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EFFECT OF DESIGN CHANGING OF RING CLASP ON ITS RETENTIVE FORCE

(EFEK PERUBAHAN DESAIN *RING CLASP* TERHADAP KEKUATAN RETENSI)

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Abstract

Different designs of ring clasp were indicated in short or long span bounded saddle. However, few researches have been done to calculate their retentive absolute forces. The purpose of this in-vitro study was to measure the retentive force of four different ring clasp designs. A test model was made from maxillary plastic replica. Second molar was seated in silicone mould then poured with dental stone. 24 cobalt-chromium ring clasp designs were fabricated to engage 0.5mm undercut using standard casting technique. They were examined radiographically for any casting defects. The dislodging force was measured for each clasp using universal testing machine. The results showed that ring clasp design 2 produced the highest retentive force, while, clasp 4 was the lowest among the other clasps. In addition, significant difference regarding the mean retentive force was estimated among designs 1, 2 and 4. The means of retentive force of ring 1, 2, 3, and 4 were equal to 17.40 ±2.97, 17.52 ±3.05, 12.35±0 .98, and 11.15±2.15 N, respectively. Modifying the ring clasp design by adding extra rest or fortification will change its retentive force using the same undercut depth. Each ring design provides definite retentive force. As conclusion, each ring clasps design offered specific retentive force in dry environment. However design 2 presented the highest force rate while design 4 was the least retentive.

Key words: ring clasp design, direct retainer, retentive force

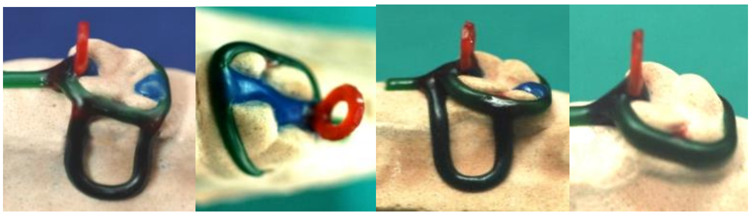
INTRODUCTION

Clasp or direct retainer is one of the indispensable components of removable partial denture (RPD). It is responsible for anchoring RPD to the residual teeth. Generally, RPD retention is provided through the use of the extra or intracoronal retainers. Ring clasp is one of the extracoronal circumferential clasps. It provides excellent support and bracing and can be used in undercut depth equal to 0.5 mm or sometimes more.[1] Its single arm encircles nearly the whole tooth circumference to engage an undercut area located mesiobuccally or mesiopalatally in the same plane of the occlusal rest and close to the saddle. [2] Ring clasp has long arm, therefore, additional reinforcement should be added to reduce its flexibility and to enhance its rigidity.[3] Different ring designs were used in retaining RPD. However, little information is available regarding their indication and achievable retentive force in the literature. The purpose of this study was to measure and to compare the mean retentive force of four different ring designs in fixed undercut depth under dry environment.

MATERIALS AND METHODS

This is invitro study. A maxillary plastic model (Frasaco AG-3 WOK 40) was used to produce master stone cast. The model was duplicated using silicone material (Wirosil®Bego, Germany) according to the manufacturer's instructions.

Figure 1. Replica stone cast with natural second molar



Desgin type	Design 1	Design 2	Design 3	Design 4	Total
Clasp No.	6	6	6	6	24

Figure 2. The different ring clasp designs

A natural second molar was selected compared to the plastic molar size and seated inside the silicone mould. Subsequently, the mould was poured with dental stone (Figure 1).

