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Evaluation Of Retentive Properties Of Different Attachments For Implant-Retained Maxillary Overdentures- An Original Research

Dr. Samiksha Dubey[1] , Dr. Rajsandeep Singh[2] , Dr. Sachin kumar Jadhav[3] , Dr Balaji Venugopal[4] , Dr. Sonal Jain[5] , Dr. Neha Chauhan[6] , Dr. Damarasingu Rajesh[7]

1. *MDS, Prosthodontist, JRF Periodontology, KGMU, Lucknow, Uttar Pradesh, India. drsamikshadubey@gmail.com*
2. *MDS, Prosthodontics, Senior resident, Government Medical College & Hospital, Chandigarh. Singhrajsandeep1@gmail.com*
3. *MDS, Public Health Dentistry, Post Graduate Institute Of Dental Sciences, Rohtak, Haryana. Jadhav.Sachinkumar1204@gmail.com*
4. *MDS, Senior Assistant Professor, Dept.of Dental Surgery , Govt. Viluppuram Medical College and Hospital, Mundiyampakkam, Viluppuram, Tamil nadu, India.*
5. *MDS, Senior Lecturer, Department of Prosthodontics. Madha Dental College and Hospital, Chennai, Tamil Nadu. drsonaljain24@gmail.com*
6. *MDS, Public Health Dentistry, Post Graduate Institute Of Dental Sciences, Rohtak, Haryana. nehachauhan462@gmail.com*
7. *OMFS, PhD Scholar, Dept of OMFS, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat. rajeshoralsurgeon@gmail.com*

Corresponding Author: Dr. Samiksha Dubey, MDS, Prosthodontist, JRF Periodontology, KGMU, Lucknow, Uttar Pradesh, India. drsamikshadubey@gmail.com

ABSTRACT

Introduction: The aim of our study was to evaluation of retentive properties of different attachments for implant-retained maxillary overdentures.

Materials and Methodology: Two implant replicas (CMI), of 3.75 mm diameter and 10 mm length, were placed in the intraforaminal region. Acrylic resin mandibular overdentures were fabricated and provision was made to receive three different overdenture attachment systems, prefabricated ball/o-ring attachment, Hader bar and clip attachment, and Locator® implant overdenture attachment stud type. Using a universal testing machine, each of the models were subjected to 100 pulls each to dislodge the overdenture from the acrylic model, and the force values as indicated on the digital indicator were tabulated both before and after thermocycling (AT).

Results: The statistical model revealed a significantly different behavior of the attachment systems both before and AT. The ball/o-ring and bar attachments developed higher retentive force as compared to the locator attachment. The bar and clip attachment exhibited the highest peak as well as the highest mean retention force at the end of the study. The Locator® attachment showed a decrease in retentive potential after an early peak.

Conclusions and Clinical Implications: The ball/o-ring and bar and clip attachments exhibit higher retentive capacities than the Locator® attachment over time.

Key Words: Dislodging cycles, Locator, overdenture attachment, retentive force, thermocycling.

INTRODUCTION

The most common problem associated with the management of edentulous patients is the severely resorbed mandibular ridge, especially in older age when adaptive capacities are reduced.[1-5] The prognosis of the prosthesis depends on two important factors: (1) Retention and (2) stress distribution. Retention is the function of and is directly related to the attachment system employed. The success of implant-retained overdentures primarily depends on the retentive capacity of its attachment element to sustain its long-term functionality.[6-11] Typically, the combination of materials in overdenture attachments comprises a metal–metal or metal–plastic/nylon contact which might show differences regarding surface. In addition to this, a change in retentive capacity of the attachment systems is expected when the overdenture is subjected to a period of service in the oral cavity under the influence of inherently present fluids and ingested food and liquids during mastication and insertion and removal of the prosthesis. Micro- and macro-movement between the retentive surfaces of an attachment during mastication and removal of the overdenture will lead to wear and diminish retentive forces over time.

Thus, the aim of our study was to evaluation of retentive properties of different attachments for implant-retained maxillary overdentures

MATERIAL AND METHODS

Edentulous mandibular models were made from heat polymerized polymethyl methacrylate resin. Mandibular Overdentures were fabricated in a conventional manner using heat polymerized polymethyl methacrylate resin-(DPI Heat Cure, DPI, Mumbai, Maharashtra, India.

Three overdenture models were prepared and five denture samples were prepared for each group.

- Group 1 - Ball/o-ring attachment
- Group 2 - Bar and clip attachment
- Group 3 - Locator® attachment.

The implant analogs (CMI 3.75 mm × 10 mm) were placed in the acrylic models using physiodispenser, simulating the conventional placement of implant in osteotomy site in the mandible and subsequently secured with resin cement (Relyx™, 3M ESPE, USA)

IMPLANT OVERDENTURE ATTACHMENT SYSTEMS

- Prefabricated ball/o-ring attachment (Lifecare Biosystems, Thane, India)
- A metallic housing with a rubber o-ring component was used for the ball and ring attachment.
- Hader bar and clip attachment
- A castable Hader bar of length = 22 mm; diameter = 1.8 mm = 13 gauge.

Nylon rider-length = 5 mm; width = 2.6 mm - moderate retention

- Locator® attachment (Zest Anchors LLC, USA) [Figure 2c] Tissue cuff length = 1.0 mm; diameter = 3.86 mm Locator male blue inserts retention force = 1.5 lbs (6.7 N) Maximum convergence = 20°.

