

INDIRECT RETENTION IN PARTIAL DENTURE DESIGN

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INDIRECT RETENTION IS REQUIRED ON ALL extension-base partial dentures retained by clasps (Figs. 1 and 2). It is required also when the tooth at one end of a denture base is clasped for retention but the tooth at the other end is not suitable for retention. Extension-base partial dentures are needed more often than any other type of removable partial denture. If these statements are true, then we need to consider indirect retention carefully.

BEGINNING OF INDIRECT RETENTION

Kennedy¹ wrote that Cummer advanced the idea of indirect retention and had revolutionized partial denture designing. Cummer² reasoned that the rationale of indirect retention was a modification of a Class 1 lever. Indirect retention was a valuable contribution to partial denture design. However, it is a much better example of a Class 2 lever than a Class 1 lever.

REVIEW OF THE PRINCIPLE OF LEVERS

Levers are classified according to the location of the fulcrum, the power, and the resistance in respect to each other. There are three classes (Fig. 3). In Class 1, the fulcrum is between the power and the resistance. The resulting mechanical advantage can be greater or less than one depending upon the location of the fulcrum along the lever. The Class 2 lever has the resistance between the fulcrum and the power, and has a mechanical advantage that is always greater than one. In Class 3, the power is applied between the fulcrum and the resistance. Its mechanical advantage is always less than one.

The mechanical advantage of a lever is expressed as the quotient of the power arm length divided by the resistance arm length.

INDIRECT RETENTION AND THE CLASS 2 LEVER

Indirect retention is an application of a Class 2 lever (Fig. 4). The tooth surface on which the indirect retention rests is the *fulcrum*. The retentive part of the direct retainer clasp becomes the *resistance*, and the *power* is represented by any force that tends to move the denture base away from the underlying tissue. The

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Fig. 1

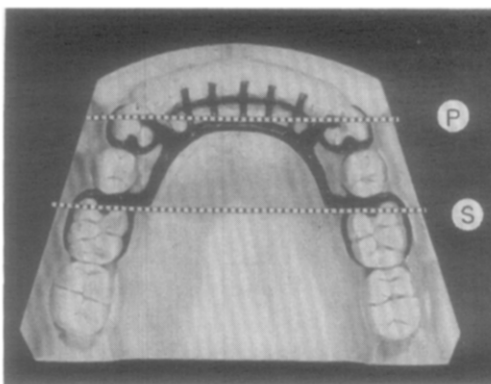
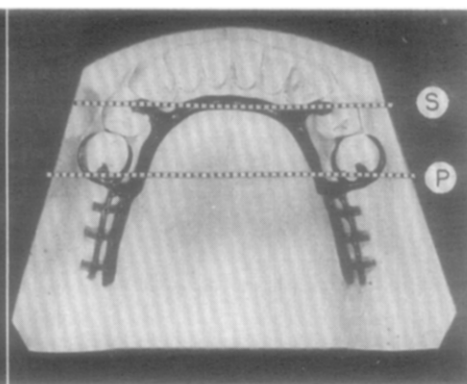
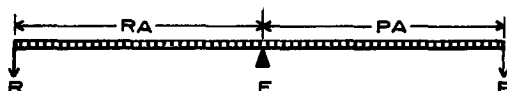


Fig. 2

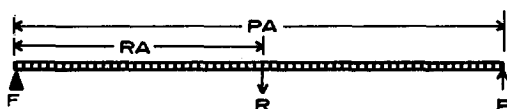
Fig. 1.—A distal extension partial denture framework. (*I*) indirect retention.Fig. 2.—A mesial extension partial denture framework. (*I*) indirect retention.

CLASS I



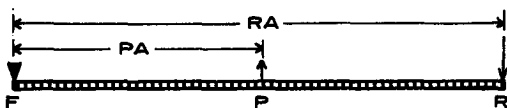
EXAMPLE = SEESAW

CLASS 2



EXAMPLE = WHEELBARROW

CLASS 3



EXAMPLE = SHOVEL

Fig. 3.—The three classes of levers. (*F*) fulcrum; (*R*) resistance; (*P*) power or force; (*RA*) resistance arm; (*PA*) power arm.

resistance arm length, then, is the distance between the retentive part of the direct retainer clasp and the pivotal edge of the indirect retention. The potential length of the power arm is the distance between the free end of the denture base and the pivotal edge of the indirect retention.

