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CLASP RETENTION USING VARIABLE UNDERCUT DEPTHS

(RETENSI CANGKOLAN MENGGUNAKAN VARIABEL KEDALAMAN GERUNGAN)

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Abstract

Retentive force may be increased in deeper undercuts. Three clasps were examined for this hypothesis in order to analyze the retentive force change properties for each clasp design with increasing undercut depth only. A total of 36 cobalt-chromium clasps, using half-round pattern and standard casting technique were fabricated. Three groups of clasps; Rest-Plate-Akers system, half-half, and Akers were engaged in 3 increasing undercut depths (0.25, 0.35, and 0.5 mm) on natural premolars. The test model was stone duplicate of plastic replica. Clasp retentive force was measured using universal testing machine. The results showed that the retentive forces for the tested undercuts (0.25, 0.35 and 0.5mm) were 8.59±1.89, 14.74±2.70 and 15.21±1.17 N for Akers; 3.06±0.88, 4.26±0.29, and 5.9±0.53 for half-half; and 0.9±0.15, 2.06±0.60, 2.3±0.50 N for Rest-Plat-Akers system respectively. Besides, the retentive force for each clasp design increased in a different way with each incremental augmentation of undercut depth. As a conclusion, changing the undercut depth altered the retentive force of the used clasp. Therefore, a clasp chosen for a definite undercut depth also can be used for deeper undercut on the same abutment when higher retentive force is required with respect to the other indication criteria.

Key words: rest-plate-Akers system, half-half, ring

INTRODUCTION

"The clasp is the oldest and still probably will continue to be the most popular usable means of retaining partial dentures".[1] Ideally, the retentive force of clasp is slightly greater than the expected retentive force (withdrawal force).[2] However, some researchers demonstrated that 5N is the required force to dislodge the clasps.[3,4] Many factors involve in the retentive force generated by clasps. LaVere[1] summarized them in three categories: the fitness of the clasp to the abutment, the flexibility of the retentive arm, and the condition of the abutment. In addition, the shape of the abutment, friction coefficient, clasp design, dimensions of the crown, angle of cervical convergence,[5,6] guiding plane,[7] polishing and sandblasting[4] are after factors that directly affect the retentive force of any clasp. The purpose of this study was to measure the absolute retentive force of some clasps engaging different undercut depths and to analyze their retentive force variation with increased undercut depths (0.25, 0.35, 0.5mm).

MATERIALS AND METHODS

This study is an in vitro study. A total of 36 cobalt-chromium clasps were used in this study**.** The clasps were fabricated using half-round pattern and standard casting technique. A maxillary plastic model (Frasaco AG-3 WOK 40, Germany) was duplicated to produce a working stone cast after removing the left maxillary second premolar and first molar teeth from the plastic model (Figure 1).

Figure 1. Maxillary plastic model filled with wax to prepare the master models for premolar

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The model was duplicated using silicone (Wirosil® Bego, 52007, Germany) according to the manufacturer's instructions. Three natural maxillaries nearly equal dimension premolars were selected with different buccal undercuts (0.25, 0.35, 0.50 mm). Three master casts, each one holding natural first premolar with definite undercut, were produced using the silicone mold after seating the teeth inside the silicone mold. Before setting; two captive screws were fixed 3 mm away from the border of the mold to fasten the cast to a custom-made jig.

The casts were surveyed at zero tilt position. Rest seats were prepared on the abutments following the principles described by Stewart. [5] Guiding planes were prepared using the milling machine (AF 30, milling machine, Switzerland) approximately 2 mm in height and located on the proximal surface below the marginal ridge. The prepared master casts were copied in triplicate using silicone (Wirosil®Bego, 52007, Germany) then poured by stone. Three clasps were selected for this study; Rest-Plate-Akers (R-P-A), half and half (H-H), and Akers (A). A custom-made gauge was fabricated to measure 0.35 mm undercut depth. The resulted working casts were re-surveyed using the previous tilt. The surveyline was marked off and each clasp assembly was drawn on the abutment leaving 1/3 of the retentive arm run below the survey line.[8]

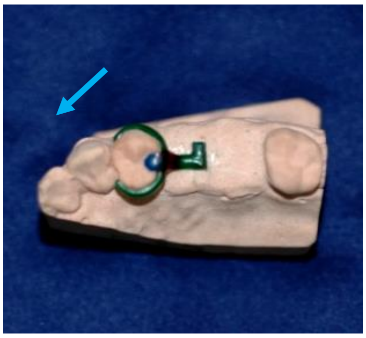

Figure 2. The wax extension to distinguish between clasps after casting

The undesirable undercuts were blocked and the entire length of the clasp arms was ledged. Small balls of wax were placed on the mesiobucal, distolingual and mesiolingual line angles of the tooth as reference points for the retentive and reciprocal arms. Each corrected cast was duplicated by reversible hydrocolloid material to produce 4 molds. A total of 36 refractory casts were poured to be used for adapting the wax model of the clasps. A small wax ring hook was attached to the waxed rest parallel to the path of insertion using the surveyor to pullout the cast clasp later. To identify the clasp type (for each undercut depth) after casting, a small wax projection was added to the saddle of each clasp in reverse directions for 0.25 and 0.35 mm undercut, and none for 0.50 mm (Figure 3).