Retention force testing before thermocycling

With the UTM (Instron 5567 compression tension tensile meter), each of the models were subjected to 100 pulls each to dislodge the overdenture from the acrylic model, and the force values as indicated on the digital indicator were tabulated [Figures 5 and 6]. The dislodging force was applied in a vertical direction in the center of the acrylic block joining the two metallic clamps holding the overdenture with the UTM operating at a crosshead speed of 2 mm/30 ms. The readings were taken from the start of the test.

All the overdentures with the attachments placed on the edentulous models were subjected to manual thermocycling using S-U-Polytubs; one maintained at 5 ± 1° and other at 55 ± 1°. The test samples were subjected to a total of 5000 cycles with each cycle equivalent to 30 s of dwell time in each temperature controlled tub with a transfer time

of 10 s, with 5000 thermal cycles being equivalent to 6 months of service in the oral cavity.[24] None of the samples failed.

Retention force testing after thermocycling

Each of the models was again subjected to 100 pulls each to dislodge the overdenture from the acrylic model and the force values as indicated on the digital indicator were tabulated.

RESULTS

The mean concentration (± standard deviation [SD]) was 56.26 (9.77) at baseline, 51.30 (5.08) at after thermocycling (AT). A significant decrease was seen between AT and baseline ($Z = -5.969$, $P < 0.001$) after the completion of 5000 thermal cycles [Tables 1-5].

The mean concentration (±SD) was 70.66 (12.09) at baseline, 65.18 (10.89) at AT. A significant decrease was seen between AT and baseline ($Z = -7.728$, $P < 0.001$)

The mean concentration (±SD) was 41.72 (6.53) at baseline, 36.74 (9.32) at AT. A significant decrease was seen between AT and baseline ($Z = -4.446$, $P < 0.001$)

The bar and clip attachment showed the highest mean retentive force of 70.66 N and 65.18 N before and AT, respectively. The maximum retentive force was exhibited by the bar andclip attachment, 82.3 N (cycle no. 56); followed by Locator® attachment, 66.7 N (cycle no. 41); and ball/o-ring attachment, 65.4 N (cycle no. 13). A decrease in the retention force was observed in all the three attachment systems after subjecting them to thermal cycles and this decrease was found to be statistically significant ($P < 0.05$). Table 1.

Table 1: Summary of statistical analysis

Parameter	Ball/o-ring attachment	Bar and clip attachment	Locator® attachment
Mean±SD			
BT	56.26	70.66	44.72
AT	51.30	65.18	36.74
Initial mean retentive force	40.3±15.83 N	46.9±13.9 N	33.5±9.77 N
Minimum retentive force	20.6 N	39.5 N	33.1 N
Maximum retentive force	65.4 N (cycle number 13)	82.3 N (cycle number 56)	66.7 N (cycle number 41)
Change in retentive force after thermocycling	Decreases	Decreases	Decreases
P	<0.001 statistically significant	<0.001 statistically significant	<0.001 statistically significant

SD: Standard deviation, BT: Before thermocycling, AT: After thermocycling

DISCUSSION

The underlying principle in employing retentive implant-overdenture systems for the treatment of edentulous patients is to increase denture retention and stability, thereby promoting chewing function as well as patient comfort and compliance.[12-15]

Stud type, ball, and conventional bar attachments are the commonly used anchorage systems in implant-supported overdentures and their efficacy is scientifically supported.[16-19] Hence, these attachment systems were chosen for this study.

Splinted conventional bar attachments have demonstrated superior retentive capacities over unsplinted systems. However, they have a few disadvantages; they are initially more expensive, difficult to repair, and maintaining

oral hygiene seems difficult, especially for fragile elderly individuals.[18-20] In comparison with the bar attachments, ball anchors were preferred by clinicians because they were less technique sensitive, cost-effective, easy to use and to repair.[13] Stud type attachments such as the Locator® were introduced as a concept to simplify restorative procedures in implant-supported overdentures. This system is relatively easy in fabrication and demonstrated clinically superior results when compared with ball and bar attachments relative to prosthodontic complications and hygiene.[19]

This study was performed under a controlled experimental simulation to evaluate the retentive forces of three different types of anchorage systems used for implant-supported overdentures. The experimental set-up, however, may have had a few limitations. The sample size of the specimen used was relatively small, but was in accordance with previous similar experiments.[20]

It has to be kept in mind that for the current in vitro experiment, only mono-directional forces were applied, which does not represent a realistic model for a clinical situation with overdentures. There, the main forces are generated in the region of the first molars which will lead to rotational forces on the attachments through leverage.[12-13]

During the course of the study, the different attachments showed a complex evolution with peaks as well as increasing and/or decreasing mean retentive forces. The statistical model revealed a significantly different behavior of the attachment systems.

The ball/o-ring and bar attachments developed higher retentive force as compared to the Locator® attachments. The bar and clip attachment exhibited the highest peak as well as the highest mean retention force at the end of the study [Table 1]. The Locator® attachment showed a decrease in retentive potential after an early peak.

CONCLUSION

The ball/o-ring and bar–clip attachments maintain their retentive capacity longer than the Locator® attachment. A decrease in the retention force was observed in all the three attachment systems after subjecting them to thermal cycles and this decrease was found to be statistically significant. Further research is required to understand the loss in retention force of various overdenture attachment systems.

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