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In Vitro Comparative Study of Retention of Maxillary Kennedy Class I Removable Partial Denture Retained with Four Different Designs of Esthetic Clasps

Abstract

Purpose: To study the effect of clasp, design, material, and amount of retentive undercut of esthetic clasp on retention of removable partial dentures restoring maxillary Kennedy class I removable partial denture.

Methods: Eight standard educational acrylic resin models represent maxillary Kennedy class I with remaining teeth extending from the right first premolar to the left first premolar teeth were used in the study. Both first premolars teeth of each cast were prepared to receive full ceramometal crowns with mesial occlusal rest seat, proximal guiding planes, and different mesio-buccal retentive undercuts of 0.25 mm for four models, and 0.50 mm in other four models. Four different removable partial denture esthetic clasps on both maxillary first premolar crowns were used; Equipoise clasps, RPA clasps fabricated by cobalt-chromium alloy and covered with Teflon tube, RPA clasps fabricated by polyamide material, RPA clasps fabricated by acetal resin material. Metal ring hooks were fabricated, soldered to the occlusal rest of clasp assembly. Each clasp was seated manually to be pulled by the jig of the universal testing machine to measure retention of the removable partial denture. Data was collected and statistical analysis was performed.

Results: RPA clasps covered with Teflon tube recorded the highest retention force {mean value (13.92 \pm 1.41 N) followed by Equipoise clasps group (5.19 \pm 0.59 N) then Polyamide clasps group {(4.99 \pm 0.34 N)}, while acetal resin clasps group recorded the lowest retention force mean value (3.33 \pm 0.33 N). Regardless to clasp type, it was found that 0.25 mm retentive undercut recorded higher retention force than 0.50 mm undercut.

Conclusion: Within the limitations of this *in vitro* study, it could be concluded that RPA clasps fabricated by cobalt-chromium alloy and covered with Teflon tube recorded the highest retention force.

Keywords: Esthetic clasps; Metal free clasps; Retentive undercuts values; In vitro study

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Introduction

In an era of implants and fixed prosthesis, the removable partial dentures (RPDs) are up to this time a treatment of decision for an extensive variety of patients and clinicians [1]. Patients often question to the placement of a metal clasp if it is a visible part of removable partial dentures (RPDs) [2].

These days, there is an expanding of the accentuation on aesthetic, dental specialist have been worried about giving aesthetics and functional RPDs to their patients and this made the mission more troublesome in view of the objective now is accomplishing ideal aesthetic of the denture, while looking after retentive, stable, and wellbeing of supporting tooth and supporting tissue [3].

Numerous systems to defeat this quandary incorporate; the use of lingual positioned clasp, [4] the painting of clasps with tooth colored resins, [5] engaging of mesial rather than distal undercut [6]. RPDs without metal clasps has recently been utilized as a part of dentistry [7,8].

The Equipoise clasp is a retentive lingual back action clasp which encloses more than 180° of the greatest circumference of tooth, be reached out from the mesial and surround to the lingual and distal surfaces of the tooth to engage the distobuccal undercut. Equipoise pities the abutment tooth as it disengages when the partial denture is in function [9]. Masking of clasps can be done using acrylic resin or composite material. The contradictorily in the coefficients thermal expansion of metal and these materials represent an issue [10].

An extensive number of thermoplastic resins have been produced for the development of a "nonmetal clasp denture", in a broad sense to achieve anterior retention that fulfills esthetic requirements. The stability of nonmetal clasp dentures can be enhanced by including a metal rest or framework to this denture. To an extent it is known that, all producers of thermoplastic resins and labs of nonmetal clasp dentures have suggested the first denture configuration, including the resin clasp design, from a self-governing point in view; this issue has never been illuminated from an investigative purpose of view [2].

In a perfect world, the retentive force of clasp is somewhat more prominent than the normal retentive force. This force as the case may be superfast in deeper undercuts; different clasps were inspected for this speculation with a specific end goal to examine their retentive force [11].

This research aimed to study the effect of clasp, design, material, and amount of retentive undercut of esthetic clasp on retention of removable partial dentures restoring maxillary Kennedy class I RPDs.

Materials and Methods

This *in vitro* study was done on eight standard educational acrylic resin models (BH303; Nissin Dental Products Inc., Kyoto, Japan) represent maxillary Kennedy class I cases. The remaining teeth were extending from the right first premolar to the left first premolar teeth.

Both first premolar teeth of each model were prepared to receive full ceramo-metal crowns with mesial occlusal rest seat, proximal guiding planes, and different mesio-buccal retentive undercuts of 0.25 mm in three models from the eight models, and 0.50 mm in other three models. The remaining two models have the retentive undercuts on the distobuccal surface of the tooth with either depth of 0.25 mm and 0.50 mm respectively.

