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Improved design for the Thompson dowel semiprecision intracoronal retainer

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An analysis of the Thompson dowel semiprecision intracoronal retainer showed that a number of steps in the design of the dowel need to be more clearly defined.[1] A new design for the dowel is needed to make this retainer more effective.

Application of a detailed understanding of the mechanics of the dowel will eliminate some of the variables in design which detract from the ideal functioning of this retainer. Such details as the position of the center of rotation and exactly how the dowel should be eased have not been published previously. Thompson[2] assumed the center of rotation was in the mid-well area, while Knowles[3] and later Koper[4] considered it to be coincident with the inner shelf line of the abutment well. In the current design the rotational center is in fact 0.19 mm in from the inner shelf line, where the well is 2 mm deep and 1.5 mm wide. The rotational center is also slightly below the shelf line (Fig. 1).

The position of the center of rotation is a function of the separation of the dowel from the shelf Δe, the looseness of the fit, the width of the dowel mesiodistally, and the contour of the eased parts of the dowel. Using the hinge axis locating system devised by McCollum,[5] the center of rotation was found on scale working models. Because there is great variability in the exact position of the center, predictable alignment of the retentive recesses is difficult. Ideally, dowels should be free to rotate out from the wells without binding on the walls, and the retentive bosses should be perfectly aligned with the center of rotation so that no torquing of the abutments can occur.

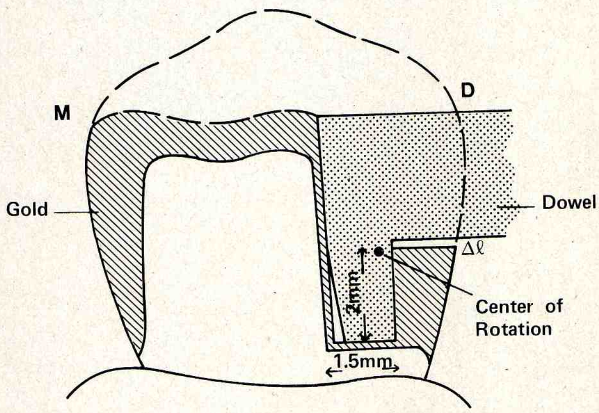

Fig. 1. The center of rotation is within the body of the dowel and slightly below the shelf line.

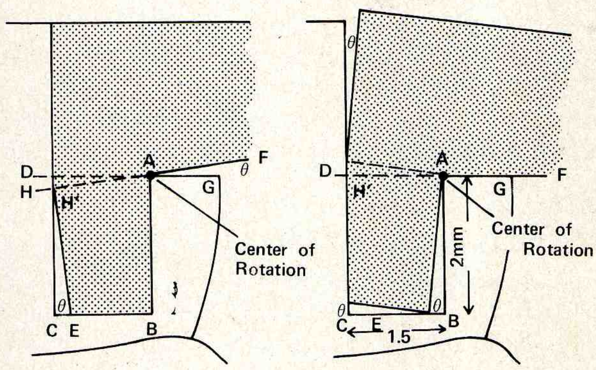

Fig. 2. Mesiodistal sections through the new dowel in the rest (*left*) and rotated position (*right*), showing the center of rotation.

THE NEW DESIGN

In seeking a new design for dowels a number of systems were examined. The final selection was based on simplicity of design and the manner in which the objectives were accomplished. One requirement was that the center of rotation be in a constant and predictable position for any dowel (Fig. 2).