Figure 3. The clasp ready for testing

The clasp assemblies were then invested and casted using Co-Cr alloy (Wironit, Bego, Germany), finished and electropolished following the standard technique. The polishing procedure was limited to remove nodules and burs. The clasps were examined radiographically to detect any casting defect using dental X-ray machine (Siemens, 1448 237 D3195, Germany) and source of 70 kV/7mA with exposure time of 1.2 second at 0.5 m distance. [9]

A movable custom-made jig was used to clutch the master cast inside small upward opened container perpendicular to the pulling chain. Each clasp was seated manually to be pulled by the jig of the universal testing machine (UTM) (Shimazdu testing machine AG-X, 10N-10KN, Japan). The UTM applied a tensile load at crosshead speed of 10 mm/min until automatically stopped. This procedure was repeated 10 times for each clasp (Figure 4).

Figure 4. Pulling out the clasp by UTM

One-way ANOVA was used to test the hypothesis that the mean retentive forces were not equal among the different clasp designs and variable undercuts. To explain the effect of increasing the undercut depth, the mean retentive force of each clasp type was plotted and analyzed against the engaged undercut depth to assess the changes in the clasp retention.

RESULTS

The absolute retentive forces generated by the different clasps engaging 0.25, 0.35, and 0.5 mm undercuts were; for Akers's clasp, the mean forces were 8.59±1.89, 14.74±2.70 and 15.21±1.17 N. While, for H-H clasp, they were 3.06±0.88, 4.26±0.29, and 5.9±0.53 N. Finally, for R-P-A clasp, the mean forces were 0.9±0.15, 2.06±0.60, and 2.3±0.50 N (Table 1).

Table 1. The mean retentive force of R-P-A, H-H, and Akers

Clasp type	Undercut depth	N.times	Mean	SD
R-P-A	0.25 mm	4x10	.90	.15
	0.35 mm	4x10	2.06	.60
	0.50 mm	4x10	2.30	.50
H-H	0.25 mm	4x10	3.06	.88
	0.35 mm	4x10	4.26	.29
	0.50 mm	4x10	5.90	.53
Akers	0.25 mm	4x10	8.59	1.86
	0.35 mm	4x10	14.74	2.70
	0.50 mm	4x10	15.21	1.17

Table 2. ANOVA results of the difference between the clasps

Clasp type	Source of variation	Mean Square	F	Sig.
R-P-A	Between Groups	2.255	10.737	.004*
	Within Groups	.210		
H-H	Between Groups	8.119	21.382	.000*
	Within Groups	.380		
Akers	Between Groups	54.596	13.512	.002*
	Within Groups	4.040		

Actually, the mean retentive force of Akers was higher compared to the other clasps (Table 2).
The difference is significant (p value ≤ .05) between different undercut depths

The retention of each clasp augments with the increasing of undercut depth. The tendency of this raise was dissimilar for the studied clasps.

Increasing the undercut depth by 0.1 and 0.15 mm resulted in rise of the relative mean retentive force by 2.2 and 2.5 times for R-P-A, and 1.4 to 1.9 for H-H, and 1.7 to 1.77 for A. This result might explain why the retentive force for R-P-A increases sharply when the undercut slightly deepens or double-augment. On the other hand, other clasps like A and H-H did not show the same high rate increment in retentive force when the undercut became deeper (Table 3).

Table 3. The ratio of retentive force augmentation in relation to different depth of undercuts

	Undercut in mm				
Clasp retention(N)	0.25	0.35	Ratio	0.5	Ratio
R-P-A	0.9	2.06	2.2	2.3	2.5
H-H	3.06	4.26	1.4	5.9	1.9
Akers	8.59	14.74	1.7	15.21	1.77

DISCUSSION

The amplitude of undercut depth significantly affected the clasp retentive force. Keeping the other clasp related factors constant while positioning of the retentive tip at deeper undercut resulted in marked increment of retentive force.[5,6] The retentive force for Co-Cr clasp was variable and depending on the design and the undercut depth engaged. Therefore, there was no specific force value can be assigned for cast clasp to be within 4-5 N as some authors stated.[2,10] Meanwhile, fixing the dislodging force at 4-5N of any cast clasp difficult to be achieved in clinical practice due to a number of uncontrollable variables[1] like the design of clasp used, flexibility of the retentive arm,[5,11] dimension of the crown, angle of cervical convergence,[6] coefficient of friction[4] guiding plane, and lastly polishing and sandblasting.[4]

In conclusions, the most retentive clasp was the Akers followed by H-H and R-P-A. This finding partial was in controversial to LaVere findings who stated that R-P-A assembly was the most retentive clasp on the natural tooth. This discrepancy might be due to the type or dimension of the crown and the methodology he used. LaVare used two mandibular teeth, frameworks, and more than one location to pullout the framework. However, in the present study only maxillary tooth was concerned and only one clasp unit was pulled out through one anchoring location. Increasing the undercut did not augment the retentive force of the different clasps similarly but in different manner depending on the clasp design and its initial retentive force. However, R-P-A showed the highest ratio (2.5 times) increased compared to the other clasps.

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