Educational models with the retentive undercuts on the distobuccal surface of the first premolar with either depth of 0.25 mm and 0.50 mm were received two metallic RPDs retained by Equipoise clasps fabricated by cobalt-chromium alloy material (Star Loy C[®] Degudent, Dentsply, Petropolis, Brazil). Another two educational models with the retentive undercuts on the mesiobuccal surface of the first premolar with either depth of 0.25 mm and 0.50 mm were received two metallic RPDs retained by

RPA clasps fabricated by cobalt-chromium alloy. The retentive arm covered with Teflon tube. Another two educational models with the retentive undercuts on the mesio-buccal surface of the first premolar with either depth of 0.25 mm and 0.50 mm were received two metallic RPDs retained by RPA clasps in which the retentive arm fabricated by polyamide material (Deflex Nuxen SRL, Buenos Aires, Argentina). The last two educational models with the retentive undercuts on the mesio-buccal surface of the first premolar with either depth of 0.25 mm and 0.50 mm were received two metallic RPDs retained by RPA clasps in which the first premolar with either depth of 0.25 mm and 0.50 mm were received two metallic RPDs retained by RPA clasps in which the retentive arm fabricated by Acetal resin (Valplast Int. Corp. USA).

For the casts of Equipoise clasp

Each educational acrylic model was duplicated to produce a total of six refractory cast. Each cast was waxed by readymade wax to design partial denture frame works with anteroposterior palatal strap major connector, single minor connector continued over the marginal ridge bilaterally terminated with mesial occlusal rest, proximal plates on the distal proximal surfaces of the last abutments, and saddles bilaterally. A tapered half-round clasp wax pattern was adapted to the top of the minor connector and runs palatally, downward and distally above the height of contour of the abutment to engage finally in the distobuccal retentive undercut to form the Equipoise clasp arm. The wax pattern was sprued, invested, burned out; metal casted, electro-polished (**Figure 1**).

For the casts of RPA clasp covered with Teflon tube

Each educational acrylic model was duplicated to produce a total of six refractory cast. Each cast was waxed as in group I with exception in clasp design, which was RPA clasp raised from proximal plate and runs buccally, downward and mesially above the height of contour of the abutment to engage finally in the mesio-buccal retentive undercut. After Sprued, invested and metal framework constructed as same as group I, the clasps were covered by Teflon tube (**Figure 2**).

For the casts of clasp with polyamide material

Each educational acrylic model was duplicated to produce a total of six refractory cast. Each cast was waxed as in group I with exception of the clasp design, which was RPA clasp as in group II. A special square aluminum flask (Roko flask, USA) was used; the wax pattern was sprued, invested. The wax was washed out by clean hot water and steam. Multipress eco (Roko, USA) machine was adjusted to the preset program for the deflex polyamide material, which adequate quantity of the deflex polyamide material transparent type was loaded into a disposable cartridge. The material was injected at 280°C. When the temperature and pressure were at appropriate, the start/injection key was pressed. After 20 minutes, the flask was removed followed by devesting, the sprue was cut. Finishing and polishing was done. The acrylic artificial teeth were fitted on the free end saddle of the framework (**Figure 3**).

For the casts of clasp with Acetal resin material

Each educational acrylic model was duplicated to produce a

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total of six refractory cast. Each cast was waxed as in group I with exception of the clasp design, which was RPA clasp as in group II. The wax was sprued, invested and flasked as group III. Adequate quantity of the Bio-Dentaplast material was loaded into a disposable cartridge. Thermo press 400 machine (Bredent, Germany) was adjusted to the preset program for the Bio-Dentaplast material. After injected the material, the flask was removed followed by devesting, the sprue was cutted. Finishing and polishing was done (**Figure 4**).

For all groups the following steps were done

A small metal ring hook was soldered to the occlusal rest of each clasp assembly parallel to the path of insertion using the surveyor to pullout the cast clasps later. 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 5 mm/min until automatically stopped. This procedure was repeated 10 times for each cast (**Figure 5**).

Statistical Analyses

Statistical analysis was performed using Aasistat 7.6 statistics software for Windows (Campina Grande, Paraiba state, Brazil). Data analysis was performed in several steps. Initially, descriptive statistics for each group results. Two-factor ANOVA test were performed to detect significance between variables (clasp and undercut). One way ANOVA followed by Tukey's post-hoc





Figure 2 RPA clasp covered by Teflon tube.



Figure 3 Polyamide esthetic clasps.



Figure 4 Acetal resin esthetic clasps.



