Aesthetic Clasp Design for Removable Partial Dentures: A Literature Review

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SADJ June 2005
Vol. 60 no 5 pp 190 - 194

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ABSTRACT

Removable partial dentures (RPD) are an effective and affordable treatment option for partial edentulism. If the main reason for seeking treatment is the need for improved aesthetics, treatment should be geared towards achieving this goal. This article is the result of a literature study on aesthetic clasp design for the conventional RPD. In this context, the position of the clasp on the tooth, clasp types, clasp material and alternative methods of retention are reviewed. Although published in reputable journals, the authors report that many articles published on this subject are of a descriptive nature and lack scientific evidence. Therefore, clinicians are encouraged to be critical in their interpretation of literature and the application of published information in their clinical practices.

INTRODUCTION

Numerous treatment options exist to restore the partially edentulous mouth.[1,2] Removable partial dentures (RPD) are an effective and affordable treatment modality to restore function and aesthetics.[3] If the main reason for seeking treatment is the need for improved aesthetics, treatment should be geared towards achieving this goal.[1, 2, 4] Failure to recognize patient expectations can lead to non-compliance and failure of treatment.[2]

Aesthetics influence the appearance, dignity and self-esteem of an individual. The understanding of what is aesthetically acceptable or not varies for different groups of people (specialists, general dentists and patients).[4] The dentist has the responsibility to make recommendations to achieve the best aesthetic outcome for a particular patient.

RPD design is the responsibility of the clinician.[5] A comprehensive pre-treatment clinical examination provides the clinician with all the data required for the design of a biologically and aesthetically acceptable RPD. Good communication between the dentist and the dental technician ensures that the prescribed design is executed correctly.[4] The use of a dental surveyor to determine the path of insertion, the location and depth of the undercuts and the parallelism of guiding planes are indispensable processes in designing a RPD.[6,7,8] Many patients find the display of clasp assemblies aesthetically unacceptable.[9,10]

A PubMed and Silver Platter literature search was conducted covering the period 1970-2004 using the key words "aesthetic removable partial denture", including additional related articles and links. From these searches a total of 43 publications were selected for this review. 16 of these selected publications were descriptive articles, 9 were clinical case reviews and only 18 were publications reporting research results. It is important to note the large amount of descriptive articles and case reviews published in this field, thus urging the reader to be critical in the interpretation of material that is made available in dental journals. A limited amount of information was retrieved from prosthetic textbooks as well as from Internet searches using the search-engine "Google".

The purpose of this article is to review literature reporting on the aesthetic merit of the retentive components of the RPD, e.g. clasps, path of insertion and guide planes.

CLASPS

Clasps are used as direct retainers for the RPD. The flexible clasp tip engages the undercut of the abutment to provide retention.[1,11,12] The components of any clasp assembly must satisfy six biomechanical requirements: retention, stability, support, reciprocation, encirclement and passivity.[1,3] In addition, the clasp assembly must ideally not affect aesthetics adversely. Careful selection of clasp position on the individual tooth, clasp type, clasp material, clasp location in the dentition and the number of clasps are important.

Position

The position of greatest convexity on the tooth, which is determined by surveying, serves as a guide in the placement of clasps. Clasps can be classified into infrabulge and suprabulge clasps.[6,10] The suprabulge clasp approaches the undercut from an occlusal direction and is more visible. The infrabulge clasp, approaching the undercut from a gingival direction, also referred to as the gingivally approaching clasp, has more potential for being hidden in the distobuccal aspect of a tooth.[13] The infrabulge clasp has been thought to be more retentive than the suprabulge clasp because it possesses an inherent tripping action - although there is no evidence for this in the literature.[10] Shaping enamel surfaces and the use of composites can modify the convexity of a tooth surface and allow placement of clasps into a less visible position.[14] Clasps approaching the undercut from the distal aspect are less visible than mesially approaching clasps.[15]

Types of clasps

A. Suprabulge clasps

1. **Circumferential clasp / C-clasp**[1,10,16,17]
   This commonly used clasp encircles a tooth by more than 180 degrees. It is aesthetically undesirable when used anteriorly as it has an occlusal origin and metal is displayed. The acceptibility may increase slightly, depending on the type of material used. This will be discussed in the section: Choice of material.

