Original Article

Comparative analysis of the retention of locator attachments and ball attachments in implant supported mandibular overdentures

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Objective: To compare the retention of ball attachments versus locator attachments in implant-supported mandibular overdentures during 5000 insertion and removal cycles.

Methodology: This quasi – experimental study was conducted from January 2022 to October 2023. The sample size was 20 edentulous mandibular models and overdentures adequately seated with their respective housings. The overdentures were subjected to 5000 cycles of dislodging force using a universal testing machine, and the maximum loads needed to disengage the overdenture were measured for each cycle. The force values were then calculated. The data were analyzed using SPSS 22.

Results: There was a significant difference in retentive forces between ball and locator types of attachments ($p<0.001$). The locator type had better retentive forces (52.45±4.97) than the ball type (32.61± 4.28). During the cycles, there was a decrease in retention in both types of attachments. Pearson's correlation showed a strong negative correlation between the number of pulls and retention in both types of attachments. The locator type showed a significantly lower retention loss than the ball-type attachment.

Conclusion: The locator attachment mechanism was more favorable from a clinical standpoint. The drop in retention was attributable to both attachment systems; it was substantially lower in the case of the locator attachment system.

Keywords: Denture bases, denture retention, overdenture, prosthodontics.

INTRODUCTION

Successful complete denture therapy begins with carefully assessing the patient's physical and oral conditions and determining a treatment plan to deliver optimal results.[1,2] For an edentulous mandible, a two-implant overdenture is recommended as the primary treatment option.[2] Currently, there are numerous attachment systems available for securing overdentures. These may either splint the implants together (using bar attachments) or leave them unsplinted (utilizing stud-type attachments).[3] Studies have shown that implant overdentures are better than conventional complete dentures in every aspect.[4-7]

The long-term success of an implant-retained overdenture significantly relies on the attachment element's retentive capacity.[5] However, clinical scenarios have unveiled challenges with specific attachment types, such as premature retention loss, which escalates treatment expenses.[6-9] Utilizing ball-type retentive attachments for overdentures is a commonly employed, straightforward, and cost-effective treatment option.[10] Nevertheless, its prolonged use often results in wear of the ball attachment, leading to diminished retention and compromised denture stability.[3,11]

In contrast, the Locator attachment, a relatively newer option, has gained popularity due to its unique features. Locators are particularly beneficial for patients with limited inter-arch distance as they mitigate denture base deformation and fracture risks. These attachments are resilient, self-aligning, offer varying degrees of retention, and incorporate built-in angulation compensation mechanisms.[12] Nonetheless, they are susceptible to wear and may experience retention loss over time, emphasizing the need for vigilant monitoring and maintenance.[13] This in-vitro study evaluated and compared the retention of ball attachments versus locator attachments in implant-supported mandibular overdentures during 5000 insertion and removal cycles.

METHODOLOGY

This quasi-experimental study was conducted from January 2022 to October 2023 at the Institute of Dentistry, CMH Lahore Medical College. It was approved by the IRB of the University College of Medicine and Dentistry (Ref No: UCD/ERCA/21/11gl). The sample size was calculated using Epi-info software using mean values of ball attachment (retentive values) = 9.70 ± 7.94 N and locator attachment retentive forces = 21.70 ± 10.13 N at 95 % Confidence Interval and 80% power of the study.[14] The total sample size came to be 20 (10 in ball attachment and 10 in locator attachment).

The inclusion criteria were edentulous mandibular models and mandibular overdentures with correct dimensions, which were adequately seated and latched to their respective implant attachments. Models that failed to meet quality control standards, were not properly seated on the models, or failed to lock with the attachment were excluded.

Two mandibular casts were made from standardized edentulous molds using heat-polymerized polymethyl methacrylate resin. The site for implant placement was prepared on the acrylic model, simulating the conventional placement of the implant in the osteotomy site in the mandible; two implant analogs (4mm×11.5mm) were placed in each model and were subsequently secured with resin cement.

