

Comparative evaluation of retention of different attachment systems and techniques in implant retained overdentures: An in vitro study

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Abstract

Aim: To evaluate and compare the retention of different attachment systems and techniques which will be used in implant retained overdentures.

Materials and method: In this study edentulous mandibular models were made from heat cure acrylic resin. Mandibular overdentures were fabricated in a conventional manner using heat cure acrylic resin. The implant replicas were placed in the acrylic models using milling machine simulating the conventional placement of implant in osteotomy site in the mandible. Each attachment systems was secured into the implant replicas

on the acrylic resin model and the overdentures with the corresponding housing, was subsequently placed on it and tightened. Each of the three attachment system were grouped and each acrylic model had five fabricated overdentures. The retention force was evaluated with the help of Universal testing Machine. Each of the models was objected to 100 consecutive pulls to dislodge the overdenture from the acrylic model. The dislodging force was applied in a vertical direction with the help of universal testing machine and the values were then tabulated.

Results: Header bar and clip attachments showed highest mean retentive force (11.84 ± 0.95 N) after subjecting to hundred consecutive pulls. Two ball attachments showed the lowest mean retentive force (8.74 ± 0.98 N).

Keywords: Loss Teeth, Implant, Overdenture, Dislodging Force

Introduction

The loss of teeth leads to adverse biomechanical sequel. The placement of implants enhances the support, retention and stability. Both fixed and removable implant-supported restorations successfully addresses the problems associated with complete dentures in edentulous mandibles.^{1,2}Ideally a prosthesis that is completely supported, stabilized and retained by implants should be designed. The major limiting factor for fixed treatment is financial constraint. In such circumstances implant-supported overdenture is cost-effective treatment modality. Implant supported overdentures are the restoration of choice in complex restorative situations where facial support is needed and are relatively simple to construct, can restore both dental and alveolar tissues, are economical and are able to satisfy the esthetic demands of complex restorative situations.³The 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.⁴This compromised situation consequently results in the fabrication of unsatisfactory dentures with poor retention and stability which can further precipitate psychosocial problems.⁽⁵⁻⁸⁾

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.⁴Hence in this vitro study evaluation and comparison of ball attachments and bar attachments with implant retained overdenture was done.

Aim of the study

Aim: To evaluate and compare the retention of different attachment systems and techniques which will be used in implant retained overdentures.

Objectives

1. To evaluate the retention of two implant retained overdenture with ball attachments.
2. To evaluate the retention of four implant retained overdenture with ball attachments.
3. To evaluate the retention of implant retained overdenture with hader bar attachment.
4. To compare the retention between these attachment techniques.

Materials and methods

- Edentulous mandibular acrylic resin models made with heat polymerized polymethyl methacrylate resin (DPI HEAT CURE, DPI, MUMBAI, MAHARASHTRA, INDIA).
- Acrylic resin mandibular overdentures fabricated with heat polymerized polymethyl methacrylate resin (DPI HEAT CURE, DPI, MUMBAI, MAHARASHTRA, INDIA).
- Implant replicas (3.75mm D×11mm L ADIN DENTAL IMPLANT SYSTEMS LTD, ISRAEL). Fig 2
- Prefabricated RS Ball Attachments 1mm w/Hex (ADIN DENTAL IMPLANT SYSTEMS LTD, ISRAEL).
- Hader bar and clip attachments (CEKA PRECI-LINE: PRECI-HORIX COMBO #1741, BELGIUM).
- Milling machine (MARIOTTI, CUCCIOLO, ITALY). Fig 2

- Universal testing machine (MODEL-AMT-SC, POWEL-220V, A.S.I. SALES PRIVATE LIMITED, NEW DELHI). Fig 2

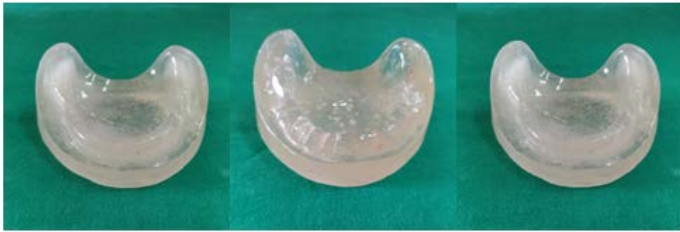


Fig 1: Heat cured clear acrylic edentulous mandibular model.