2. **Modified circumferential clasp**
   According to this case report[18], a gold clasp is cast to resemble a small gold inlay. It is inconspicuous and processing is fairly easy. The noble alloy clasp is retentive and resilient with good yield strength as is concordant with the literature. (Figure 1)

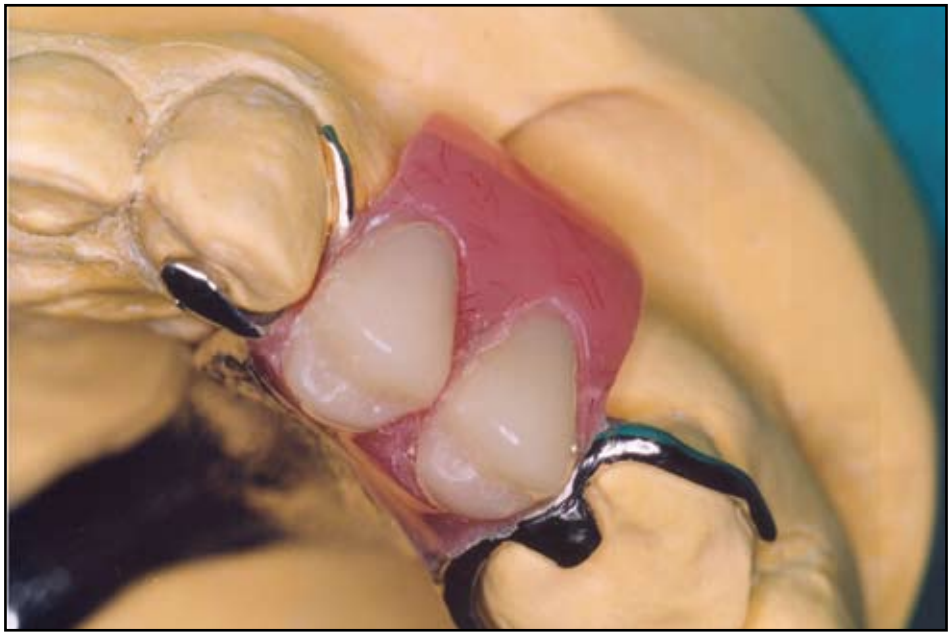

Figure 1. A Modified Circumferential/ C-clasp on the canine. The clasp engages a 0.25mm - 0.50mm undercut. It emerges from the distal aspect.

