EFFECT OF EDENTULOUS RIDGE LENGTH ON THE FIT OF OCCLUSAL RESTS OF A PARTIAL DENTURE METAL FRAMEWORK

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ABSTRACT

Several factors have been identified in the literature that appear to affect the adaptation of RPD frameworks to the cast or to the teeth, but no information is available on the effect of the length of the edentulous span. The aim of this in vitro study was to assess the effect of edentulous ridge length on the fit of RPD occlusal rests to the working cast. A model of a Kennedy class III modification 1 dental arch with four metal abutments and two edentulous areas ridges of different lengths was used for the study. Following rest seats and guide planes preparation, 30 identical working casts were obtained to produce 30 RPD frameworks. No attempt was made to improve the fit of the casting on the working cast. The frameworks were seated on the working casts, boxed and encased in dental stone prior to sectioning through the rest seats in an antero-posterior direction. The gaps between the rests and rest seats were measured at the marginal ridge (R), center (C), and terminal location (T) of each rest to the nearest 1 µm. The mean gap of the three locations was significantly greater in the longer edentulous ridge in both the premolar and molar abutments (p<0.001). The gap at the (C) location was 2-3 times the gap at the (R) and (T) locations. Of the 120 occlusal rests, 22% did not contact the opposing rest seat at any measured point (>50 µm). It can be concluded that the fit of the bounded saddle RPD framework occlusal rests is worse on abutments adjacent to long edentulous ridges compared to those adjacent to short edentulous ridges.

Key words: *Denture partial, Removable, Rest seat Adaptation, Edentulous ridge, Laboratory research.*

INTRODUCTION

It is important that occlusal rests of a partial denture framework make an intimate adaptation to the rest seats in order to transmit the functional force axially to the abutments and prevent tooth movement and soft tissue damage.[1] Previous studies have shown that a large number of occlusal rests have limited or no contact with the floor of their corresponding rest seats.[2-4] In one study,[5] the authors described the difficulty of obtaining a predictable fit of removable partial denture (RPD) castings. Stern et al.[2] evaluated the degree of adaptation between 20 removable partial denture (RPD) cast occlusal rests and the occlusal rest seats in the mouth. There were no contacts in 21% of occlusal rests, and the remaining rests showed contacts on a random basis. They also found that mandibular class I and class II RPD rests fit significantly better in their rest seats than mandibular class III and class IV RPD rests. However, no such significant difference was found in similar types of maxillary RPDs. The authors suggested that the increase in geometric complexities in class III and class IV and the resultant increased distortion is a possible explanation for the fit variation in mandibular RPDs which is not evident in maxillary RPDs.

It has been suggested that the fit of the chrome cobalt RPDs may be compromised by poor mouth preparation, inaccurate master casts, error in wax blocking out and duplication, variability in expansion of the refractory material, and the techniques used in the fitting and polishing of metal frameworks.[6-9] Furthermore, the volume of base metal alloy shrinks upon solidification from 2.0 to 2.3 %, which results in a lack of fit.[10, 11] It has been suggested that the shrinkage of

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castings is dependent on the geometry of the casting.[10,12,13] Roydhouse and Skinner[14] suggested that the lack of fit of occlusal and incisal rests of cast RPD framework was due to the increase of the height of teeth in the investment cast, because they lie in a dimension in which the investment is free to expand. They also reported that the cobalt chromium castings undergo a 10 to 20 times greater change in the vertical direction than in the horizontal direction.

It has been suggested by Earnshaw[10] and Phillips[15] that the percentage elongation and shrinkage of cobalt chromium alloy may vary according to geometry. In addition, the greater the space area of the casting in relation to its volume, the less the shrinkage, so that the length of the edentulous span and design of the framework can affect accuracy.[16]

Though a number of factors affecting the fit of the RPD frameworks have been identified in the literature, previous studies have not evaluated the effect of the length of the edentulous ridge on the adaptation of the occlusal rests on the rest seats. The present laboratory study evaluated the effect of two different lengths of the edentulous ridge on the adaptation of rests of a mandibular class III, modification 1 RPD framework on their corresponding rest seats of a working casts.

