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COMPARATIVE STUDY OF THE RETENTION FORCE BETWEEN TWO RESILIENT ATTACHMENTS IN MANDIBULAR IMPLANT OVERDENTURE (AN INVITRO STUDY)

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ABSTRACT

Objectives: This study aimed to compare the retention force of two different attachments namely, locator and resilient telescopic attachment in retaining two implant-assisted mandibular overdenture.

Materials and Methods: Sixteen identical mandibular complete dentures were processed to be attached to a completely edentulous epoxy cast. Two implants were placed in the cast's interforaminal region with the aid of a surgical guide. Dentures were randomly divided into two equal groups to be implant retained by either locator attachment (Group A), or telescopic attachment (Group B) using the direct pickup technique. Using the universal testing machine, a vertically oriented tensile load was applied parallel to the path of insertion until the attachments were detached from the abutments. The maximum load required for detachment (retentive force) was calculated at the baseline and following repeated insertions and removals.

Results: Significant differences were observed in all three-time points (initial time point, after 90 days, and after 180 days) in both attachments. The Locator group had a significantly higher mean in comparison to the Peek telescopic group ($p < 0.001$).

Conclusions: The locator had better retention than the peek telescopic group according to vertical dislodging forces in all three-time points.

KEYWORDS: Locator, telescopic attachment, retentive force, implant-assisted

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INTRODUCTION

Implant-assisted overdentures have been proven to result in fewer problems than those associated with traditional complete dentures when rehabilitating a completely edentulous arch [(1)].

Suggested that two implants supporting an overdenture may be sufficient to have good clinical results.

Many researchers have suggested that two implants can be sufficient for retaining an overdenture with no dramatic effect on stress distribution or peri-implant tissue health [(2)].

Several types of attachments are readily used for retaining implant overdentures. There is a conflict in research regarding which type of attachment is superior to the other [(3)]. Many clinicians prefer the use of stud attachments as it has the least complicated technique [(4)]. Ball and socket attachments are the most popular ones as it is simple and affordable[(5)]. It was also found that it transmits less stress to the surrounding tissues in comparison to bar attachments [(6)].

In 2001, Zest Anchors developed the Locator attachment system as a new addition to stud attachment. It has a low-profile design making it the best choice in cases with limited interoclusal space [(7)].

The self-alignment and dual retention design enables the attachment to be easily and quickly repaired or replaced compared to other attachment systems [(8)].

Telescopic attachments have been used since 1989 [(9)]. Two implants placed in the canine region with strong telescoping attachments for overdenture retention proved to be a viable and effective therapeutic option with long-term success [(10)]. This approach may be advantageous in manipulation, maintaining oral hygiene measures, and patient satisfaction, particularly in the case of a severely atrophied edentulous mandible in elderly patients [(10)].

MATERIAL AND METHODS

An epoxy resin models were made to represent a completely edentulous mandibular arch without alveolar undercuts [(11)].

A)Fabrication of mandibular complete dentures

Custom trays with spacers and stoppers were performed on the epoxy models. Final impressions were made using Auto-mixed regular body vinyl polysiloxane (VPS) impression material and tripoding pressure. Impressions were boxed and poured into Type III dental stone using a vacuum mixer to obtain master casts. On the stone models, trial denture bases with wax occlusion rims were made and mandibular acrylic teeth were arranged and adjusted.

Processing of dentures followed by, finishing and polishing were done.

B) Surgical guide fabrication

Cone beam computed tomography (CBCT) was used to scan the epoxy models; the obtained DICOM data were converted into STL model.

The epoxy model's DICOM and the STL files were imported to a surgical guide planning software (Blue Sky Planning Software). Both files were superimposed using the five small indentations. To manage the position of the implants relative to the canine area, Implant planning was prosthetically driven using the virtual overdenture. The implants were planned 22 mm apart between the canines and premolar bilaterally, to mimic the distance between the natural canines. The implant's dimensions used were 3.3 mm in diameter and 10 mm in length (Vitronex V-line Implant, Vitronex Co. Ltd., Italy).

- The designed 3D surgical guides were printed by 3D printer from a special material (Resin dental material SG-100, South Korea).

C) Implant placement

Two dummy implants were inserted in canine region using a surgical guide following conventional drilling technique after fixation of the surgical guide on the cast (Figure 1, Figure 2). To mimic osseointegration, implants were attached to the epoxy models by using resin cement. (Figure 3)

Fig. (1) Epoxy resin model with surgical guide seated

Fig. (2) Implant drilling through surgical guide

Fig. (3) Cemented two implants

Two different types of attachments were used to connect the denture to the implants:

Group I (Locator attachment)

- Locator attachments (Zest Anchors, Inc, homepage, Escondido, CA, USA) composed of:

1. Locator abutment (Figure 4): The female part, medium, with a gingival height of 3mm, screwed to the dummy implant using the locator insertion key.
2. Locator matrix (Figure 5): a metal housing containing a male insert to be picked up to the fitting surface of the overdenture.
3. Retention male inserts: different color nylon inserts representing different range of retention. It is fitted into the metal base of the locator matrix using the locator press tool.