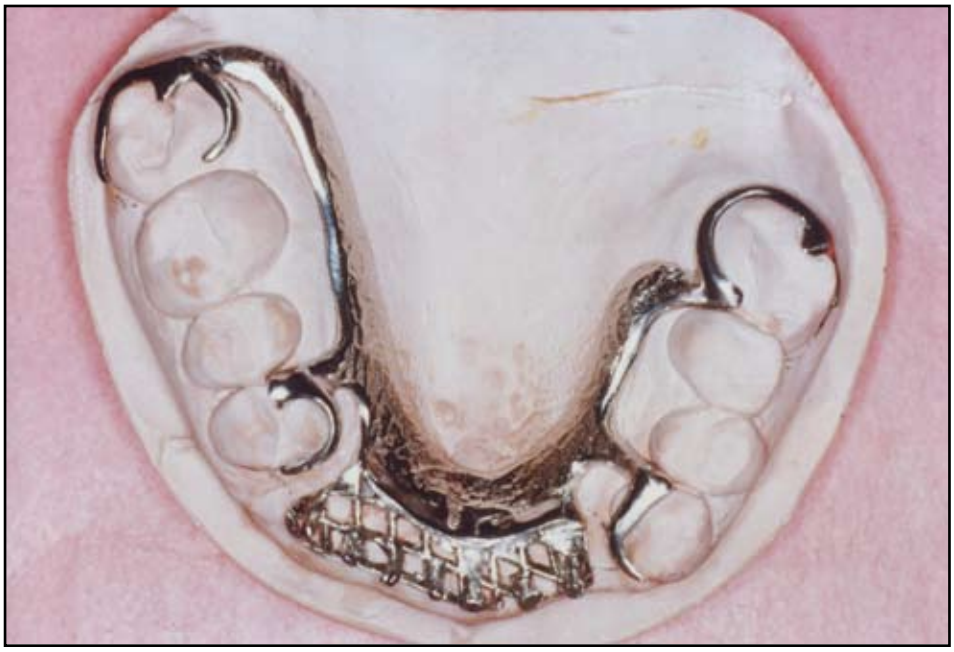

Figure 3a. Equipoise Clasp: Occlusal view of the clasps placed on the 13 and the 24 as part of a Kennedy class IV RPD.

3. Back-action clasp

Owen reported its use on upper premolars.[19] The clasp arm bends backwards at the buccal bulge of the tooth to reach the distal undercut, increasing its length and making it less obvious. Research compared load distribution on the abutment in distal extension RPDs. Of all clasp designs studied, the back-action clasps with mesial rests were reported to have excellent results with regards to mechanical behaviour.[20] Another study compared three retentive mechanisms in a unilateral RPD. The framework with the back-action clasp showed the greatest early load resistance dislodgment, and thus retention, among the three designs.[21] (Figure 2)

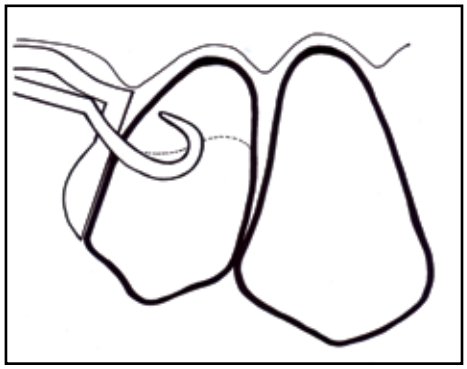

Figure 2. Schematic illustration of the Back-action clasp. The distal part of the back-action clasp bends back to reach the distobuccal undercut. (Drawing based on C.P. Owen's Fundamentals of RPD).

4. Equipoise clasp

Goodman developed and described the equipoise system,[22] the action of which is based on the principles of the back-action clasp. The equipoise clasp was developed claiming to address all the requirements of a successful clasp as well as aesthetics and favorable load distribution to the abutment.[23] Clasp tips are placed in preparations in the enamel of the proximal surfaces of the abutment teeth. According to testimonials on the internet site of the Equipoise® Dental Institute, this clasp has successfully been in use for the last 35 years, but no scientific evidence proves this statement.[24] The only published case study describes an equipoise clasp next to a distal extension in combination with another aesthetic alternative, the intracoronal attachment bordering a tooth-supported saddle of a maxillary RPD.[23] The author suggests either alternative when aesthetics is of primary concern.

5. Modified equipoise clasp

The sound enamel preparations were deemed destructive and a modification of the equipoise clasp was proposed by De Kock and Thomas.[25] They showed it to be a practical and viable option for improved aesthetics and acceptable retention for Kennedy Class IV situations. (Figure 3a and 3b)

6. Hidden clasp[26]

These clasps have been advocated for the Kennedy Class IV situations. The design achieves its aesthetic qualities by engaging the proximal undercuts often naturally present on teeth. Disadvantages would include that of (a) complex designs, (b) permanent deformation after repeated flexure, (c) abutment displacement as no reciprocation is provided, (d) rotation of the clasp if a restricted path of placement is not used with resultant loss of retention, (e) variable retention and, (f) difficulty in cleaning. (Figure 4)

7. Flexible lingual clasp

According to a clinical report by Pardo-Mindan and Ruiz-Villandiego, a lingual clasp is indicated when the buccal arm

Figure 3b. Labial view of a different RPD with an equipoise clasp on tooth 22, satisfying the aesthetics as the clasp assembly is inconspicuous.