MATERIALS AND METHODS

A model of a mandibular Kennedy class III, modification 1 dental arch was constructed with the abutment teeth made of cast metal (Kera N, Eisenbacher Dentalwaren, Germany) and the edentulous ridges and base made of dental stone. The four metal abutment teeth were 34, 37, 45, and 47 (Mandibular 1st premolar and 2nd molar on the left side and mandibular 2nd premolar and 2nd molar on the right side). The left edentulous ridge span was longer than the right edentulous ridge span (18, 12 mm respectively). The metal crowns were prepared to have occlusal rest seats and parallel guiding planes with the aid of a surveyor. The abutments were designated from left to right as ML (left molar), PL (left premolar), PR (right premolar), and MR (right molar). The deepest portion of the rest seat was made using a number 2 round diamond bur to a depth of 1.5 mm. The deepest portions of the four occlusal rest seats were marked under magnification with a small dot using an oil point. A straight line joining the deepest points on the rest seats of the same side was drawn and extended over the anterior and posterior land areas of the dental cast. A similar line was drawn on the other side of the cast. These lines will serve as a guide during sectioning of the specimen (Fig 1) Tripoding was accomplished by scoring four lines on the vertical portion on the anterior and posterior parts of the base to join the lines that were made on the landing areas. The lines were then scored 1 mm deep to ensure duplication on each working and refractory cast. The design of the metal framework was drawn on the experimental model and scored with a sharp instrument to ensure accurate reproduction of the design on each working cast as well as on each refractory cast.[10]

A total of 30 custom trays were fabricated in autopolymerizing acrylic resin (Fasttray, Bosworth Co., Skokie, IL.) with 2 mm wax relief. The trays were stored for 48 hours at room temperature before use to allow for dimensional stability.[17,18] The trays were coated with adhesive (Dentsply Caluk) as recommended by manufacturer and allowed to dry for 15 minutes before making the impression.[19]

Thirty impressions of experimental cast were made with polyvinyl siloxane impression material (Reprosil, LD Chaulk, Millford, Del) according to the manufacturer's instructions. The impressions were poured immediately in Die Keen stone (Die Keen Modern Materials, Columbus, Ohio) to produce 30 working casts. Each working cast was oriented on the surveyor using the scored lines on the vertical portion of the base of the cast. Each working cast was blocked out with pink wax below the height of contour. Wax ledges were not prepared on the abutment teeth, as clasps were not included in the design. The blocked-out casts were duplicated in Perflex duplicating material (Austenal Co., Chicago, IL). The material was manipulated according to the techniques recommended by the manufacturer. On the refractory casts, the removable partial denture design was waxed following the duplicated scored lines on the cast. A total of 30 investment casts with standardized wax -ups were invested in identical investment material and cast in cobalt chromium alloy (Wironit, Bego, Bremen, Germany) using a centrifugal induction casting machine (How Medica, Inc., Chicago, IL). The investment rings were benchcooled to room temperature before the castings were retrieved. The sprues and flash of metal were carefully removed from the cast frameworks with white stone under 10x magnification then were polished and finished as described by Brudvik and Reimers[9] without altering the tooth framework interface. All of the procedures were executed by one operator.

The metal frameworks were seated on their corresponding working casts using light finger pressure and then boxed and encased in dental stone (Die Keen). The vertical wall of the base was left uncovered as these carry scored lines for orientation of the casts and the rest seats. These lines helped orient the casts on a mounting devise for sectioning without the need of a dental surveyor. A mounting device made of autopolymerizing acrylic resin was used to align the encased boxed casts to the cutting saw (Isomet 11-1180, Buehler Ltd, Evanston IE). A low speed saw was used to section each boxed cast through the midpoint of the occlusal rest seats of the metal framework (Fig. 2). Following the sectioning of the encased boxed casts, the surfaces were made smooth using a fine grit sand paper mounted on a rotating wheel under running tap water.

Another mounting device made of autopolymerizing acrylic resin was used so that each sectioned cast could be mounted in the same position on the mounting table of a traveling microscope (TM 10 Measuring Microscope, Titan, Buffalo, NY) (Fig. 3). Each sectioned framework provided a left and a right segment of an arch for evaluation of a total of 120 occlusal rests. Measurements of the gaps between the rest and rest seat were made at increments of one-third the overall mesiodistal dimension of a particular rest using a traveling microscope with a measuring accuracy of 1 micrometer. The three locations were the marginal ridge (R), the center (C), and the terminal part (T). A rest was considered to have a 'good' fit if the gap between corresponding rest and the rest seat was measured as 50 micrometer or less.[2,12] For description purposes, the location of each measuring point (of the rest) is mentioned first, followed by the tooth (Molar or premolar) and the side (left or right) of the arch.