Fig. (4) Components of Locator attachments (Locator abutment)

Fig. (5) Locator matrix with Retention male inserts

Group II (Telescopic attachment)

Primary crowns fabrication

- A lab scanner was used to scan each implant's abutment.
- Then the Exocad software was used to design the primary crowns with a 6 mm height and a deep chamfer finish line.
- A single PEEK resin blank was used to mill the primary crowns using a milling machine.
- Before cementing the primary crowns, conditioning the titanium alloy of each abutment using a primer (MKZ Primer; bredent GmbH & Co KG MKZ Primer, bredent, Germany) was done.
- Using a self-adhesive resin cement, the primary crowns were cemented on the abutments following the manufacturer's instruction (Voco cement, Germany). (Fig. 6)

Fig. (6) Cemented primary copings

Secondary crowns fabrication:

- Each primary crown underwent scanning.
- The CAD software was used to design the secondary crowns
- Using the same milling machine, secondary crowns were milled from one PEEK resin blank.

Direct pickup of the abutments/housings using an auto-polymerized acrylic resin:

For group I

A white spacer ring is placed on every locator abutment to prevent resin from flowing underneath the matrices during pick-up.

- Locator matrix was plugged into locator abutments. (Figure 7) Sufficient relief was provided over the locator matrix in the fitting surface of the overdenture. Vents were made in the denture base lingual to the attachments to facilitate the flow of excess acrylic resin.

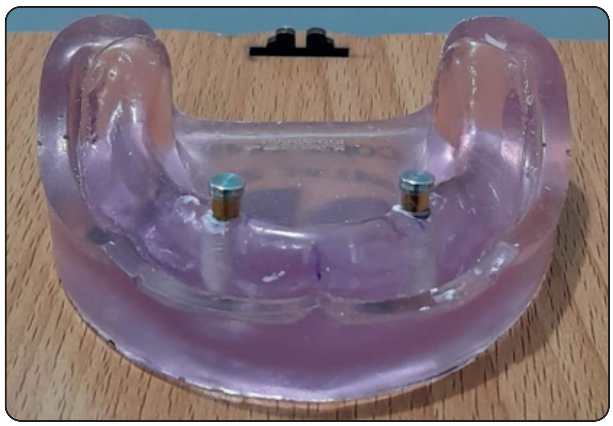

Fig. (7) Locator matrix plugged into locator abutments

For group II

- The secondary crowns of resilient telescopic attachment were oriented in the correct position on the primary crowns.
- Then they were picked up to the fitting surface of the overdenture the same way as previously mentioned. (Figure 8)

Fig. (8) Picked up secondary copings

Measurement of retention (Vertically dislodging forces) [12-16]

- For the overdentures in both groups four holes were made at the first premolar and first molar region bilaterally.
- Four cobalt chromium hooks were screwed at the four holes after reliving the acrylic from the fitting surfaces. (Figure 9)
- Four 8-cm metal chains were attached to the four hooks of the overdenture and connected to the head of a universal testing machine via a metal bar.
- The metal bar with two holes was attached to the metal chains' endings. In the middle of the metal bar, another chain was attached connecting it to the universal testing machine's head.
- At the base of the universal testing machine, the test model was fixed and centered beneath the crosshead, with the occlusal plane aligned parallel to the metal plate. (Figure 10)
- A computer algorithm was used to calibrate and balance the testing machine for compensation of the prosthesis and chains' weight.
- During the retention test, the universal testing machine (LLOYD LRX, LLOYD instruments Ltd., Fareham, Hampshire, UK) was used to apply 4-point tensile loads on the overdenture in a vertical orientation.
- Loads were applied parallel to the path of insertion till the attachments detached from the abutments.
- The machine consists of a cross-head perpendicular to 2 vertical arms. A load cell is attached to the cross-head controlling its speed and direction. A computer-controlled software was used to adjust its tensile movement mode and collect data [17].
- The cross-head speed was maintained at 50 mm/min to simulate the denture's speed while moving away from the ridge during mastication [18].
- The retentive force or maximum load required to detach the overdenture from the test model was calculated.