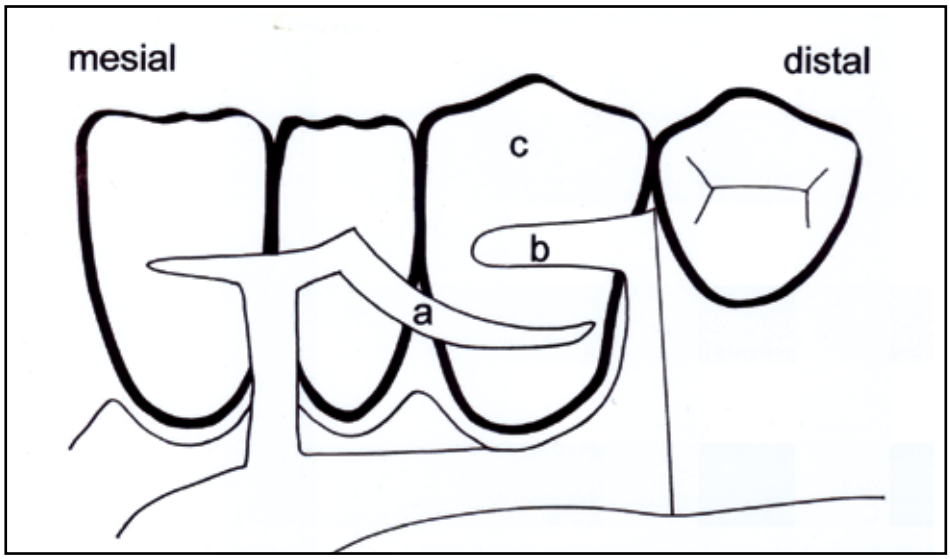

Figure 5. Schematic illustration of the Flexible Lingual Clasp. a = clasp engaging the undercut; b = rest prepared within the crown; c = crowned tooth.

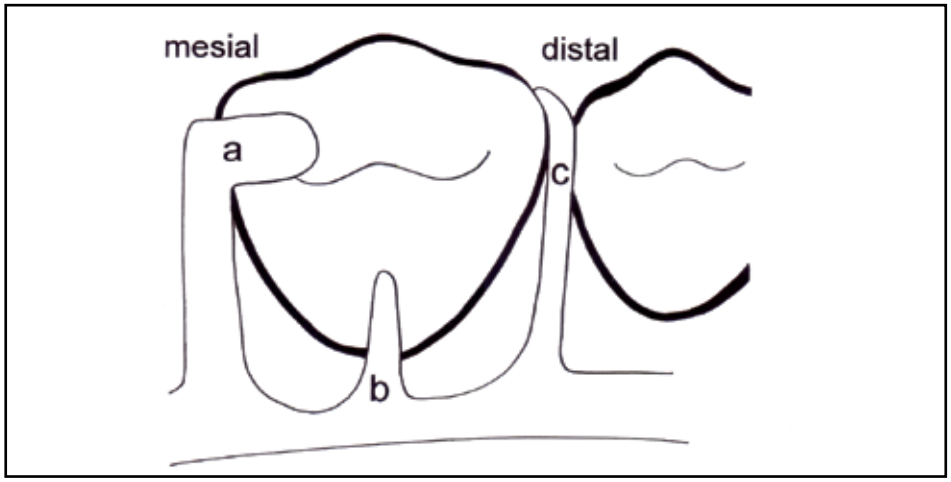

Figure 6. Palatal/ Lingual I Bar. Schematic illustration of the clasp with an unobtrusive occluso-buccal extension. a = mesial rest, b = palatal/ lingual I-bar, c = proximal plate extending onto buccal surface for reciprocation.