In all probability, the power arm never functions at its full potential length because forces that tend to unseat the base act most often on the teeth on the base.

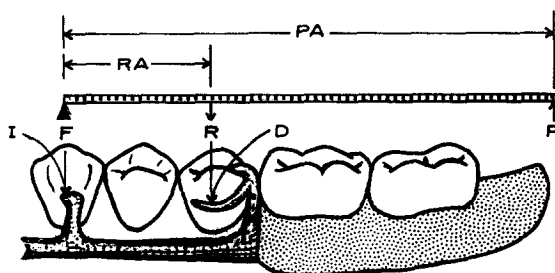


Fig. 4.—Indirect retention as the fulcrum end of a Class 2 lever. (*I*) indirect retention; (*D*) direct retention; (*F*) fulcrum; (*R*) resistance; (*P*) power or force; (*RA*) resistance arm; (*PA*) power arm.

In function, therefore, the length of the power arm is shorter than its potential length.

FACTORS THAT INFLUENCE THE EFFECTIVENESS OF INDIRECT RETENTION

A list of factors that influence the effectiveness of indirect retention must include the following:

1. *The effectiveness of the direct retention (the resistance).*—Indirect retention cannot be more effective than the direct retention of the clasps. Actually, indirect retention does not begin to function until the physiologic retention contributed by the extension base is overcome and, simultaneously, the resistance offered by the direct retention is challenged. Therefore, the direct retention must be adequate.

2. *The effectiveness of the tooth and its rest seat (the fulcrum) on which the indirect retention rests or pivots.*—A fulcrum must offer positive support for a lever to function most effectively. Its efficiency may be reduced if indirect retention is placed on inclined surfaces of teeth. It should be placed in rest seats on teeth capable of supporting its function. The capability of any tooth to support the function of a rest can be enhanced by preparing the rest seat so that forces are directed parallel to the long axis of the tooth.

3. *The rigidity of the major and the minor connectors (the lever).*—A lever must be rigid to effect a positive action. This means that the connectors must be rigid.

4. *The mechanical advantage of the lever.*—The lower the mechanical advantage, the more lifting force is necessary on the extension base to overcome the resistance of the direct retention and move the base off its seat—in other words, decrease the mechanical advantage of the lever and increase the effectiveness of the indirect retention. This is the key factor in indirect retention.

WAYS TO REDUCE THE MECHANICAL ADVANTAGE

Basically, there are two ways to reduce the mechanical advantage of a Class 2 lever. One is to shorten the power arm at the power end of the lever. If the power arm is shortened at the fulcrum end, the mechanical advantage will be increased because the resistance arm is shortened the same amount but proportionately more.

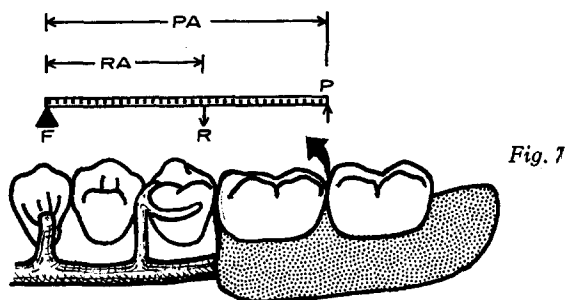
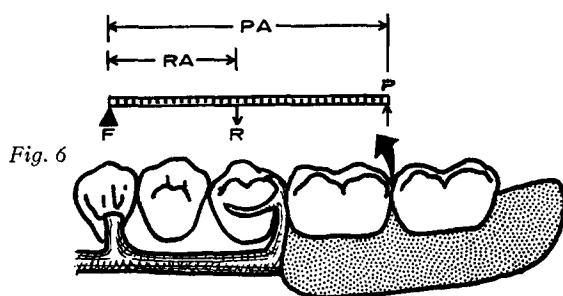
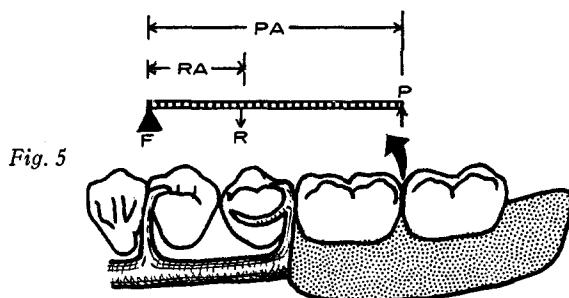
Since forces that tend to unseat extension bases act most often on the teeth

