An analysis of the rotational axes of semiprecision and precision distal-extension removable partial dentures

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The conventional axis rotation theory is based on the principles of occlusion presented by McCollum and Stuart.\(^1\) Thompson,\(^2\) Knowles,\(^3\) Koper,\(^4\) and McLeod\(^5,6\) have shown that with a rotating retainer an axis of rotation exists about the fulcrum line on either side of the dental arch. Lack of alignment of the rotational axis on either side of the arch produces torque on the abutments when the prosthesis is in function. This torque must be compensated for by altering the retainers to accommodate the lateral movement associated with the resultant axis. In the ideal situation precision attachments (deep rest retainers) should be aligned in both the horizontal and vertical planes.

REVISED AXIS ROTATION THEORY

The Thompson dowel retainer has been used to analyze the mechanics of the typical hinge retainer.\(^5,6\) McLeod\(^6\) examined the principles governing the manner in which the stress-directing intracoronar retainer functions.

The importance of these principles as they apply to the Thompson dowel retainer are equally significant to all precision and semiprecision retainers as stress directors in the distal-extension removable partial denture. When retainers such as the Gerber, Dalbo, Crismani, and P.D. are used in any bilateral situation, the centers of rotation must be axially aligned to permit freedom of rotation during function (Fig. 1). If these rotational centers are not coincident, forces that stress the lateral components of the retaining mechanism are inherent (Fig. 2). The correct alignment of the axis on both sides of the arch is essential and is the theoretical basis for the "cones of movement" theory\(^3\) as applied to the Thompson dowel retainer and all other rotating deep rest retainers (Fig. 3).

ANALYSIS OF THE DALBO HINGE RETAINER

The bilateral Dalbo hinge retainer has been selected to show the application of the revised axis rotation theory. Previous authors\(^7,8\) have suggested that the Dalbo hinge retainer should be aligned by bisecting the angle between the midline of the edentulous ridge and the sagittal plane (Fig. 4). This is a departure from the theoretical ideal and has been used empirically as a compromise to avoid lingual bulging of the retainers. It is cautioned that this is not the most appropriate

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Fig. 2. When attachments are not aligned, resultant axis of rotation is at an angle $\Theta$ to horizontal plane. Only cones of movement occur about this axis.

Fig. 3. Diagram showing cones of movement about resultant axis $AB$ when this axis is at angle $\Theta$ to horizontal $XY$.

Fig. 4. Alignment of attachments with line bisecting angle between sagittal plane and midline of alveolar ridges. This system is not recommended, as lateral stresses are produced in function.

Fig. 5. Fracture of anterior splint with attempted repair indicated by arrow. Note that alignment of attachments is divergent.

However, the base can rotate when the revised concept is applied to the design. It is recommended that all precision and semiprecision retainers for a distal-extension removable partial denture be aligned in the manner shown in Fig. 1, with the centers of rotation axially coincident in both the horizontal and vertical planes. Heckney$^9$ has discussed the flexibility of the bilateral distal-extension removable partial denture in spite of the belief that the major connector imparts rigidity. He has also shown that in reality only a slight displacement of the denture base (0.3 mm) toward the tissue occurs during mastication. These two facts could be used to justify the nonalignment of the retainers in the empirical system. There are many occasions when
Fig. 6. Photographs of experimental models: A (top left and right), with attachments divergent, and B (middle left and right), with attachments parallel and aligned. In model A there is no freedom of movement; in B rotation is freely permitted. Bottom photograph, C, shows degree of freedom of rotation in ideal situation. (Unilateral Dalbo attachments have been used for purposes of clarity and effective demonstration.)

Fig. 7. Distal view of abutments with Dalbo attachments showing where binding occurs between wings of female and T bar of male with lateral displacement during rotation.
it is desirable to use retainers, yet a compromise is the only way in which this can be accomplished. It is generally accepted that the most ideal result should be sought regardless of how difficult it might be to achieve.

COMPENSATING MECHANISM FOR RETAINERS AT DIFFERENT LEVELS

When there is a difference in the level of the retainers across the dental arch, an altered axis of rotation is produced. This axis is the result of the individual factors associated with each attachment on either side of the arch. The resultant axis has limited cones of movement that require the retainer to be relieved to permit rotation without binding on the lateral components. In the Dalbo hinge retainer the manner in which the functional mechanism is relieved is related to the angle $\theta$ (Fig. 7). The relief is obtained by reducing the lateral surface of the male T beam (Fig. 8). An alternative to this adjustment procedure is to redesign the prosthesis so that the attachments remain correctly aligned. This is accomplished by altering the path of placement of the prosthesis (Fig. 9). The final result should be tested by rotating it freely on
the cast before the crowns are seated and the prosthesis placed. It is a common observation that many removable partial denture wearers insert their prostheses by biting them into place. Therefore, the path of placement should be in harmony with the arc of closure.

CONCLUSIONS

1. The conventional technique for using hinge retainers seems to produce lateral torque and undesirable stress on the abutments.

2. The revised axis rotation theory suggests that it is appropriate to align the attachments so that their rotational axes are coincident across the dental arch in both the horizontal and vertical planes.

3. The revised theory can be applied to all semiprecision and precision hinge retainers for the distal-extension removable partial denture.

4. Where freedom of rotation cannot be achieved with these conventional hinges, an alternative such as the ASC 52 (Bell International Inc., San Mateo, Calif.) or the resilient Ceka (J. F. Jelenko Co., New Rochelle, N.Y.) should be used.

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REFERENCES


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