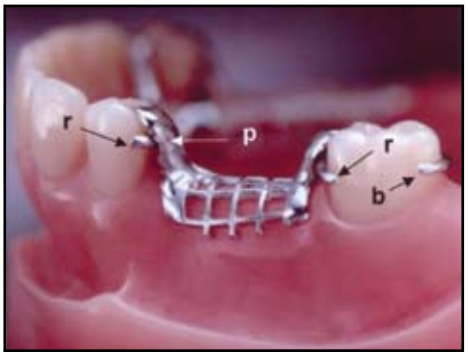

Figure 4. "Saddle-Lock Hidden Clasp" (Photograph courtesy of Distinctive Dental Studio Ltd, Illinois, USA). r = retainer that emerges from denture base to engage the undercut on the proximal tooth surfaces; b = bracing arm; p = proximal minor connector with relief space to allow flexure of the retainer.

is not to be seen.[27] In this case a rigid clasp with increased flexibility and limited length emerges from a mesial minor connector or proximal plate. With this clasp, however, the abutment needs to be crowned. The rest seats are prepared within the crown. Disadvantages include that of cost (due to crowns) and the fact that its use is limited to the mandible only. (Figure 5)

8. Ball-clasp

This clasp engages the undercut in the embrasure between two teeth, which is useful when teeth have short clinical crowns or if no natural buccal undercut is present. The clasp also acts as a rest because it passes over the occlusal embrasure. It has very little flexibility and both teeth need to be reciprocated.[19] The clasp may provide adequate retention although no evidence has been reported in the literature.

B. Infrabulge clasps

1. Bar-clasp[1, 6, 10, 28, 29]

An example would be the I-bar as part of the RPI-system for the distal extension RPD. Less metal is displayed than with an occlusally-approaching clasp. The approach arm must not be visible as it crosses the gingiva. It is not recommended in a patient with a high smile-line and for patients with a prominent canine eminence. Hansen and Iverson describe a modification of the conventional I-bar to be used on the canine. A distofacial ridge is created on the canine (a) by acid-etching and adding composite or (b) within the design of an indirect ceramic restoration. This ridge provides the required retention as well as resistance against

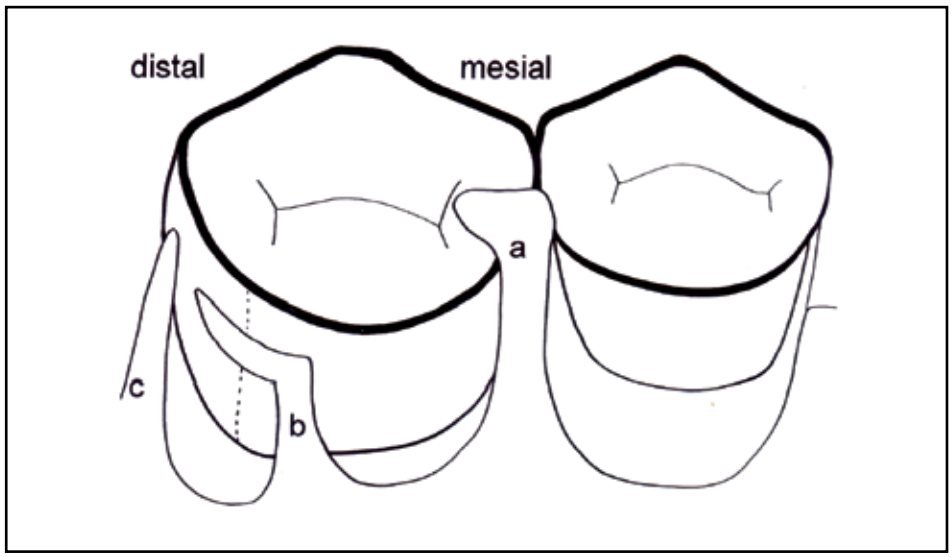

Figure 7. Schematic illustration of the RLS-System: the acronym for Rest; L-bar; Stabilizer clasp assembly. a = mesio-occlusal Rest; b = distolingual L- bar direct retainer ; c = distobuccal Stabilizer.

