Medical and Research Publications
International Open Access

Research Article **Journal of MAR Dental Sciences (Volume 3 Issue 5)**

Comparative Evaluation Of Retention In Implant Supported Mandibular Overdentures Using "O" Ring And Locator Attachment: An Invivo Study

Dr. Rinu Thomas, Dr. Malathi Dayalan, Dr. Srinu G., Dr. Ravikumar Nagabhairava

Corresponding Author: Dr. Rinu Thomas.

Received Date: October 08, 2021

Published date: November 01, 2021

Abstract

Purpose of the study: *The purpose of this study is to compare the retention in mandibular implant supported overdenture using "O" ring and Locator attachment system.*

Materials and Methodology: *Sixty completely edentulous patients were selected based on inclusion and exclusion criteria and were divided into three groups. Group I/Control group: conventional maxillary and mandibular denture, Group II/ "O" ring group implant supported overdenture in mandibular arch with "O" ring attachment and conventional maxillary denture and Group III/Locator group: Implant supported overdenture in mandibular arch with Locator attachment and conventional maxillary denture. All the sixty patients were divided into three groups based on interarch space. Patients with an interarch distance of > 20mm were selected for O ring attachments and patients with an interarch distance of > 6mm < 20mm were selected for locator attachments. CBCT scan was done for mandibular jaw rehabilitated with complete denture which was incorporated with gutta purcha in canine region.*

The surgical procedure was carried out and two implants were placed in the canine region. After three months of healing period the cover screw was replaced with healing cap. The healing cap was removed, cuff height was selected and the suitable "O" ring and Locator abutment and attachment were selected. Individual abutment Pickup was inserted over the implants. Border moulding was done to obtain the functional depth of the sulcus and final impression was recorded using elastomeric impression material using closed tray impression technique. The overdenture attachment analogs were placed into the pickup and the impression was poured with type IV dental stone. Conventional maxillary denture and implant supported mandibular overdentures were fabricated according to standard prosthetic scheme. According to standardised protocol O ring and locator attachments were fitted in the mandibular denture by indirect technique (laboratory processing).

***Results**: The statistical analysis revealed significant difference (p<0.01) in retention within the three groups (conventional denture and implant supported overdenture). The retention offered by Locator group was superior to "O" ring and conventional mandibular denture.*

***Conclusion**: Within the limitations of this invivo study it was concluded that retention of mandibular overdenture using Locator group was much superior than "O" ring group and control group.*

***KeyWords**: Interarch space, CBCT, closed impression tray technique, polyvinylsiloxane impression material*

Introduction

Edentulism is defined as the loss of all natural teeth and is an important public health issue globally for its high prevalence and associated disability. Although it is not fatal, edentulism directly affects facial appearance, nutrition, and the ability to eat, speak, and socialize. (1- 4) Meticulous diagnosis and treatment planning are critically important in obtaining a predictable outcome. (5)

Residual ridge resorption is a multifactorial disease. Ridge atrophy is most dramatic during the first year after tooth loss followed by a slower but more progressive rate of resorption. The anterior mandible resorbs 4 times faster than the anterior maxilla. Wolff's law states that bone remodels in relationship to the force applied. A removable complete denture does not stimulate and maintain bone; rather it accelerates bone loss. The load from mastication is transferred to the bone surface only, not the whole bone. As a result, blood supply is reduced and total bone volume loss occurs. (6,7)

Rehabilitating edentulism with an implant is a well-documented procedure and an early placed implant can even slow down the inevitable residual ridge resorption **(**RRR**)**. **(**5**)**

Over the past two decades, numerous studies have demonstrated that the mandibular two- implant overdenture is a simple and an effective option. This has led to a shift in therapeutic philosophy and eventually to the development of the McGill consensus statement on Overdentures. The consensus suggested that "the mandibular two-implant overdenture was the first-choice minimal treatment objective for edentulous patients". **(**8**)**

An implant-supported overdenture **(**ISO**)** is a removable complete denture combined with implants designed to improve stability in the oral environment. Implant-supported overdenture are indicated in patients who cannot afford a fixed implant-supported overdenture or who have phonetic-aesthetic problems as loss of lip support, long clinical crowns, or wide interproximal spaces.9 The two-implant supported overdenture is not the gold standard of implant therapy it is the minimum standard that should be sufficient for most people, taking into account performance, patient satisfaction, cost and clinical time.**(**10,11**)**Implant-supported overdentures result in patients being able to masticate harder food with an increase in their maximum bite forces and no pain compared to conventional dentures. **(**10,11**)**