Fig 2: Placing implant replicas with the milling machine

The present study was carried out in vitro in the department of Prosthodontics and Crown & Bridge, Institute of Dental Sciences, Bareilly and Mechanical Department of G.B. Pant University of Agriculture and technology, Uttarakhand to evaluate and compare the retention of different attachment systems and techniques which will be used in implant retained overdentures.

1. Three edentulous mandibular models were made from clear heat polymerized polymethyl methacrylate resin.(DPI HEAT CURE, DPI, MUMBAI, MAHARASHTRA, INDIA) Fig:1
2. The implant replicas (3.75mm D×11mm L ADIN DENTAL IMPLANT SYSTEMS LTD, Israel) were placed in the acrylic models with the milling machine, simulating the conventional placement of implant in

osteotomy site in mandible. At first pilot drill of dimension 2mm was used and subsequently 2.3 mm, 2.8 mm,3.2 mm and 3.6 mm drills were used. Fig:2

3. In the first acrylic model two implant replicas were placed in the interforaminal region of the mandible simulating OD1 treatment option of Misch classification. In the second acrylic model two implant replicas were placed at OD2 treatment option of Misch classification (i.e two implant abutments joined by bar). In the third acrylic model four implant replicas were placed equidistant from each other between the interforaminal region.
4. Each attachment systems were secured into the implant replicas on the acrylic resin model.

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

Group I: Overdentures with two ball attachments on two implants. Fig 3

Group II: Overdentures with four ball attachments on four implants. Fig 4

Group III: Overdentures with Hader bar and clip attachment on two implants. Fig 5



Fig 3: Intaglio surface of the cured denture base of two ball attachment



Fig 4: Intaglio surface of the cured denture base for four ball attachments



Fig 5: Intaglio surface of cured denture base for hader bar attachment

Experimental Setup

Each attachment system was secured into the implant replicas on the acrylic resin model and tightened to 35 Ncm. Heat cured overdentures with respective attachment systems were placed on the acrylic edentulous mandibular models. With the UTM (MODEL-AMT-SC, POWEL-

Table 1: Mean Retentive Force (N) For Group I

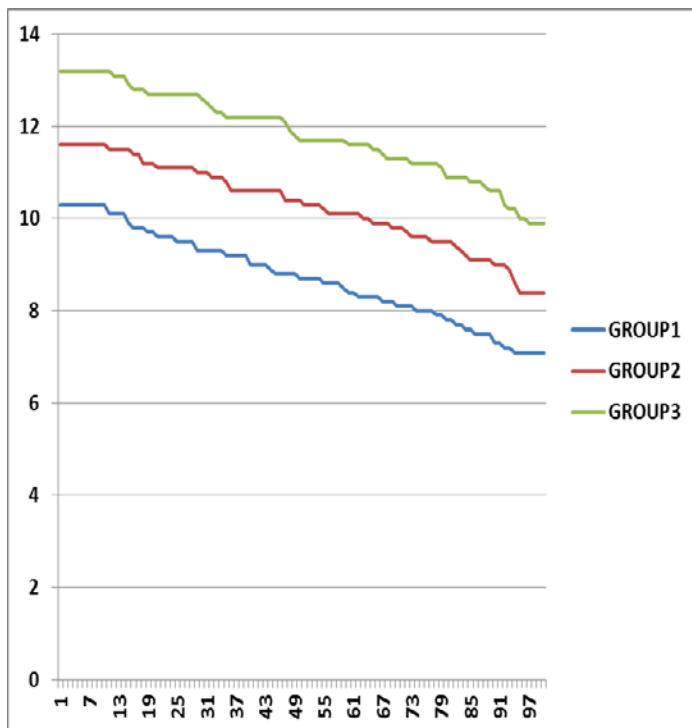
Group I	N	Minimum(N)	Maximum(N)	Mean(N)	Std. Deviation
Sample1	100	7.50	10.50	9.11	0.94
Sample2	100	7.50	10.00	8.94	0.77
Sample3	100	7.00	10.50	8.70	1.09
Sample4	100	7.00	10.00	8.41	0.97
Sample5	100	6.50	10.50	8.53	1.18