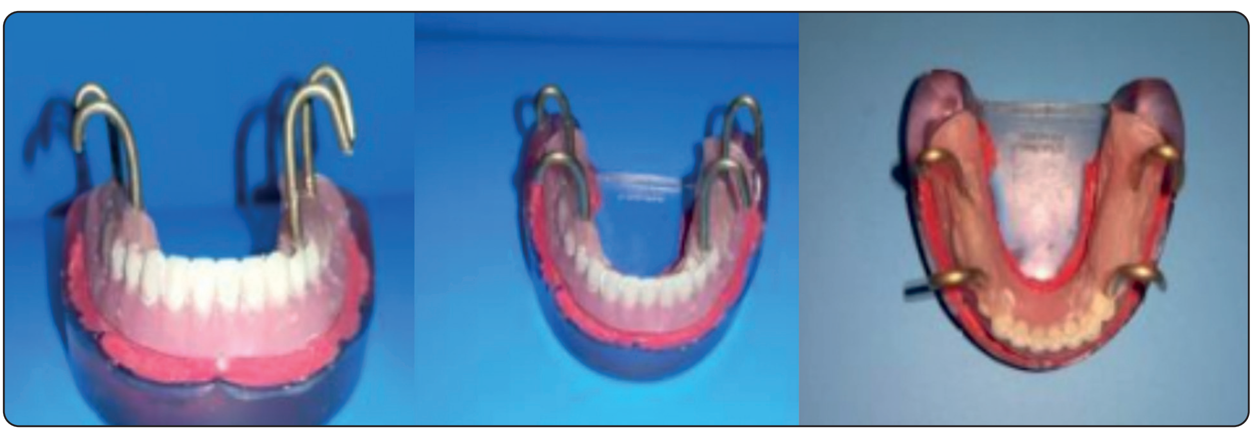

Fig. (9) Dentures with cemented 4 hooks by self-cure acrylic resin

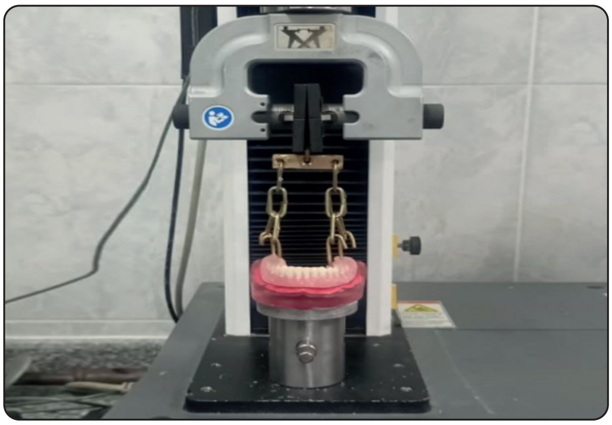

Fig. (10) Universal testing machine

Statistical analysis

Student T Test was used to assess the statistical significance of the difference between the two study group means.

Repeated measures ANOVA Test was used to assess the statistical significance of the difference between more than two means at different times.

A p-value is considered significant if <0.05 at confidence interval 95%.

RESULTS (TABLE 1)

Comparing the Locator group to the Peek telescopic group according to vertical dislodging forces, significant differences were observed in all three time points. At the initial time point, the Locator group had a significantly higher mean (35.9) compared to the Peek telescopic group (8.1) ($p < 0.001$).

Similarly, after 90 days, the Locator group still exhibited a significantly.

Higher mean (0.13) compared to the Peek telescopic group (6.5) ($p < 0.001$).

Finally, after 180 days, the mean vertical dislodging force for the Locator group decreased to 28.3, while the Peek telescopic group showed a mean of 4.3 ($p < 0.001$). (Figure 11)

TABLE (1) Vertical dislodging forces measurements at different times among studied groups

		Locator group (n=8)	Peek telescopic groups (n=8)	Test	p
Initial	M ±SD	35.9±9.2	8.1±1.3	17.857	<0.001*
	Median(Range)	37.4(23.8-47.3)	6.6(4.6-8.5)		
After 90 days	M ±SD	31.0±8.1	6.5±1.4	39.815	<0.001*
	Median(Range)	31.6(20.8-41.6)	6.6(4.6-8.5)		
After 180 days	M ±SD	27.7±7.3	4.3±0.7	14.633	<0.001*
	Median(Range)	28.3(18.3-37)	4.2(3.5-5.4)		