Retention is the foremost factor that gives fulfilment of successful treatment to the patient. Many physical forces and factors have been credited with in enhancing retention e.g. atmospheric pressure, vacuum, adhesion, cohesion, wettability, surface roughness, gravity, surface tension, viscosity, base adaptation, border seal and muscular control.5

Thus it can be quantified with a force gauge which is a measuring instrument used to measure force during a push or pull test. In a clinical set up a handheld gauge "digital force gauge" is selected as an instrument of choice. **(**10**)**

Various types of attachment systems are currently available to restore implant-supported overdenture **(**IOD**)**. These implant-supported overdenture attachment systems are selected based on factors such as durability, patient demand, cost effectiveness, technical simplicity, and retention. Hence while selecting an attachment system, factors such as the location and form of the arch, height and location of implant has to be weighed equally. Basically a splinted or nonsplinted two implant supported overdenture can be used if good or excellent anatomical conditions with an inverted "U" shape alveolar ridge exists or ridge without severe resorption, with good support and lateral stability and when patient has basic demands. **(**12**)**

According to Al-Ghafli et al. implant angulation affects negatively the attachment retention longevity.13 "O" ring and locator are two attachment systems which can be placed parallel without occupying much prosthetic space. Both have a male metallic abutment and a female nylon part **(**can also be metallic in case of "O" ring**)**. It is the simplicity in design and easy replaceability that make them stand apart from other attachment system for implant supported overdenture. **(**12,13**)**

In the past several authors have studied different attachments but clinical studies comparing retention of "O" ring and locator attachments are sparse. Defining an acceptable level of retention for a retention system stays elusive and producers supply limited information concerning retention system power and wearing in time.

Hence the aim of this article was to compare retention of "O" ring and Locator attachment system in mandibular implant supported overdenture.

Materials and Methods

SELECTION OF PATIENTS

The present in vivo study was carried out in the Department of prosthodontics, The oxford dental college and hospital, Bangalore. Patients with completely edentulous maxilla and mandible were selected for the study. Cone Beam Computed Tomography **(**CBCT**)** of the maxilla and mandible were taken at the Magnus diagnostics, Bangalore. The retention of the attachments was analysed in the department of prosthodontics using a Digital force gauge **(**LUTRON**)**.

All the patients were selected on the basis of the following inclusion and exclusion criteria14:

Inclusion criteria

- Conventional denture in the maxillary arch
- Medically and psychologically suitable for implant surgery

Exclusion criteria

- Insufficient alveolar bone height for implants **(**<12 mm**)**
- History of head and neck radiation
- Systemic and neurologic disease including:

  - Type 1 diabetes, pituitary and adrenal insufficiency and untreated hypothyroidism
  - Risks associated with bacteraemia **(**e.g. immune compromise, steroids, prosthetic heart valve**)**
  - Bone disease **(**e.g. paget's disease, fibrous dysplasia, histiocytosis**)**
  - History of congenital or acquired uncontrolled bleeding

- Chronic granulomatous disease **(**tuberculosis**)**
- Previous oral implant treatment
- Need for additional preprosthetic surgery
- Medically/psychologically unsuitable for surgery
- History of tobacco smoking

Sixty patients with completely edentulous maxilla and mandible were enrolled in the study. Approval from the ethical committee was obtained. Patients who were convinced with proposed treatment procedure were selected in the study. A written informed consent was obtained from all the patients prior to the treatment. All the sixty patients were examined by a prosthodontist and patients were divided into three groups namely group 1, group 2 and group 3:

• Patients with an interarch distance of > 20mm were selected for "O" ring attachments.
• Patients with an interarch distance of > 6mm < 20mm were selected for Locator attachments.

- Group 1. Twenty patients with conventional maxillary and mandibular denture
- Group 2. Twenty patients with maxillary conventional denture and implant supported mandibular overdenture with "O" ring attachments
- Group 3. Twenty patients with maxillary conventional denture and implant supported overdenture with locator attachments

Surgical procedure

1. A conventional complete denture was fabricated for maxillary and mandibular arch and gutta purcha points were incorporated in the canine positions of the mandibular denture. Cone beam computed tomography **(**CBCT**)** scan of mandibular conventional complete denture was taken to provide information about the bone quantity in the canine region of the mandible for the placement of two implants.

