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 ± 1.41 N) followed by Equipoise clasps group (5.19 ± 0.59 N) then Polyamide clasps group ((4.99 ± 0.34 N), while acetal resin clasps group recorded the lowest retention force mean value (3.33 ± 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

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 the abutment surface can 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 the abutment surface can be reached out from the mesial and surround to the lingual and distal surfaces of the tooth to engage the distobuccal undercut.

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, burnout; 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 by as 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 total of six refractory cast. Each cast was waxed as in group I with exception in 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).
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 flanked 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 tests were performed to detect significance between groups within each undercut. Student t-test was performed to detect significance between main subgroups. P values ≤ 0.05 are considered to be statistically significant in all tests.

Results

Table 1 illustrates descriptive statistics of maxillary Kennedy Class I RPDs retention force as function of aesthetic clasp type engaging different 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 ± 1.12 N) than the 0.5 mm retentive undercut (2.68 ± 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...
a higher retention force mean value (14.18 ± 1.12 N) than the 0.5 mm retentive undercut (13.66 ± 1.76 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 ± 1.21 N) than the 0.5 mm retentive undercut (4.83 ± 1.17 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 ± 1.35 N) than the 0.5 mm retentive undercut (2.51 ± 0.98 N). This difference in retention force is statistical significant (Figures 6 and 7).

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 (13.66 ± 1.76 N) followed by polyamide aesthetic clasp (4.83 ± 1.17 N) then Equipoise aesthetic clasp (2.68 ± 0.77 N) while Acetal resin aesthetic clasp recorded the lowest retention force mean value (2.51 ± 0.98 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.

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 ± 1.76 N) followed by polyamide aesthetic clasp (4.83 ± 1.17 N) then Equipoise aesthetic clasp (2.68 ± 0.77 N) while Acetal resin aesthetic clasp recorded the lowest retention force mean value (2.51 ± 0.98 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

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

| Group (Aesthetic Clasp Type) | Retentive Undercut | Mean X ± SD | Min. | Max. | Mean X ± SD | Min. | Max. |
|-----------------------------|-------------------|-------------|------|------|-------------|------|------|
| Group I (Equipoise aesthetic clasp) | 0.25 mm | 7.69 ± 1.12 | 6.43 | 9.82 | 2.68 ± 0.77 | 1.45 | 5.03 |
| | 0.5 mm | 2.68 ± 0.77 | 10.5 | 19.36 |
| Group II (RPA clasp covered by Teflon tube) | 0.25 mm | 14.18 ± 1.12 | 11.98 | 16.97 | 13.66 ± 1.76 | 10.5 | 19.36 |
| | 0.5 mm | 13.66 ± 1.76 | 10.5 | 19.36 |
| Group III (polyamide aesthetic clasp) | 0.25 mm | 5.15 ± 1.21 | 3.43 | 9.41 | 4.83 ± 1.17 | 2.95 | 8.55 |
| | 0.5 mm | 4.83 ± 1.17 | 2.95 | 8.55 |
| Group IV (Acetal resin aesthetic clasp) | 0.25 mm | 4.15 ± 1.35 | 1.41 | 6.44 | 2.51 ± 0.98 | 1.14 | 4.18 |
| | 0.5 mm | 2.51 ± 0.98 | 1.14 | 4.18 |

**Table 2** Comparison of the retention force results (Mean ± SD) for different aesthetic clasps as function of retentive undercut type.
Table 3 Comparison of the retention force results (Mean ± SD) for 0.25 mm retentive undercut as function of aesthetic clasp.

| Variable                                         | Mean X | ± SD  | Rank | Statistics       |
|--------------------------------------------------|--------|-------|------|------------------|
| 0.25 mm undercut                                 |        |       |      |                  |
| Group I (Equipoise aesthetic clasp)              | 7.69   | ± 1.12| B    | 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| C    |                  |
| group IV (Acetal resin aesthetic clasp)           | 4.15   | ± 1.35| C    |                  |

The amplitude of undercut depth significantly affected the clasps retentive force. Keeping the other clasps 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 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.

Conflict of Interest
The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.
Table 4 Comparison of the retention force results (Mean ± SD) for 0.5 mm retentive undercut as function of aesthetic clasp.

| Variable                                              | Mean X  | ± SD  | Rank | Statistics            |
|-------------------------------------------------------|---------|-------|------|------------------------|
| 0.5 mm retentive undercut                             |         |       |      |                        |
| Group I (Equipoise aesthetic clasp)                   | 2.68    | ±0.77 | C    | 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 | B    |                        |
| Group IV (Acetal resin aesthetic clasp)               | 2.51    | ±0.98 | C    |                        |
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