Before initial setting, two captive screws were placed inside the stone nearly 3 mm away from the mould border to fasten the cast later on a custom-made jig. The master cast was surveyed at zerotilt position. An undercut depth equal to 0.50 mm was measured and marked in the mesiobuccal area using undercut gauge. On the occlusal surface of the molar, distal and mesial rest seats were prepared equal to 2.5 x 2.5 x 1.5 mm. and checked according to Stewart technique.[4] Using milling machine (AF 30, milling machine, Switzerland), guiding plane was prepared on proximal surface in the occluso gingival direction and approximately 2 mm below the marginal ridge.[3] The prepared cast was duplicated using silicone to obtain a stone working cast that was resurveyed at the same tilt. The location of the undercut depth (0.50 mm) and the survey line were marked off on the abutment tooth. The clasp border was outlined and ledged on the tooth and the undesirable undercuts were blocked out. The master cast was trimmed to reduce the base size for easy duplication with reversible hydrocolloid. 24 refractory cast copies were produced from the master stone cast. Six refractory casts were assigned for each ring design selected for this study (Figure 2).

Ring 1, incorporated two rests (mesial and distal). The reciprocal arm started from the mesial rest then encircled the lingual and distal surfaces of the tooth to join the distal rest, and then joined the retentive arm to be engaged in mesiobuccal undercut area. The re-enforcing arm (strut) extended from the mesial to distal rests and located away from the gingival margin by 7-8 mm.

Ring 2, contained two rests joined to form continuous occlusal bar 2mm in width and it needed a prepared cavity .[5]

Ring 3, included mesial and distal rests like in case of ring 1 design except that the reenforcement arm was connected to the minor connector near the rest .[3]

Ring 4, enclosed only one mesial rest and continuous arm that encircled the crown to end at the mesiobuccal undercut .[4]

A short wax projection representing the saddle was placed in the edentulous area. A small ring was attached to the mesial rest parallel to the path of insertion to be used later as anchor to pulout the clasps by the universal testing machine (UTM) (Shimazdu testing machine AG-X, 10N-10KN, Japan). The clasps were casted using Co-Cr alloy (Wironit, Bego, Germany) and conventional casting technique. They were sandblasted, finished and electropolished using the usual procedure. The fitting surfaces of the clasps were kept intact during removing the burs, nodules and other type of roughness. Each clasp was examined radiographically for internal casting defect using dental X-ray machine (Siemens, 1448 237 D3195, Germany) with a source of 70 kV/7mA and exposure time equal to 1.2 second, located at 50 cm from the source.[6] Adjustable custom-made jig was constructed to hold the master cast in a small container and to fix it opposite to the pulling chain. Before measuring the retentive force, one end of the chain was connected to the upper jig of the UTM while the other end was anchored to the clasp ring through S-form hook (Figure 3).

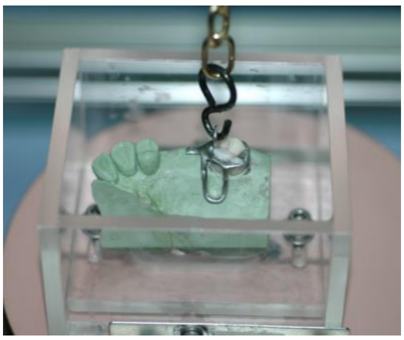


Figure 3. Pulling out action

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The chain hardiness was examined for high pulling force resistance against elongation or deformation using higher tensile force than the expected limit of the ring clasps. Each clasp pulling was repeated 10 times with a crosshead speed of 10 mm/min after seating it manually. The withdrawal force was calculated automatically by the testing machine.

Data were analysed using statistical software (SPSS version 15) and one way analysis of variance (ANOVA) was applied to assess the statistical difference between the mean retentive forces of each ring clasp design in dry environment. Unpaired t-test was used to estimate the difference between the retentive force mean of each ring clasps.

RESULTS

The measured mean retentive forces of each clasp were 17.40±2.97, 17.52±3.05, and 12.35±0.98, 11.15± 2.15N for design.1, 2, 3, and 4 respectively (Tabel 1).

Table 1. The mean retentive force in Newton of different ring clasps

Ring Designs	No. Records	No. clasp	Mean	SD
Design1	10	6	17.40	2.97
Design2	10	6	17.52	3.05
Design3	10	6	12.35	0.98
Design4	10	6	11.15	2.15

Design 2 ring clasp produced the highest retentive force while design 4 demonstrated the lowest. Generally, the mean retentive forces of the diverse ring clasp designs were significantly different (p<0.001, Table 2).