2. Routine blood examination was done for all the 40 patients who underwent implant placement. Antibiotic prophylaxis was given 24 hours prior to implant placement. Local anesthesia **(**Lox 2% adrenaline 1: 200000**)** was injected using 23gauge needle with inferior alveolar nerve block. The fabricated denture was used as a stent and the canine region was marked. Once the surgical area was anesthetized a crestal incision was placed followed by which a mucoperiosteal flap was reflected. The implants were placed at the location of the former cuspids, according to a standardised surgical protocol.
- After a healing period of 3 to 4 months the implants were exposed, and two healing collars were replaced with overdenture attachments.

Prosthetic procedure

1. Prosthetic procedure was started two weeks after second stage surgery. Stock tray was used to make preliminary impression for maxillary and mandibular arch with an irreversible hydrocolloid impression material **(**Algitex, Dental products of India**)**.

2. An appropriate spacer was fabricated using modelling wax **(**Modelling wax no 2 Hindustan dental production**)**, leaving 4 mm space in the canine region of mandibular arch for abutment pick up **(**"O" ring-ADIN, Mil medical Pvt. Ltd, and Locator-Lifecare devices Pvt Ltd**)** and custom tray was fabricated with autopolymerising acrylic tray material **(**Acrylic resin try material, M P Sai enterprise**)** for both the arches. The maxillary custom tray was checked and was made 2mm short from sulcus uniformly and the secondary impression was made according to standardised procedure.
For the mandibular arch space was created in the canine region and the abutment pick up and custom tray was checked together in patients mouth for fit.

3. Border moulding was done to obtain the functional depth of the sulcus and final impression was recorded using polyvinylsiloxane impression material **(**Dentsply, Reprosil**)** along with abutment pick up. Upon removal, the abutment replica was placed into the abutment pick up, the gingival mask was attached to the abutment analog **(**"O" ring-ADIN, Mil medical Pvt. Ltd, and Locator-Lifecare devices Pvt Ltd**)** and was blocked with 2mm wax to prevent the self-cure resin from penetrating inside the analog. The occlusal rims were formed according to the standardized measurement. After the fabrication of occlusion rims the ala-tragus line was marked and tentative jaw relation and facebow record was obtained. The maxillo-mandibular relation was mounted on Hanau articulator and teeth arrangement was done. Try in was done. After the teeth arrangement was verified the wax up of the denture was done and flasking was done using dental plaster **(**plaster of paris powder I.P., Ramaraju surgical cotton mill**)** and dental stone **(**Hindustan dental products**)**. The flask was placed in the dewaxing unit and dewaxing was done. The laboratory processing cap was attached over the abutment replica and heat cure resin **(**Coltene whaldent**)** was adapted over the mould. The flask was kept under pressure in the hydraulic press for 45 min after which it was kept in the acrylizer and acrylization was done using the with short curing cycles. The finishing and polishing of the dentures was completed. The conventional maxillary and implant supported denture were inserted followed by post insertion check-up after 24 hours.

Measurement of retention with digital force gauge (15)

All the patients were seated on the dental chair in an upright position with the head resting on the head rest and the occlusal plane parallel to the floor. Digital force gauge was used to evaluate and compare retention of the mandibular conventional denture and implant supported denture at the end of the first and third month. The mandibular denture was positioned correctly on the tissues and patient was asked to rest his tongue passively in the floor of the mouth with its tip adjacent to the anterior denture teeth.

A wire loop **(**0.9mm in diameter**)** was placed on the geometrical centre of the polished lingual surface to which the pull end of the force meter **(**graduated to 5000gm**)** was attached. A vertical upward force was applied to dislodge the denture with occlusal plane parallel to the floor and the digital force measurement gauge **(**LUTRON**)** held in the palm of the hand. This force was measured in Newton and was recorded as the denture's retention. Readings were recorded and data was tabulated to evaluate and compare retention of the O ring and locator attachments.

Statistical Analysis

The data collected were entered in excel sheet and analysed using IBM SPSS Statistics, Version 22**(**Armonk, NY: IBM Corp**)**. Descriptive data were presented in the form of mean and standard deviation. The retentive values of conventional mandibular denture, implant supported mandibular overdenture with "O" ring and implant supported mandibular overdenture with Locator attachments were compared using ANOVA followed by Post hoc Tuckey test. P value < 0.05 will be considered as statistically significant.