on the bases, the mesiodistal span of these teeth should be kept to a minimum to keep the effective length of the power arm to a minimum. Where possible, smaller teeth should be used to reduce the span rather than reduce the number of larger teeth. The smaller teeth not only reduce the mesiodistal span but also the buccolingual width, thus presenting a smaller area for application of force. The denture bases should not be shortened to decrease the potential length of the power arm because the base itself contributes physiologic retention through its intimate relationship with the underlying tissue.⁸ Moreover, the retention is proportionate to the area covered by the denture base.⁴

The other way to reduce the mechanical advantage of a Class 2 lever is to lengthen the resistance arm at either of its ends. The optimum length of the resistance arm can be attained on extension-base partial dentures by placing the indirect retention as far from the denture base as feasible and by placing the retentive clasp tips of the direct retainer as near to the denture base as possible (Figs. 5 to 7). The objective is to increase the distance between the direct and indirect retention as much as feasible.

MAJOR CONNECTOR STABILIZERS AND INDIRECT RETENTION

Major connector stabilizers transmit forces from the major connector to the teeth and other tissues, and vice versa. They serve many functions. The indirect



Figs. 5, 6, and 7 illustrate ways to increase the length of the resistance arm. (*F*) fulcrum; (*R*) resistance; (*P*) power or force; (*RA*) resistance arm; (*PA*) power arm. In Fig. 5, the resistance arm is relatively short. In Fig. 6, the resistance arm is made longer by moving the indirect retention mesially to a prepared rest seat on the cingulum of the canine tooth. In Fig. 7, the resistance arm is lengthened again by moving the retentive clasp tip from the mesial toward the distal of the primary abutment tooth. Note that the ratio of the resistance arm to the power arm is more favorable for indirect retention in Fig. 6 than in Fig. 5, and most favorable in Fig. 7.

retainer does more than offer indirect retention. It helps to stabilize the major connector against vertical and lateral forces, and decreases stresses on the principal abutment teeth by transmitting forces to other teeth in the arch. Thus, the so-called indirect retainer serves many functions and is really a major connector stabilizer that offers indirect retention as its primary function. Indirect retention does one thing only.

Any minor connector plus its rest(s)—incisal, cingulum, ledge, or occlusal—on tooth surface(s) is a major connector stabilizer. Clasps for stabilization and retention may be included. At least three types of major connector stabilizers employing the minor connector are possible. One is the minor connector plus its rest(s) without clasps. Another is the minor connector plus its rest(s) with clasps for stabilization only. A third is the minor connector plus its rest(s) with clasps for both stabilization and retention. Any of the three may serve as indirect retention, but the first is used most often for that purpose.

Other partial denture units that serve to some extent as major connector stabilizers are the secondary lingual bar, the lingual plate, and the extension base. Any of these can function as indirect retention. Their efficiency, however, may be reduced since the secondary lingual bar and the lingual plate rest on inclined tooth surfaces, and the denture base rests on soft tissue. The rugae area of the palate is covered sometimes for indirect retention, but rests on the teeth are much more effective.

A secondary lingual bar and a lingual plate also tend to stabilize the teeth that they contact. That is, they prevent lingual tipping of the lower anterior teeth by the occluding forces of the upper anterior teeth and the muscle action of the lower lip.