Figure 5 The universal testing machine.

tests were performed to detect significance between groups within each undercut. Student t-test was performed to detect significance between main subgroups. P values \leq 0.05 are considered to be statistically significant in all tests.

Results

Table 1 illustrates descriptive statistics of maxillary Kennedy ClassI RPDs retention force as function of aesthetic clasp type engagingdifferent retentive undercuts depths.

Table 2 broadens Paired t-test of maxillary Kennedy Class I RPDs retention force constructed with different aesthetic clasps engaging different undercut depths. For Equipoise aesthetic clasp It was found that 0.25 mm- retentive undercut showed high retention force mean value (7.69 \pm 1.12 N) than the 0.5 mm retentive undercut (2.68 \pm 0.77 N). This difference in retention force is statistical significant. For RPA clasp covered by Teflon tube; it was found that 0.25 mm- retentive undercut recorded

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0.25 mm				0.5 mm					
		Mean X	± SD	Min.	Max.	Mean X	± SD	Min.	Max.
	Group I	7.69	± 1.12	6.43	9.82	2.68	± 0.77	1.45	5.03
Aesthetic	Group II	14.18	± 1 .12	11.98	16.97	13.66	± 1.76	10.5	19.36
Clasp	Group III	5.15	± 1.21	3.43	9.41	4.83	± 1.17	2.95	8.55
	Group IV	4.15	± 1.35	1.41	6.44	2.51	± 0.98	1.14	4.18

 Table 1 Descriptive statistics of maxillary Class I removable partial denture retention force.

Table 2 Comparison of the retention force results (Mean ± SD) for different aesthetic clasps as function of retentive undercut type.

	Variable	Mean X	± SD	Statistics
Group I (Equipoise sesthetic clasp)	0.25 mm	7.69	± 1.12	P value
Group (Equipoise destrictie clasp)	0.5 mm	2.68	± 0.77	<0.0001*
Group II (RPA clasp covered by Teflon tube)	0.25 mm	14.18	± 1.12	P value
	0.5 mm	13.66	± 1.76	0.3977 ns
Crown III (nolyamida parthatic clash)	0.25 mm	5.15	± 1.21	P value
Group in (polyanide aesthetic clasp)	0.5 mm	4.83	± 1.17	0.5056 ns
Group IV (Acetal resin aesthetic clasp)	0.25 mm	4.15	± 1.35	P value
	0.5 mm	2.51	± 0.98	0.0315 ns

a higher retention force mean value $(14.18 \pm 1.12 \text{ N})$ than the 0.5 mm retentive undercut $(13.66 \pm 1.76 \text{ N})$. This difference in retention force is statistical insignificant. For polyamide aesthetic clasp; it was found that 0.25 mm retentive undercut recorded a higher retention force mean value $(5.15 \pm 1.21 \text{ N})$ than the 0.5 mm retentive undercut $(4.83 \pm 1.17 \text{ N})$. This difference in retention force is statistical insignificant. For Acetal resin aesthetic clasp it was found that 0.25 mm retentive undercut recorded a higher retention force mean value $(4.15 \pm 1.35 \text{ N})$ than the 0.5 mm retentive undercut $(2.51 \pm 0.98 \text{ N})$. This difference in retention force is statistical significant.

Table 3 represents two-factor analysis of variance ANOVA test (P<0.0001) to compare the retention force of different aesthetic clasps when they engage the 0.25 mm retentive undercut; it was found that RPA clasp covered by Teflon tube recorded the highest retention force mean value (14.18 ± 1.12 N) followed by Equipoise aesthetic clasp (7.69 ± 1.12 N) then polyamide aesthetic clasp, (5.15 ± 0.34 N) while Acetal resin aesthetic clasp recorded the lowest retention force mean value (4.15 ± 1.35 N). The difference between Equipoise aesthetic clasp and RPA clasp covered by Teflon tube was statistically significant, although the Pair-wise Tukey's post-hoc tests showed statistical insignificant (p>0.05) difference between polyamide aesthetic clasp and Acetal resin aesthetic clasp.

Table 4 show two-factor analysis of variance ANOVA test (P<0.0001) to compare the retention force of different aesthetic clasps when they engage the 0.5 mm retentive undercut; it was found that RPA clasp covered by Teflon tube recorded the

highest retention force mean value $(13.66 \pm 1.76 \text{ N})$ followed by polyamide aesthetic clasp $(4.83 \pm 1.17 \text{ N})$ then Equipoise aesthetic clasp $(2.68 \pm 0.77 \text{ N})$ while Acetal resin aesthetic clasp recorded the lowest retention force mean value $(2.51 \pm 0.98 \text{ N})$. The difference between groups was statistically significant, although the Pair-wise Tukey's post-hoc tests showed statistical insignificant (p>0.05) difference between Equipoise aesthetic clasp and Acetal resin aesthetic clasp.