220V, A.S.I. SALES PRIVATE LIMITED, NEW DELHI) 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. The dislodging force was applied in a vertical direction holding the overdenture with the UTM (Universal Testing Machine) operating at a crosshead speed of 0.5mm/min. The datas was then subjected to statistical analysis analysis to obtain the result.

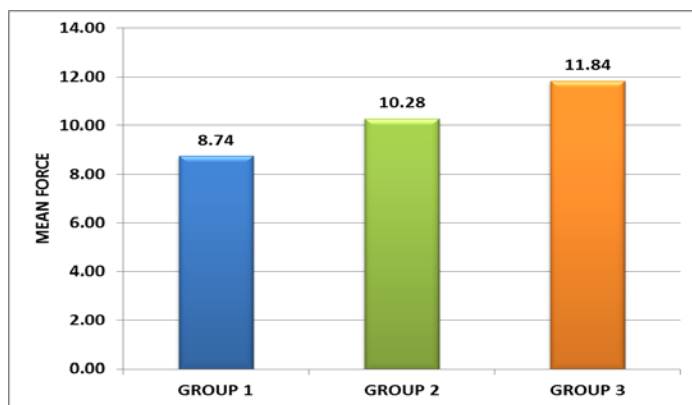
Results

Retentive force of each of the samples was tabulated 100 times and then mean value with standard deviation was determined for each of the samples. Samples of Group III- Hader bar attachment showed the highest retentive force The outcome of the results is shown by the tables cited below:

Graph 1: Retentive Force (N) In Different Groups.



Graph 2-Mean Retentive Force (N) In Different Groups.



Data Were Summarized As Mean And Standard Deviation. Groups Were Compared By One-Way Analysis Of Variance (Anova) And The Significance Of Mean Difference Between (Inter) The Groups Was Done By Test. $P < 0.05$ Was Considered Statistically Significant. Analysis Was Performed By Spss (Statistical Programming For Social Science) 23 Software (Windows Version 17.0).

Table 2: Comparison of Mean Force (N) In Different Groups By One Way Anova.

	GROUP I	GROUP II	GROUP III	F-Value	P-Value
Sample1	9.11 ± 0.94	10.11 ± 0.87	11.54 ± 1.11	155.06	< 0.001*
Sample2	8.94 ± 0.77	9.6 ± 0.97	12.16 ± 0.96	354.07	< 0.001*
Sample3	8.7 ± 1.09	10.74 ± 0.98	12.21 ± 0.89	317.76	< 0.001*
Sample4	8.41 ± 0.97	10.28 ± 0.94	11.75 ± 0.79	346.03	< 0.001*
Sample5	8.53 ± 1.18	10.7 ± 0.98	11.53 ± 1.06	206.38	< 0.001*

*. The mean difference is significant at the 0.05 level.