Figure 8. An illustration of the Twin-Flex technique. A 19 gauge wrought wire is positioned in the mesial undercut of the canines adjacent to the edentulous space which should then be secured in place with wax. Additional wax is also placed along the length of wire beneath its height of contour, which will facilitate placement of the wire in the cast channel in the major connector that will house the Twin-Flex clasp.

distal displacement using a less conspicuous I-bar.[30]

2. Palatal I-bar

According to research by Highton *et al* on the retentive capabilities of labially and palatally placed I-bars, the latter achieves better retentive and aesthetic results than the former.[31] It is usually shorter due to spatial confines and as a result is more rigid, offering more resistance to displacement. (Figure 6)

3. RLS-system[32]

This is the acronym for mesio-occlusal rest, distolingual bar and distobuccal stabilizer. It has been advocated for distal extension RPDs when the RPI system cannot be used due to lack of a buccal undercut, or when aesthetics would be severely compromised. The authors claim success in fulfilling the aesthetic requirements of a large number of patients over the past few years, but fail to follow-up with scientific evidence. (Figure 7)

4. Twin-flex clasp or spring-clasp[33]

This is a flexible clasp utilizing mesial-distal retention. The one article describing the manufacturing of the clasp reports that it is adjustable and can be used with the normal conventional path of insertion, with resultant improved aesthetics. It consists of a wire clasp soldered into a channel that is cast in the major connector. Disadvantages include irreparability once fractured, the major connector being very thick over the wire, increased cost due to extra laboratory procedures, and toxicity because of galvanic corrosion. No scientific evidence on any of the clasp's properties could be found. (Figure 8)

5. Twin-flex improved clasp[34]

The authors claim that as this clasp is not soldered onto the framework, toxicity associated with galvanic corrosion is eliminated. They further claim that the major connector is not so thick, clasps are easily adjustable and replaceable and it can be used on all RPD designs.

Clasp material

Cast chromium clasps cover large areas of the tooth and as a result a large area of metal is displayed.[1, 35] Due to their relative rigidity, a well-defined limited-sized undercut should be employed. Wrought wire clasps may be aesthetically more acceptable than cast chromium clasps due to different light reflection from the round surface.[1] They have greater tensile strength than cast clasps.[1, 35, 36] Due to their flexibility they can engage larger undercuts and may therefore be less visible - but gauge size is the determining factor.[37]

Gold-alloy clasps were thought to have good flexibility and resiliency and are aesthetically more pleasing, but are expensive.[1, 35, 38] Their flexibility is a factor of the gauge number, although not the only deciding factor, with different alloys displaying different flexibility for the same gauge number. In the case of platinum-gold-palladium clasps, maximum stress decreased with larger gauge numbers.[37, 39]

Technopolymer clasps were developed for addressing the aesthetic concerns of RPDs.[13, 40, 41] They are manufactured from thermoplastic acetal resin (polyoxymethalene) material with a highly crystalline structure which ensures greater flexibility, high transverse strength and radiolucency. Aesthetic acceptability constitutes its major advantage as several tooth shades are available for use anteriorly, but long-term studies still need to be conducted. (Figure 9) Disadvantages include: bulkiness, lack of adjustability, need for special equip-

Figure 9. A Circumferential Technopolymer clasp on tooth 21 engaging the mesial undercut.

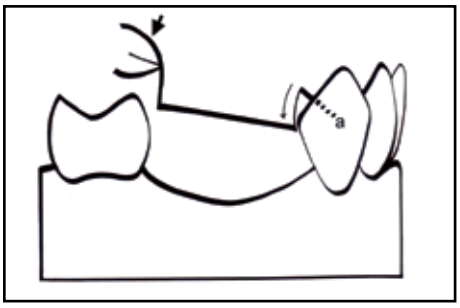

Figure 10a. Diagrammatic representation of seating of the RPD framework, eliminating anterior clasps. [From Jacobson: JPD 1994; 71:271-7]. a = long anterior rest acting as the rotational centre for insertion of RPD.