Discussion

In vitro studies be upset from imperfection; Firstly, the RPDs movements intraoral is not only treated with mechanical considerations, however be conditional on the neuromuscular movement of the patient. Secondly, the modality of loading intraoral is markedly more complex than the implementation of load *in vitro*. Finally, the oral mucosa is fabricated with soft acrylic resin material that is various than the intraoral normal mucosa of the patient [12].

When a retentive undercut is not be located with a surveyor on the abutment tooth, it may be formed artificially by a class V restoration, reshaping of enamel surface, or silhouetting with composite resin, or constructing a ceramo-metal crown to felicitous the RPD direct retainer [13]. In this study a ceramometal crowns were fabricated on both abutments teeth to produce the predetermined retentive undercuts.

Sato *et al.* [14] concluded that the retentive force of 5 N is desired for appropriate function of PRDPs, while Frank *et al.* [15] stated that the retentive force of 3 to 7.5 N be a symbol for a convenient

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	Variable	Mean X	± SD	Rank	Statistics
0.25 mm undercut	Group I (Equipoise aesthetic clasp)	7.69	± 1.12	В	P value<0.0001*
	group II (RPA clasp covered by Teflon tube)	14.18	± 1.12	A	
	group III (polyamide aesthetic clasp)	5.15	± 1.21	с	
	group IV (Acetal resin aesthetic clasp)	4.15	± 1.35	с	

Table 3 Comparison of the retention force results (Mean ± SD) for 0.25 mm retentive undercut as function of aesthetic clasp.





amount of retention for a maxillary Kennedy class I RPDs. In this study for 0.25 mm retentive undercut all clasp groups achieve acceptable amount of retention, but for 0.50 mm retentive undercut only RPA clasp covered with Teflon tube and polyamide aesthetic clasp were possess adequate amount of retention, while Equipoise aesthetic clasp, and Acetal resin aesthetic clasp were not possess adequate amount of retention.

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. In this study, regardless of clasp type, totally it was found that 0.25 mm

retentive undercut recorded a higher retention force than the 0.50 mm retentive undercut. However with 0.25 mm undercut it was found that RPA clasp covered by Teflon tube recorded the highest retention force, followed by Equipoise aesthetic clasp, then polyamide aesthetic clasp, while Acetal resin aesthetic clasp recorded the lowest retention force, but with 0.50 mm undercut it was found that RPA clasp covered by Teflon tube recorded the highest retention force, followed by polyamide aesthetic clasp, then Equipoise aesthetic clasp, while Acetal resin aesthetic clasp, then Equipoise aesthetic clasp, while Acetal resin aesthetic clasp recorded the lowest retention force. This is in accordance with the research of Abdulhadi *et al.* [11] who deducted that the amplitude of retentive undercut depth significantly influenced 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.

The retentive force of an acetal resin aesthetic clasp perhaps is not sufficient for maxillary Kennedy class I RPDs retention because of the significantly low retentive force result from the low modulus of elasticity of acetal resin. But the acetal resin aesthetic clasps may be suitable for RPDs when aesthetics or periodontal health of abutment teeth is the primary concern [16]. The results of the present study verify these findings, which an Acetal resin clasps group recorded the lowest retention force in both 0.25 mm and 0.50 mm undercut depths.

Conclusion

Within the limitations of this study, it was concluded that: RPA clasp covered by Teflon tube may be considered a promising clasp regarding retention, however, rapid wear of Teflon cover, even with it is easy replacement, and is still hindering its wide use.

Equipoise aesthetic clasp in undercut 0.25 mm, gives an acceptable retentive value. Polyamide aesthetic clasp is a recommended clasp to maximize retention in undercut area of 0.50 mm, which is unfavorable for casted Co-Cr clasps. Acetal resin clasps have the lowest retention force in all groups in both undercut depths.

Conflict of Interest

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

	Variable	Mean X	± SD	Rank	Statistics
0.5 mm retentive undercut	Group I (Equipoise aesthetic clasp)	2.68	±0.77	с	P value<0.0001*
	Group II(RPA clasp covered by Teflon tube)	13.66	±1.76	A	
	Group III (polyamide aesthetic clasp)	4.83	±1.17	В	
	group IV (Acetal resin aesthetic clasp)	2.51	±0.98	с	

 Table 4 Comparison of the retention force results (Mean ± SD) for 0.5 mm retentive undercut as function of aesthetic clasp.

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