FULCRUM LINES AND INDIRECT RETENTION

On extension-base partial dentures with bases extending distally, the fulcrum line is usually defined as an imaginary line passing through the rest seat in the most posterior abutment tooth on each side of the arch. Then the fulcrum line passes

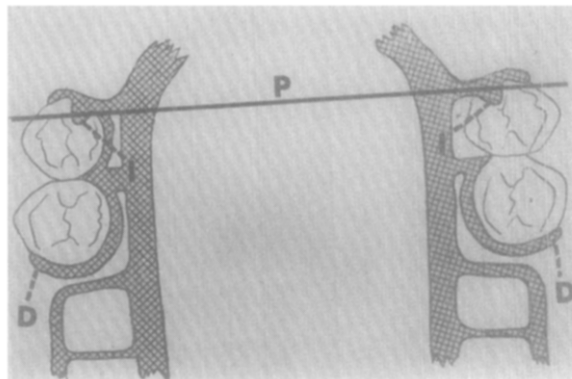


Fig. 8.—A partial denture design without rests on the principal abutment teeth. Consequently no fulcrum line is associated with these teeth. (*P*) primary fulcrum line; (*D*) direct retention; (*I*) indirect retention. (Courtesy of Dr. Victor L. Steffel.)

through the rest area of the most anterior abutment tooth on each side of the arch when the denture base extends mesially. For these definitions to be valid, the principal abutment teeth must have rests on them. This is not always true, since some partial dentures do not have a rest on the principal abutment tooth but on the next tooth in the arch (Figs. 8 to 10). Moreover, a second fulcrum line may be established when indirect retention is present (Figs. 11, 12). Therefore, "the fulcrum line" should be redefined and referred to as the "primary fulcrum line" to distinguish it from the secondary fulcrum line. The primary fulcrum line on distal extension partial dentures, then, is an imaginary line passing through the most distal rest seat (of a tooth) on each side of the arch. If the denture base extends mesially, the primary fulcrum line passes through the most mesial rest seat on each side of the arch.

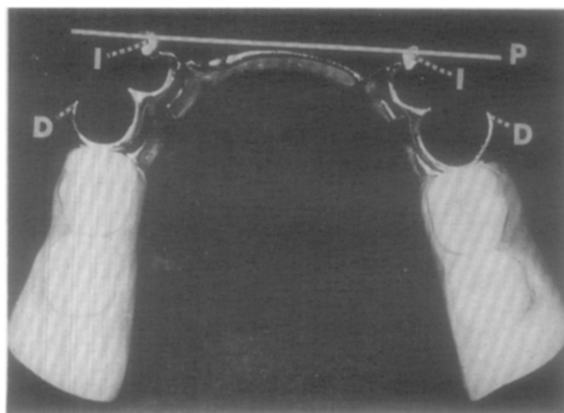


Fig. 9.—An example of the design illustrated in Fig. 8. (*P*) primary fulcrum line; (*D*) direct retention; (*I*) indirect retention. Note that the stabilizers resting on the first premolars establish the primary fulcrum line and serve as indirect retention, hence there is no secondary fulcrum line. From Steffel: *THE JOURNAL OF PROSTHETIC DENTISTRY* 12:524, 1962.

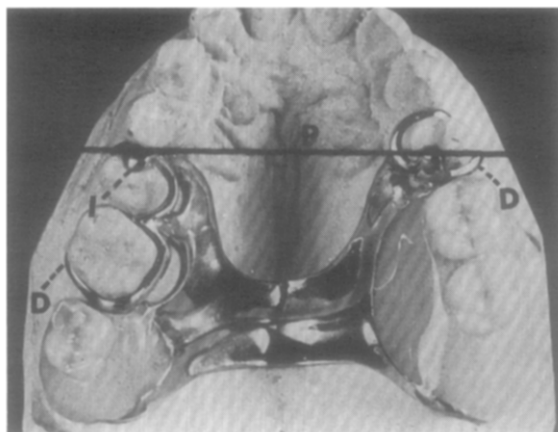


Fig. 10.—A removable partial denture with the primary fulcrum line passing through the rest seat of the principal abutment tooth on one side of the arch but not on the other side. (*P*) primary fulcrum line; (*D*) direct retention; (*I*) indirect retention. Courtesy of Dr. Victor L. Steffel.