Results

The study compared the retention in mandibular implant supported overdenture using "O" ring and Locator attachment system with conventional denture as control group. There was statistically insignificant difference for "O" ring and Locator attachment at baseline and after 3 months, substantiating that the "O" ring and

Locator attachments were highly retentive and effective irrespective of the time interval **(**Table1, Figure 1 a, b, c**)**. There was statistically significant difference observed between Group 1, Group 2 and Group 3 at baseline as compared to the retention values obtained after 3 months **(**Table 2, Table 3, Figure 2, Figure 3**)**

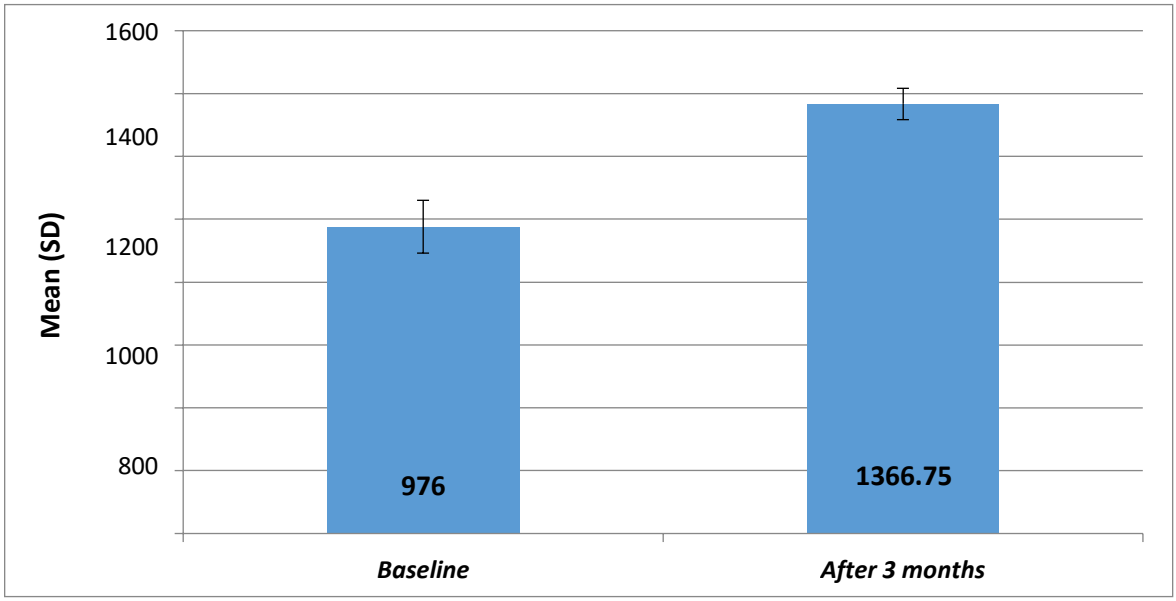
SL.NO.	Group 1 (control group(gm))		Group 2 (O ring (gm))		Group 3 (Locator (gm))	
	Baseline	After 3months	Baseline	After 3months	Baseline	After 3months
1.	932	1332	2760	2760	5000	5000
2.	831	1316	2890	2890	4180	4180
3.	996	1322	2760	2760	4328	4328
4.	1101	1401	2280	2280	4950	4950
5.	998	1317	2290	2290	4960	4960
6.	974	1309	2360	2360	4160	4160

7.	956	1332	3180	3180	4570	4570
8.	968	1345	3290	3290	4360	4360
9.	899	1386	2890	2890	4620	4620
10.	994	1345	2170	2170	5000	5000
11.	1093	1455	2110	2110	4780	4780
12.	1045	1460	2130	2130	4550	4550
13.	1070	1473	2775	2777	4320	4320
14.	1112	1347	2818	2820	5000	5000
15.	970	1353	2190	2190	5000	5000
16.	984	1368	2680	2680	4210	4210
17.	885	1318	2750	2750	4439	4439
18.	906	1378	2970	2970	4330	4330
19.	809	1385	2930	2930	4636	4636
20.	997	1393	2970	2070	4900	4900