Table 2. ANOVA result for the difference among the four ring clasps

Source of variation	Sum of Squares	DF	Mean Square	F	Sig.
Mean Between Groups	200.276	3	66.759	11.239	.000*
Within Groups	118.794	27	5.940		

*Significant

Pairwise comparison test showed there were significant differences among ring 1,3 and 4 (p<0.05, Table 3).

Table 3. Pairwise comparison of mean retentive force among different ring clasp designs

Designs	Designs	Mean Diff.	Sig.
Design 1	Design 2	-.118	1.000
	Design 3	5.06	.009*
	Design 4	6.26	.001*
Design 2	Design 3	5.17	.007*
	Design 4	6.37	.001*
Design 3	Design 4	1.20	.829

*Significant

DISCUSSION

Ring clasp may be used containing one, continuous, or two rests. However, their indications have not clearly been mentioned in the literatures. The ring design 1, 2 and 3 are supposed to distribute the load evenly on isolated abutment located at the end of bounded long span edentulous arch. The ring clasp was supposed to provide adequate to moderate retentive force. However, our findings demonstrated that modifying the ring clasp design by either increasing number or changing the rest form can alter its retentive force using the same undercut depth and location. In addition, short strut will increase signifycantly their retentive force. Hence, many forms of ring clasp can be identified in the literatures. Consequently, different indications for each clasp design should be declared and specified. Therefore, ring clasp with one rest may be used in short bounded saddle and when no excessive retention is required. Two rests ring clasp with short strut can be used when the periodontal condition of the abutment is excellent and there is need for more retentive force. Continuous rest ring clasp may be chosen when the location of the strut can irritate the nearby structures or because of the presence of tissue undercut and the need for excessive retentive force. The mean retentive force of design 2 was the greatest followed by design 1, however, there were no differences between the two designs. This might be due to rigidity of both clasps provided by the strut. The presence of continuous occlusal rest as in ring 2 or short strut as in ring 1 connected to long clap arm fortifies the clasp and increased its rigidity and thus reduced its elasticity. Consequently, the retentive arm will be shorter compared to the other designs. The absence of lingual or palatal strut in design 2 adds to patient's comfort, and tongue movement will be improved. In addition, it enhances the gingival and periodontal health prognosis due to the fact that it does not impinge on the free gingiva and prevent plaque accumulation. On the other hand, this clasp overcomes the limitation of design 1 and 3 when there is a soft tissue undercut adjacent to the abutment tooth[5]. However, the covering and preparation of the occlusal surface increased tooth vulnerability to caries. Therefore, protective measure should be systematic when using this clasp by crowning.

In design 1, the strut projects from the mesiolingual corner of the reciprocal arm and ends in the distolingual area. Alan et al. stated that in any event the supporting strut should be regarded as start of minor connector from which the flexible retentive arm was originated. [4] It means, in case of design 1, the retentive arm of ring clasp originates from the distolingual aspect of reciprocal arm, therefore shorter arm of this design reduces the possibility of flexibility and it provides more retention.

Design 3, produced retentive force of 12.35 N which was lower than design 1 and 2. This reduction might be due to increased flexibility due to longer retentive arm and strut, especially, its retentive arm originated from the midlingual aspect of reciprocal arm[4].

Design 4 (unsupported ring) had the lowest retentive force 11.15 N. This might be due to the absence of any re-enforcement in this clasp. This clasp assembly cannot provide effective reciprocation or cross-arch stability[1-4]. In addition without using either extra rest or/and strut the long arm of the clasp will be more flexible. Therefore, the result was less retention. Moreover, this design was argued by Alan et al. who reported that this clasp should never be used due to its free open and close as a ring and can provide neither reciprocation nor stabilization. [4] Besides, it does not include extra occlusal rest (distal rest). In conclusion, each ring clasp design offered specific retentive force in dry environment. However, design 2 presented the highest force rate while design 4 was the least retentive. This variation in the force provided by different ring clasp designs offers additional indications for more clinical situations.

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