Ball abutments were screwed on the implants on one model, whereas locator abutment was secured to the implants on the other acrylic model. Ten mandibular overdentures with respective housings were fabricated on each acrylic model (Fig. 1).

(a) **(b)**

Fig. 1: (a) Ball attachments (b) Locator attachment with plastic cap.

Acrylic overdentures, each equipped with respective attachment systems, were placed onto acrylic edentulous mandibular models. Self-cure acrylic was used to affix bilaterally to each denture, positioned in the molar-premolar region and interconnected by an acrylic shaft (Fig. 2).

Each overdenture underwent dislodging force assessment using a Universal Testing Machine (UTM). The UTM was configured with a fixed 50 mm/min crosshead speed to replicate the rate of overdenture motion away from the ridge during functional movements.[8,15,16] The maximum force required to disengage the overdenture (measured in Newtons) from the test model, also known as the retaining force, was recorded. The dislodging force was applied vertically at the center of the adjoining acrylic shaft. Each overdenture in the study underwent a rigorous testing process where it was subjected to 5,000 individual pulling forces, aimed at dislodging it from the experimental model.

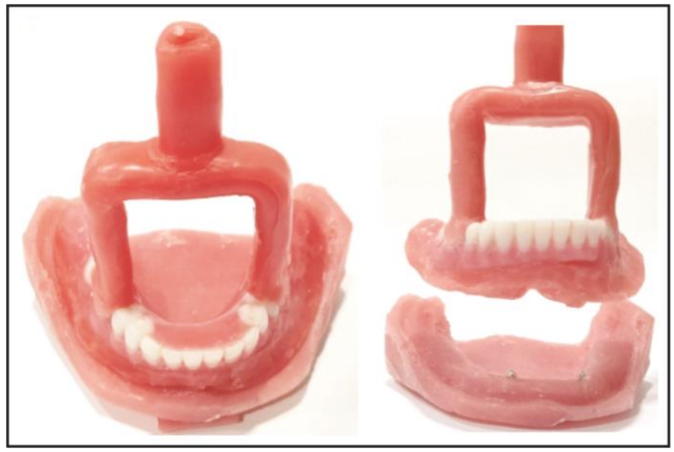

Fig. 2: The over-denture assembly is attached with self-cure acrylic resin shaft.

Statistical Analysis: The responses were analyzed using SPSS version 22. The normality of the data was assessed using the Shapiro-Wilk test. The data was normally distributed; therefore, an independent sample t-test was applied to compare mean retentive values in both attachment groups. Pearson's correlation was used to assess the correlation between the number of pulls and retention. $p<0.05$ were taken as significant.

RESULTS

The mean retentive force for the ball-type attachment was 32.61 ± 4.2 N, and the locator-type attachment was 52.45 ± 4.9 N. The maximum value of retentive force measured for the ball type of attachment was 38.3N, while for the locator type of attachment was 62.3N. The minimum retentive force for the ball type of attachment measured was 23.4N, while for

Table 1: The Comparison of Mean Retentive Forces between Ball and Locator Type Attachment over 5000 cycles.

Variable		Mean	SD	t	df	p
Attachment Type	Locator Attachment	52.45	4.97	-21.36	98	<0.001
	Ball Attachment	32.61	4.28			