Test= independent t test; * =p<0.05

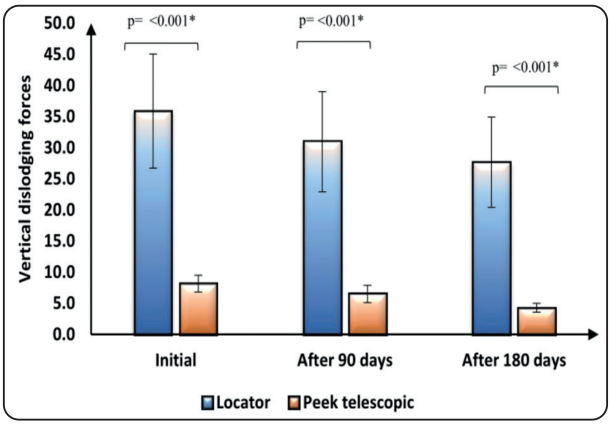

Fig.(11) Vertical dislodging forces measurements at different times among studied groups

DISCUSSION

The purpose of this study was to compare the retention between locator and PEEK telescopic attachment when used for retaining a two implant-assisted mandibular overdenture. Various retentive forces have been noticed for various attachment systems ranging from 3 to 85 N when used with two implants [19-21]. 4 N was the minimum expected retentive force for an unsplinted attachment [19]. It was estimated that retentive forces of 20 N would be adequate for retaining mandibular two-implant assisted overdentures [21-24].

Retentive force ranging from 8 N to 10 N was considered effective as a prospective crossover clinical study has revealed [25]. Others [26,27] have suggested that the retention force between 5-8 N may be quite enough.

The initial retention for the telescopic crown in the present study was found to be 8.1±1.3N. This value was higher than Elkabbany et al. [28] who compared the retention force of telescopic (conical) crowns fabricated in peek material, prepared with different cone angles of (5.5^{o} and 6.5^{o}). This difference may be due to the minimal taper preparation with nearly parallel walls used in the present study.

The initial retention for the locator in the present study was 35.9±9.2 N which is comparable to other relative studies. An in-vitro study [29] on 3-implants assisted mandibular overdentures using locator attachments, revealed that the initial retention of all the locator attachments tested has ranged from 49.58 to 62.05 N. Similarly, Evtimovska et al. [8] reported the initial retention for the Locator attachments to be 69.1 N for 2-implant assisted overdentures.

The retention force for both attachment systems evaluated in the present study was diminished with time. This result is in agreement with earlier in vitro studies, therefore it is not surprising (30-32).

The locator attachments' retentive force significantly decreased after 180 days. Kleis et al. [33] demonstrated that the wear of the male locator part resulted in 75.5% loss of retention by time, with the need for more maintenance compared to ball attachments. Uludag et al. [29] presented loss of tested locator attachments' retention, ranging from 19.52% to 21.66% over a 6 months simulation. In addition, Turk et al. [34] found that locator attachments had anotable decline in retention after subsequent cycles of 100, 200, 300, 500, and 3,000 in comparison to the preceding cycle. It was suggested that surface alteration of the nylon components is responsible for retention loss. Microscopic examination showed visual deterioration and degradation of the resilient inserts [34,35].

The retention of the resilient telescopic crown is significantly decreased over time. This finding is in agreement with other studies [36,37]. Arnold et al. [36] reported that the retention of conical telescopic peek attachment is based on friction. It also has several drawbacks, including technique sensitivity to ensure fit between the secondary and primary crown. Interlocked surfaces can result in a high initial retentive force. The overall retention is decreased due to surface abrasion by additional wear and formation of a gap instesd of the closely wedged contact.

In contrast, Güven et al. [38] reported that the mean retention force increased over long-term use after insertion-separation cycling of telescopic crowns. The absolute change in retention force between the first and the last insertion-separation cycle was reported to be 0.10 N and 0.38 N respectively.

However, it is thought that the continuous contact of double peak crowns causes incremental wear and quick loss of retention. This causes increased forces on the supporting structures and accelerates deterioration, so it is suggested to be only used with strong abutments [39].

One of the numerous factors influencing the retentive force of telescopic crowns is their taper. It was reported that the retention was decreased when the taper was increased with a 6° spread [39].

According to our results, comparing the locator group to the peek telescopic group according to vertical dislodging forces significant differences were seen in all three time points. At the initial time point, after 90 days and after 180 days the locator group had a significantly higher mean dislodging forces compared to the peek telescopic group. The two attachment systems' dissimilar sizes and designs could account for the discrepancy. Locators have a dual retention property coming from friction between the slightly larger nylon male insert and the smaller inner ring diameter of the female abutment [40,41].

However, the mean retention force of both attachments was still within the acceptable limits following examination of approximately 6 months of clinical use. To increase long-term patient satisfaction, a telescoping attachment may need an extra retentive feature.

CONCLUSION

From our results, we can conclude that:

The locator had better retention than the peek telescopic group according to vertical dislodging forces in all three-time points.

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