Comparison of mean force (Newton) between the groups was done by one way ANOVA. Mean force of Sample 1 for Group I, Group II, Group III are 9.11 ± 0.94 N, 10.11 ± 0.87 N, 11.54 ± 1.11 N respectively. Similarly for sample 2:- are 8.94 ± 0.77 N, 9.6 ± 0.97 N, 12.16 ± 0.96 N. For sample 3:- 8.7 ± 1.09 , 10.74 ± 0.98 N, 12.21

± 0.89 N. For sample 4:- 8.41 ± 0.97 N, 10.28 ± 0.94 N, 11.75 ± 0.79 N. For sample 5:- 8.53 ± 1.18 N, 10.7 ± 0.98 N, 11.53 ± 1.06 N. The highest value was obtained for all the samples of group III followed by Group II and Group I. P value is <0.001 which is statistically significant in between the groups.

Table 3: Comparison of Difference In Mean Force (N) Between Group I And Group Ii By Tukey Post Hoc.

	GROUP I	GROUP II	Mean difference	P-Value
Sample1	9.11 ± 0.94	10.11 ± 0.87	1.005 ± 0.195	< 0.001*
Sample2	8.94 ± 0.77	9.6 ± 0.97	0.655 ± 0.299	< 0.001*
Sample3	8.7 ± 1.09	10.74 ± 0.98	2.035 ± 0.343	< 0.001*
Sample4	8.41 ± 0.97	10.28 ± 0.94	1.875 ± 0.250	< 0.001*
Sample5	8.53 ± 1.18	10.7 ± 0.98	2.170 ± 0.364	< 0.001*

*. The mean difference is significant at the 0.05 level. 0.343 N, sample 4:- 1.875 ± 0.250 N sample 5:- 2.170 ± 0.364 N. Higher mean force (N)(Group II) was obtained On comparing the Samples of Group I and Group II, mean difference between the two groups of sample 1:- 1.005 ± 0.195 N, sample 2 :- 0.655 ± 0.299 N, sample 3:- 2.035 ± 0.343 N, sample 4:- 1.875 ± 0.250 N sample 5:- 2.170 ± 0.364 N. Higher mean force (N)(Group II) was obtained for each of the samples of the group. P value is <0.001 which is statistically significant.

TABLE 4: COMPARISON OF MEAN FORCE (N) DIFFERENCE BETWEEN GROUP I AND GROUP III GROUPS BY TUKEY POST HOC

	GROUP I	GROUP III	Mean difference	P-Value
Sample1	9.11 ± 0.94	11.54 ± 1.11	2.430 ± 0.318	< 0.001*
Sample2	8.94 ± 0.77	12.16 ± 0.96	3.220 ± 0.269	< 0.001*
Sample3	8.7 ± 1.09	12.21 ± 0.89	3.510 ± 0.293	< 0.001*
Sample4	8.41 ± 0.97	11.75 ± 0.79	3.345 ± 0.339	< 0.001*
Sample5	8.53 ± 1.18	11.53 ± 1.06	3.000 ± 0.275	< 0.001*

*. The mean difference is significant at the 0.05 level. 0.293 N, sample 4:- 3.345 ± 0.339 N sample 5:- 3.000 ± 0.275 N. Higher mean difference value for (Group III) Comparing the Samples of Group I and Group III, mean difference between the two groups of sample 1:- 2.430 ± 0.318 N, sample 2:- 3.220 ± 0.269 N, sample 3:- 3.510 ± 0.293 N, sample 4:- 3.345 ± 0.339 N sample 5:- 3.000 ± 0.275 N. Higher mean difference value for (Group III) was obtained for each of the samples of the group . P value is <0.001 which is statistically significant.

Table 5: Comparison of Mean Force Difference Between Group II And Group III By Tukey Post HOC

	GROUP II	GROUP III	Mean difference	P-Value
Sample1	10.11 ± 0.87	11.54 ± 1.11	1.425 ± 0.365	< 0.001*
Sample2	9.6 ± 0.97	12.16 ± 0.96	2.565 ± 0.169	< 0.001*
Sample3	10.74 ± 0.98	12.21 ± 0.89	1.475 ± 0.240	< 0.001*
Sample4	10.28 ± 0.94	11.75 ± 0.79	1.470 ± 0.308	< 0.001*
Sample5	10.7 ± 0.98	11.53 ± 1.06	0.830 ± 0.238	< 0.001*