When a second fulcrum line is produced by indirect retention (Figs. 11, 12), the prosthesis rotates about the primary fulcrum line if the denture base is forced tissueward (Fig. 13), and about the secondary fulcrum line if the denture base is lifted off the tissue (Fig. 14). However, if a second fulcrum line is not produced by indirect retention (Figs. 8, 9), the prosthesis rotates about the primary fulcrum line whether forces move the denture base toward or away from the tissue. These fulcrum lines are not the only fulcrum produced by vertical stops on the teeth, but the others are irrelevant to this discussion since they are not concerned with indirect retention.

Much can be said for the designs of the dentures in Figs. 9 and 10.*⁵ However, I shall confine my comments to indirect retention. These designs emphasize the fact that indirect retention is located in relation to the retentive part of the direct retainer clasps, not to the primary fulcrum line. As a matter of fact, indirect retention does one thing: it prevents the retentive part of the direct retainer clasps from becoming a fulcrum or point of rotation about which the prosthesis could rotate when forces move the denture base(s) away from the underlying tissue. When rotation about the clasp tips is prevented by any unit(s) of the partial denture, the denture base(s) cannot move away from the tissue until the resistance to deformation of the retentive clasps is overcome. *Indirectly* then, partial denture units

*From the files of Dr. Victor L. Steffel.

Fig. 11

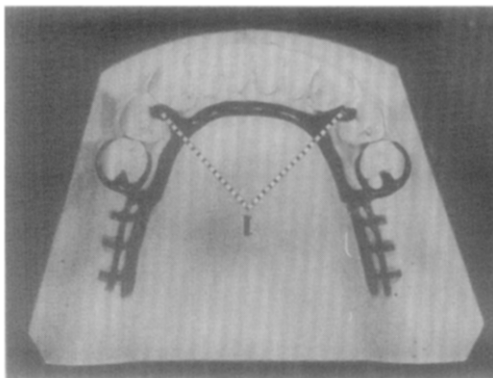


Fig. 12

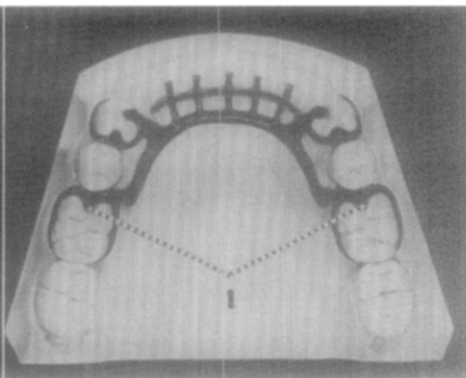


Fig. 11.—A mesial extension partial denture framework showing two fulcrum lines. (P) primary fulcrum line; (S) secondary fulcrum line.

Fig. 12.—A distal extension partial denture framework showing two fulcrum lines. (P) primary fulcrum line; (S) secondary fulcrum line.

Fig. 13



Fig. 14

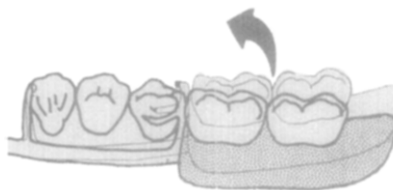


Fig. 13.—Rotation about the primary fulcrum line.

Fig. 14.—Rotation about the secondary fulcrum line.

preventing this rotation *retain* the denture bases in contact with the underlying tissue, hence the name "indirect retention."

SUMMARY

The principle of indirect retention is shown to be an application of a Class 2 lever. The so-called indirect retainer is a major connector stabilizer. A secondary fulcrum line is usually established when partial denture design includes indirect retention. Indirect retention prevents the retentive clasp tips from becoming a fulcrum about which the prosthesis could rotate when forces move the denture base away from the tissue.

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