In this design the dowel is eased so that the

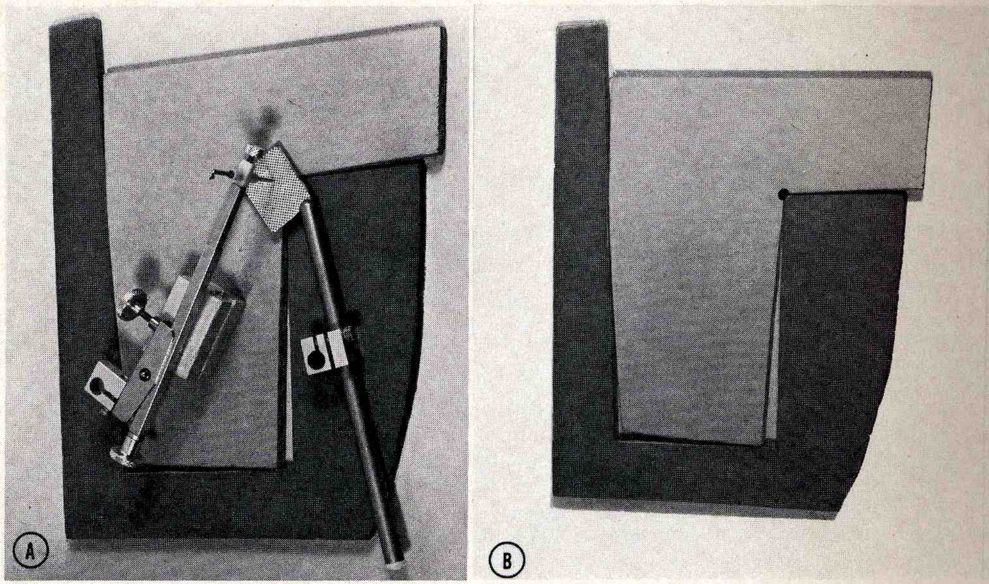

Fig. 3. Photographs of the working model. **A,** Hinge axis locating system used to find the center of rotation. **B,** Position of center of rotation at the inner shelf line of the well.

separation from the shelf is at an angle (θ) which is equal to the degree of maximum rotation required. The dowel is in contact with the inner shelf line and the floor of the well, so support is obtained from both. Once the dowel has been eased from D to E (Fig. 2), it is free to rotate through the angle θ to the vertical position. The rotational center is now coincident with the inner shelf line.

Examination of the photographs in Fig. 3 will reveal how the center of rotation was found, using the hinge axis locating system.* In the new design the center is always coincident with the inner shelf line, a predictable result.

ADVANTAGES OF THE NEW DESIGN

1. The center of rotation is always in the same position, coincident with the inner shelf line.
2. The retentive recesses can be accurately aligned with the inner shelf line, thus avoiding unnecessary torquing of the abutments.
3. There is no need to ease the dowel at B (Fig. 2). The side of the dowel AB is now the radius of a circle with a center of rotation at A. As a result the heel B will rotate freely without binding on the floor of the well.
4. The exact degree of stress relief can be controlled by altering the angle $G\hat{A}F = \theta$.
5. The dowel will be simpler to use clinically.

*Denar Corp., Anaheim, Calif.

ALIGNMENT OF THE CENTERS OF ROTATION

Ideally the shelves and the recesses should be at the same height and correspond in both the vertical and horizontal planes. Fig. 4 shows how the alignment should be accomplished. The retentive recesses and the inner shelf lines of the abutments should all be in one line at an equal distance above the tissues. This is a most critical factor in the design of precision attachment partial dentures, and failures may result from incorrect alignment.

DISPARITY IN HEIGHT OF THE SHELVES

It was explained in an analysis that differences in shelf height can exist across the arch, which alters the path of rotation of the dowels to a cone of movement.[1] This can be tolerated by flaring the walls of the wells away from the lowest shelf at an angle equal to the angle of the shelves with the horizontal (Fig. 5).

In previous designs[2] emphasis was placed on the need for the walls to be parallel and at right angles to the axis and for the buccal walls to be flared. Empirically it was found that the flare somehow improved the design. It is now understood that the buccal flare will help to reduce the binding that occurs as the dowel rotates. If a flare is to be incorporated in the design it need only be equal to the angle θ', the angle of the shelf with the horizontal.

Incorporation of an arbitrary flare on the buccal

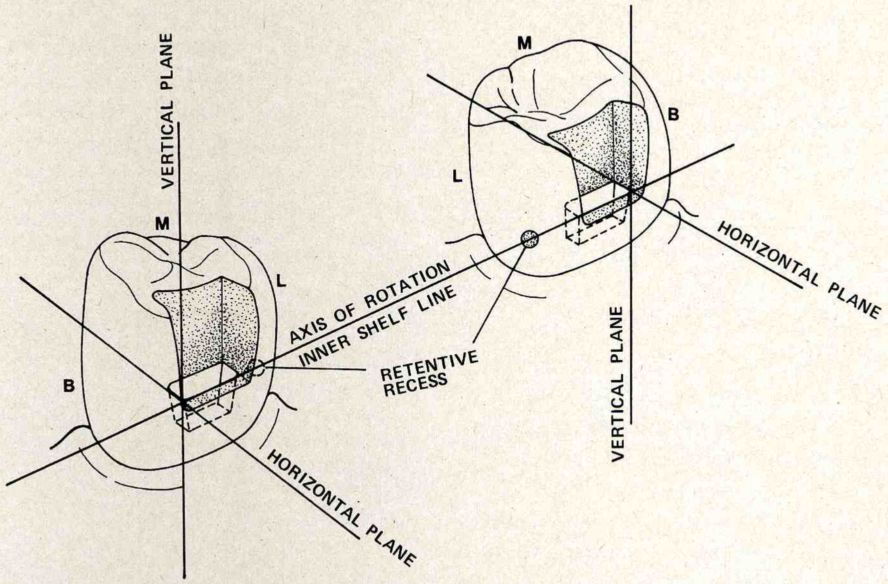

Fig. 4. Distal surfaces of the abutment teeth showing the alignment of the centers of rotation in both the horizontal and vertical planes.