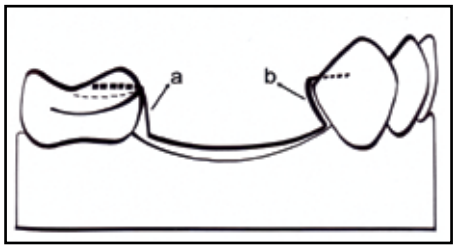

Figure 10b. RPD rotated in position. No anterior clasp. a = minor connector relieved following the curve of insertation. b = Minor connector providing retention

ment and increased cost. Research results state that deformation of acetyl resin direct retainers was significantly greater than their metal alloy counterparts. This may adversely affect their clinical performance and lead to the loss off some of their retentive characteristics.[42]

REDUCING OR ELIMINATING CLASPS

For the construction of RPDs, the Academy of Prosthodontics defined 8 standards, including retention, that are important in preserving oral tissue health.[43] Aesthetic aspects of RPD design were not part of these standards. Frank, Brudvik et al could not relate any of these standards to patient satisfaction.[44] Hence, when patient satisfaction from an aesthetic point of view is critical, one could consider the elimination of a visible clasp. Alternative paths of insertion, e.g. rotational, dual or curved, have been advocated which address aesthetic concerns.[3] These alternative paths allow one part of the framework to be seated first, followed by the remainder with the resultant decrease in clasps, but without compromising the biomechanical principles of the RPD.[3,6,45,46] The rotational path of insertion originated in the 1930s and has been described extensively.[10, 29, 47-54]

It is indicated most often for the replacement of missing anterior teeth as well as posterior tooth-bound spaces and some Kennedy Class II situations. It is contraindicated for Kennedy Class I and II cases with anterior modifications due to the potential torqueing action on abutments.[55,56] Jacobson mentions that the Academy of Prosthodontics states that it is not generally used by dentists and dental technicians due to the lack of understanding of the concept, although in recent years it has gained popularity.[46] Success in cases followed up for 10 years and longer has been demonstrated.[45,46] Rigid direct retainers of the framework are initially seated into the proximal undercuts of the abutment teeth adjacent to the edentulous area and then rotated to seat the posterior clasp assemblies.[3,45] (Figure 10a) The denture cannot be dislodged by a force perpendicular to the plane of occlusion.[10] (Figure 10b) The disadvantage is that the rigid retainer cannot be adjusted[33] and that the rest preparations are extensive. Guide planes are important to secure passive retention for RPDs and decrease the need for visible clasps.[57] Correctly prepared parallel surfaces on abutment teeth provide a definitive path of insertion and removal.[1, 3, 6-8] Ahmad *et al* state that a good fit of the framework to the guide plane is important, but this fit is made more difficult in the presence of clasps.[57] The length of the guide plane and its continued contact with the proximal plate is critical.[8]

A labial undercut can be utilized to establish a compromised path of insertion. This can only be used if a flange is indicated.[1] In this way, the denture flange assists in the retention of a denture as well as providing necessary lip-support.[1, 3, 28, 56] However, the amount of this retention has never been quantified.

CONCLUSION

Several options, including the use of RPD, are available for the treatment of partial edentulism. Patient expectations need to be established before treatment, as components of the RPD can be visible and may not be acceptable to the patient. In view of the importance of aesthetics, creative clasp design offers the possibility of reducing the visibility of clasp assemblies, rendering them more acceptable to the patient. However, the clinician must be careful in his or her choice of clasp designs as many articles are published based on clinical experience of the authors rather than research. Therefore, readers are encouraged to be critical in their interpretation of the literature and the application of published information in their clinical practices.

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The rest of this article's references (17 - 57) will be published in the online June SADJ, www.sada.co.za