Differences in the mean values of the gap between the short edentulous segment and long edentulous segment of the arch were compared for each point of measurement using the two-tailed paired t-test. The three locations of the measurements of each rest were averaged, and the pooled measurements were tested again. All tests were performed with SPSS version 11 (SPSS, Chicago, IL). All significance levels were set at 5%.

RESULTS

The mean values for gaps between the occlusal rests and the corresponding rest seats (Table 1) were significantly higher in the long edentulous segments of the arch than in the short segments ($p< 0.05$) in the R and C locations. The measured gap for location T (terminal location) of the premolars and molars of both the short and long segments were not significantly different from each other (premolar = $P<0.272$ and molar $P<0.201$) (Table 1). However, For each individual rest seat, the center location (C) showed a significantly larger gap than the other two locations (R and T).

The combined or pooled values for gaps in the long edentulous segments were significantly higher than the short span between the premolars and molars (Table 2). In total, 78% of the 120 rests evaluated

TABLE 1: MEAN GAPS BETWEEN EACH REST LOCATION AND THE CORRESPONDING REST SEAT ON THE RIGHT AND LEFT EDENTULOUS RIDGES. LOCATION: R "RIDGE", C "CENTER", T "TERMINAL"; ABUTMENT: P "PREMOLAR", M "MOLAR"; SIDE: R "RIGHT", L "LEFT"

Location/ abutment/side	Mean	SD	Significance
RPR	43.9	5.4	*
RPL	46.9	5.4	
CPR	116.0	4.5	**
CPL	123.6	4.2	
TPR	45.4	5.6	NS
TPL	46.9	5.0	
RMR	48.4	3.5	**
RML	51.6	2.6	
CMR	125.3	2.5	**
CML	131.8	3.2	
TMR	51.4	3.5	NS
TML	52.6	4.6	

TABLE 2: POOLED MEASUREMENTS OF GAPS BETWEEN RESTS AND THE CORRESPONDING REST SEAT ON THE RIGHT AND LEFT EDENTULOUS RIDGES. ABUTMENT: P"PREMOLAR", M"MOLAR"; SIDE: R"RIGHT", L"LEFT"

Abutment/side	Mean	SD	Significance
PR	68.4	3.7	
PL	72.5	3.2	**
MR	75.0	2.1	
ML	78.7	1.9	**

TABLE 3: DISTRIBUTION OF THE RESTS IN EACH ABUTMENT ACCORDING TO THE SIZE OF THE GAP BETWEEN RESTS AND REST SEATS. ABUTMENT: P"PREMOLAR", M"MOLAR"; SIDE: R"RIGHT", L"LEFT"

Abutments/side	At least one location ≤ 50 µm	All locations > 50 µm
PR	27	3
PL	27	3
MR	23	7
ML	17	13
Total	94 (78%)	26 (22%)

demonstrated at least one location where the distance between the rest and rest seat was 50 micrometers or less indicating good fit. The remaining 22% of the rests made no contact with the rest seats (Table 3). The majority of the rest seats without contacts (77%) were found to be in the molar area.

Fig 1: The experiment model with the four metal abutments showing the lines scored on the cast.

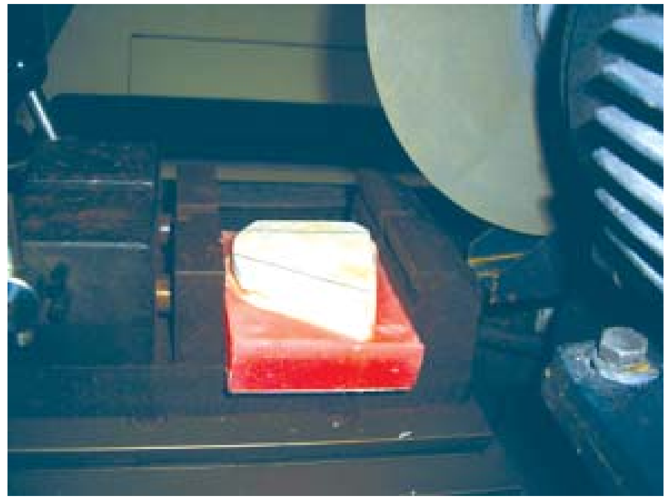

Fig 2: The encased boxed cast is aligned to the saw for cutting through the line which passes through the midpoint of the rest seat.

