunction in selected and nonselected populations of children and adolescents is reviewed. The prevalence of objective symptoms were found to range from 9.8% to 74%; subjective symptoms ranged from 19% to 85%. Muscle tenderness was the most common symptom, followed by headaches, temporomandibular joint sounds, and discomfort. These symptoms, although mild, were found in all age groups. As a consequence, **it is recommended that routine evaluation of the masticatory system be included in the initial and follow-up dental examination of children.**

Vanderas AP. *Pediatr Dentistry* 1987;9(4):312-316. **References:** 19. **Reprints:** Dr Apostole P. Vanderas, Festou and Thessalonikis Str, Kifissia Athens, Attica, Greece.—*Donald C. Kramer, DDS, MS, The University of Texas M.D. Anderson Cancer Center, Houston*