p-value was generated using an Independent Sample T-test

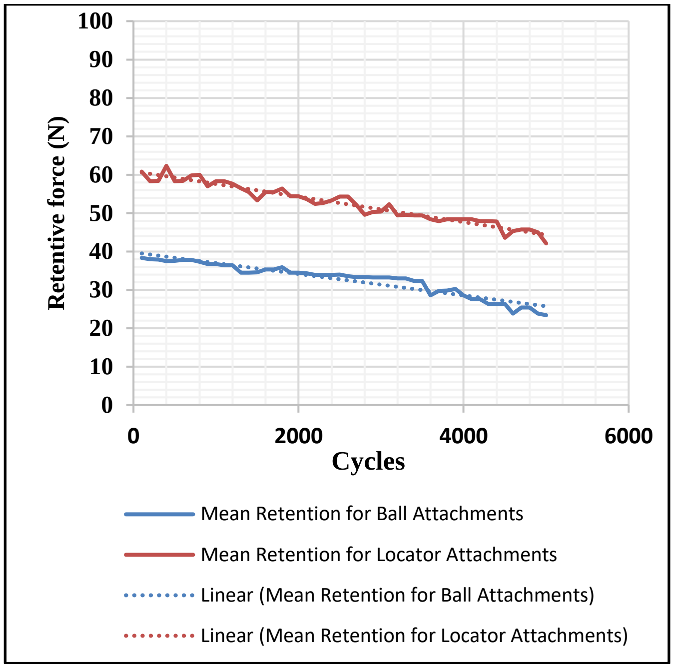

Fig. 3: The trend line for both Ball and Locator type attachment over 5000 cycles showing a decrease in retentive forces over repeated cycles.

the locator type of attachment was 42.1N.

The independent sample t-test results revealed a significant difference in tensile or retentive forces between the two groups, i.e., ball type and locator type attachments. ($p<0.001$) (Table). The locator type of attachment showed significantly higher retentive forces, (52.45±4.97 N), compared to the ball type of attachment system, (32.61± 4.28 N).

We found decreased retention or retentive forces as the number of pulls increased (Fig. 3). Pearson's correlation showed a strong negative correlation between the number of pulls and retention in both types of attachments i.e., the ball attachment ($r=-0.953$, $p=0.001$) and locator attachment ($r=-0.971$, $p=0.001$). However, overall, the Locator type of attachment showed significantly higher retention when compared to the ball type of attachment (Fig. 3).

DISCUSSION

The parameters used in this study were aimed at mimicking the conditions in the oral environment. Most previous studies have reported the speed of removal for the prosthesis to be 50mm/min; that is why the crosshead speed for the removal process was selected to be 50 mm/min in the universal testing machine.[15] Different patients have different removal actions; some use their index finger, some use their thumb, and others use combinations of fingers based on convenience.[8,17] The snap action removal of overdenture was replicated outside the oral cavity using a crosshead speed of 50mm/min.[8,16]

In-vitro studies focusing on attachment durability have revealed a decline in retentive force, accompanied by significant wear on metal surfaces, indicating that, unlike their plastic counterparts, metal components are susceptible to dimensional changes and surface wear. Despite these findings, there remains a significant gap in the literature regarding the wear behavior and processes affecting these components.[9,10,18,19]

The debate continues over which material exhibits superior resistance to wear and maintains consistent prosthesis retention over time. The relationship between the loss of retention, dimensional changes, and wear patterns on these attachments remains largely unclear and under-researched. The different parts of the attachments, especially plastic components, undergo more degradation when compared to the metallic parts.[12,20]

The self-aligning and dual-retention locator attachment facilitates insertion and removal, thereby enhancing the attachment's durability and tolerance for implant divergence of up to 40°.[21] As a result of these design attributes, the locator gained immense popularity as one of the most widely used stud attachments. It is worth noting that the locator system entails a higher maintenance when contrasted with the ball attachment.[15,22-24] Single ball attachments are not only more cost-effective but also require less technical precision.[23]

Despite appearing less retentive compared to the locator design, the ball attachment's benefits—such as its ease of use, straightforward maintenance, and affordability, extensive range of motion, and higher initial patient satisfaction-stand out as its principal advantages.[3,22] However, it's important to note that the ball attachment is prone to wear over time, leading to a gradual decline in retention, necessitating periodic replacements.[21] This study corroborates these findings, demonstrating that the ball attachment exhibits lower retention levels when compared to the locator attachment.

CONCLUSION

The ball and locator-type attachments exhibited diminished retention forces by the end of the testing cycles. Yet, the retention offered by the locator-type attachments was notably superior to that of the ball-type, demonstrating a significant difference in performance durability. The reduction in retention, attributed to both attachment systems, is much lesser in the case of the locator attachment system.

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Drafting of the article: Omer Masood Alam Shad, Hammad Hassan.
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