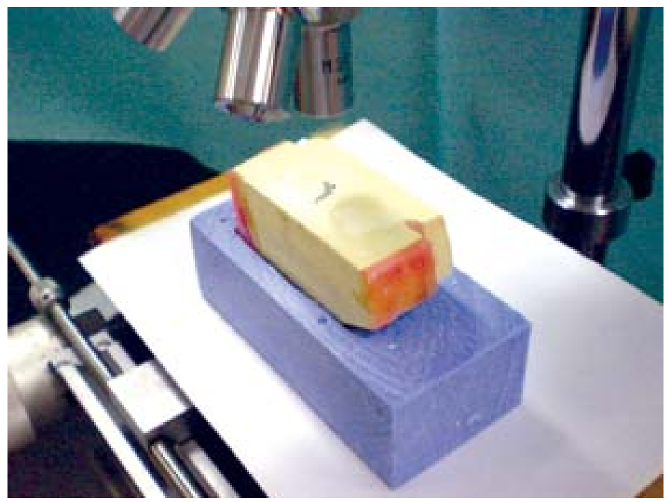

Fig 3: The sectioned specimen positioned under the traveling microscope.

DISCUSSION

The fit of the occlusal rest component of RPD frameworks in this study was found to be significantly better in the short edentulous segments of the arch. This can be explained by the proportional casting distortion to the geometry of the metal.[13]. It has been suggested that dimensional changes of castings may vary between different areas of the casting and that these changes occur more vertically than horizontally.[5,10,14,15] The increased geometry in the longer edentulous span could explain the increased casting distortion. Similar variations in dimensional changes in relation to the geometry of the casting have been found in fixed/removable telescopic dental prostheses.[13]

Molar rests showed a greater gap than premolar rests, which could be due to the difference in the size of the rest preparation. The inability to accurately adapt the framework on the cast has been attributed to the casting shrinkage among several other factors. An average casting contraction of 2.3% has been reported for cobalt-chromium alloys, in comparison to the lower contraction of nickel-containing base metal alloys (2%) and gold alloys, the latter having the most accurate casting.[10,11] The results of this study suggest that shrinkage of the metal, which is expected to be proportional to its volume, is primarily responsible for the ill-fitting of the framework rest components.

The fit of the center part of the rest was the most affected, resulting in a gap 2-3 times the size of the gaps in the terminal (T) and ridge (R) locations. The loss of contact in the center of the rest compared to the marginal ridge has also been shown previously.[2,4]

The percentage of rests (22%) that manifested no contacts in any area (> 50 µm) was similar to that reported by Stern et al.,[2] who also measured the gap at several points of the rest in a clinical study.

The other factors that could possibly affect the fit of the partial denture frameworks, such as the investment material, spruing techniques, and type of alloy, were controlled in this study. Further, the possibility of disturbing the framework contact in the rest area due to suprabulge contact of other components[4] was minimized by eliminating clasp arms from the design in this study. Careful polishing of the metal framework was performed according to guidelines by Brudvik and Reimers[9] to avoid the effect of metal loss on the contact between the tooth and framework. Still, the distortion of cast frameworks caused ill fitting of the rest in most of the rests measured. However, it should be noted that the average gap between the rest and the prepared rest seat was on average one third of those reported in previous studies.[2,4,12] The reduction of framework components by eliminating clasp arms could be an explanation for a smaller gap measured in this study . Dunham et al.[4] reaffirmed the suggestion by Stern et al.[2] that contact of other components of the RPD framework appears to exacerbate the problem of ill fitting of the rest area. It is expected that in clinical application, different alloys, investment materials, polishing techniques, and operator experience may further exacerbate the fit of the casting.[6,8,9,11]

CONCLUSIONS

Within the limitations of the study, the following can be concluded:

1. Longer edentulous ridges span appear to exacerbate the problem of ill fitting of bounded saddle RPD framework rests.
2. The largest gap measured under the rest was in its center location.
3. Approximately one-fifth of all rests in this study did not contact the rest seat at any point.

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