*. The mean difference is significant at the 0.05 level. 0.238N. Higher mean difference value for (Group III) was Comparing the Samples of Group II and Group III, mean difference between the two groups of sample 1:- 1.425 ± 0.365 N, sample 2:- 2.565 ± 0.169 N, sample 3:- 1.475 ± 0.240N, sample 4:- 1.470 ± 0.308N sample 5:- 0.830 ± 0.238N. Higher mean difference value for (Group III) was obtained for each of the samples of the group. P value is <0.001 which is statistically significant.

Discussion

A retentive denture contributes dramatically to patient acceptance of the definitive prosthesis. Stud type, ball, and conventional bar attachments are the commonly used anchorage systems in implant-supported overdentures and their efficacy is scientifically supported. Splinted conventional bar attachments have demonstrated superior retentive capacities over unsplinted systems.⁹⁻¹² In this study ball and bar attachments were used to check the retention of implant supported overdenture. Ball attachments are among the simplest of all stud attachments widely used because of their low-cost, ease of handling, minimal chair side time requirements and their possible applications with both root and implant supported prostheses.¹³ It has a screw retained male abutment in the implant with a spherical shape on its occlusal portion, and a prosthetic anchored female part that can be metallic or covered with nylon having a different retention range. These attachment do not need a great prosthetic space and they allow hinge and rotation dislodgements.¹⁴ Bar attachment constitute an excellent anchorage system that provides greater retention, enabling better force balance by its splinting effect and can also correct severe unparallelism. The retention elements or clips are interchangeable and can be reactivated. The main disadvantages of bar attachments are the need for a large prosthetic space and the risk of mucositis due to an inadequate oral hygiene under the bar.¹⁵ There are different bar designs as Ackermann Bar (spherical shape), Dolder Bar (ovoid or U shape) and Hader Bar (Keyhole shape). Here, in this study Hader Bar with two clip attachments system was used. Hader bar is classified as hinge resilient attachment and it provides mechanical snap retention. The length of the bar used was 22 mm to accommodate two clips. On statistical evaluation of the data tabulated, different attachments showed a complex evolution with

peaks as well as increasing and/or decreasing mean retentive forces. The Hader bar and clip attachment exhibited the highest peak as well as the highest mean retentive force at the end of the study. This in vitro study investigated only the retention value of overdenture attachments. In this present study only mono-directional forces were applied, which does not represent a realistic model for a clinical situation with overdentures.

Conclusion

Using complete dentures is a challenge because of decrease of force and muscle coordination and difficulty in achieving an acceptable level of prosthesis retention and stability due to bone resorption. Initially, treatment with endosseous implants consisted of the placement of four to six implants in combination with a fixed prosthesis. It proved quite successful. Implant overdenture treatment was adopted later, and long-term clinical results were shown to be excellent as well.

There is no evidence for one outstanding attachment system. The choice of systems should be orientated on the individual clinical situation and the individual needs of the patients. The attachment retained implant supported overdenture solves the problems inherited with conventional denture. In the present study, the retention of two ball attachment, four ball attachment and bar and clip attachment system was evaluated.

Within the constraint of this in vitro study, following conclusions have been drawn:

- Hader bar and clip attachments showed highest mean retentive force (11.84 ± 0.95 N) after subjecting to hundred consecutive pulls.
- Both bar-clip and four ball attachments maintain their retentive capacity longer than the two ball attachments.
- Two ball attachments showed the lowest mean retentive force (8.74 ± 0.98 N).

- An overall decrease was observed in all the three attachment systems after subjecting them to 100 consecutive pulls and this decrease was found to be statistically significant.
- Hence it can be concluded that implant supported overdenture is cost effective in comparison to implant fixed prosthesis. It also provides an exceptional stability and excellent retention.

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