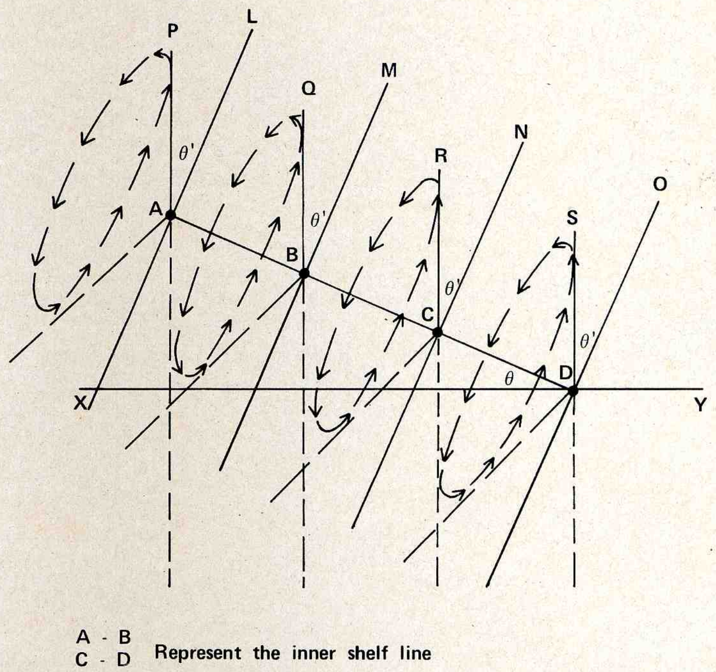

Fig. 5. When the shelves are at different heights the resultant axis of rotation is at an angle θ' to the horizontal, and only cones of movement exist for the dowels about this axis.

sides of the wells would overcome some of the torque that would occur if the shelves were incorrectly aligned. In reality, however, the way these wells are designed needs to be reconsidered. If the shelves are at the same height and are well aligned in the two planes, there is no need for any flare except for the sake of convenience. If a cross-arch discrepancy exists between the heights of the shelves, the flare should be equal to the angle of the shelves with the horizontal.

Table I. Amount by which dowel should be eased*

Maxillary	Mandibular
Well depth 2 mm	1.50 mm
C to *E* 0.175 mm	0.14 mm
D to *H* 0.080 mm	0.08 mm

*Assuming maximum rotation of 5 degrees; see Fig. 2.

SNUBBER ARMS AND RELEASE ARMS

When the shelves are aligned, these extensions enhance the design of the restoration. However, if only a poor resultant axis of rotation exists and the shelves are inclined to the horizontal, or if the shelves simply are not at exactly the same height, then the snubber arms and release arms will bind just as the sides of the dowels would. In instances where shelf heights do not correspond, the snubber arm extensions may be eased away from the surface of the abutments, and the releasing arms may be left out of the design. Easing is at the same angle as the flares on the walls.

In this new design the dowel should be eased from just below the point where the shelf line cuts the inner wall at *D* (Table I). This will preserve the tightness as the dowel rotates. The figures in Table I can also be applied to the design recommended by Koper.[2]

SUMMARY

The new design of the dowel differs from the previous one in that the dowel is in contact with the inner shelf line at all times but is eased to enable it to rotate out from the well. The exact alignment of the two shelves is important. Incorporation of anything more than the slightest flare is discouraged unless the shelves are at different heights. Finally, the lingual walls do not need to be parallel or at right angles to the axis of rotation, except where the shelves correspond perfectly and are horizontal to the tissue surface. The only requirement is that they do not diverge in the path of rotation.

The author wishes to thank all those who have helped with the preparation of this article, especially Bernard Levin, D.D.S., M.Ed., Professor, Department of Removable Prosthodontics, Valerie Almquist, B.A., who did the illustrations, and the staff of the Department of Audio-Visual Services, University of Southern California School of Dentistry.

REFERENCES

1. McLeod, N. S.: A theoretical analysis of the mechanics of the Thompson dowel semi-precision intracoronal retainer. J Prosthet Dent **37**:19, 1977.
2. Thompson, M. J.: Solution for specific problems in replacing missing teeth with partial dentures. Ill Dent J **26**:251, 1957.
3. Knowles, L. E.: A dowel attachment removable partial denture. J Prosthet Dent **13**:679, 1963.
4. Koper, A.: An intracoronal retainer: Semi-precision retainer for removable partial dentures: The Thompson dowel. J Prosthet Dent **30**:759, 1973.
5. McCollum B. B., and Stuart, C. E.: A Research Report. Basic Course in Postgraduate Gnathology. South Pasadena, 1955, Scientific Press, pp 45-46.

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