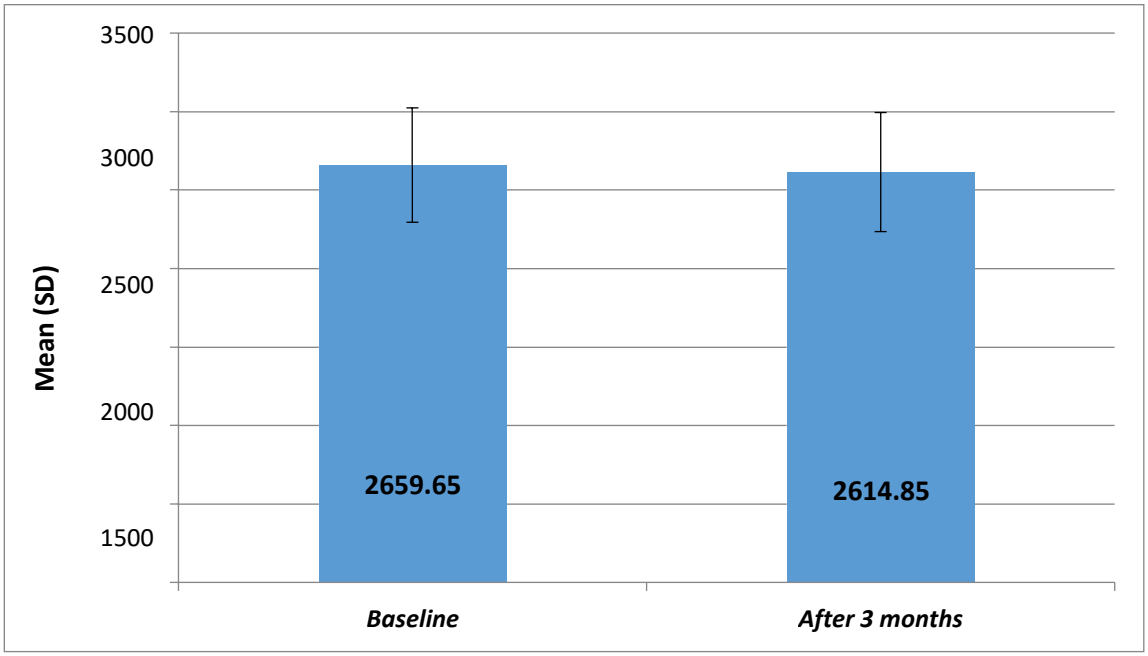
Table 1: Retentive values of conventional mandibular denture, implant supported mandibular overdenture with "O" ring and implant supported mandibular overdenture with Locator attachments.

Figure 1: Comparison of the retention values in terms of {Mean **(**SD**)**} at different time intervals in all the 3 groups using paired t test

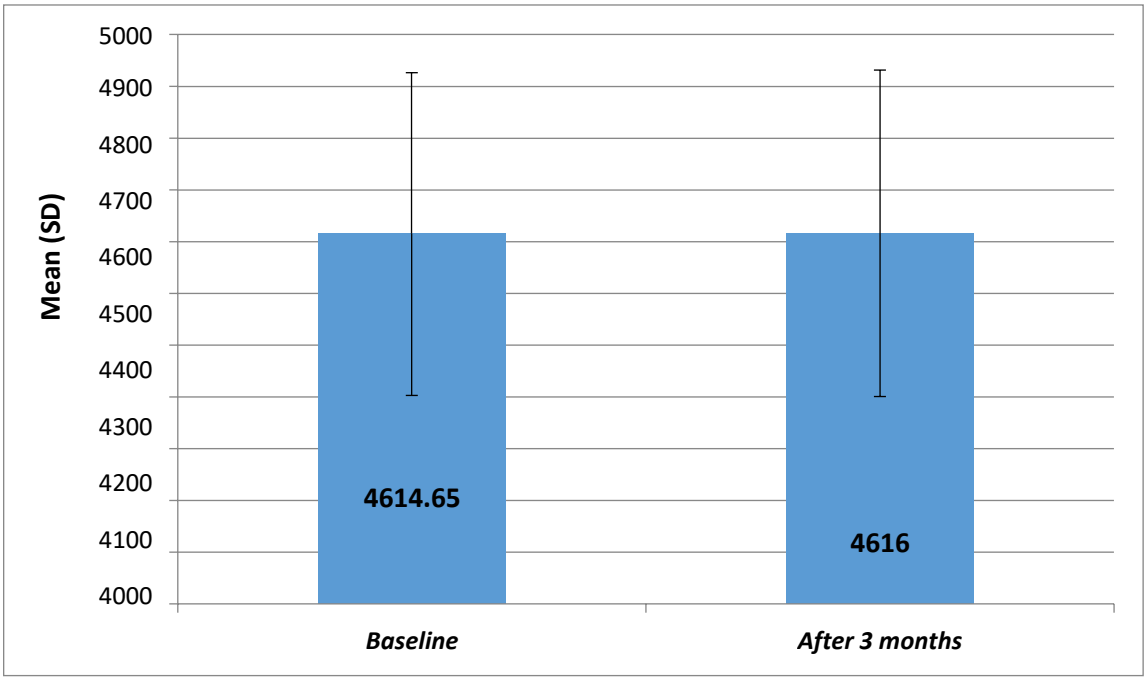
a. Control



b. O Ring



c. Locator



GROUP I: Conventional Complete Maxillary and Mandibular Denture

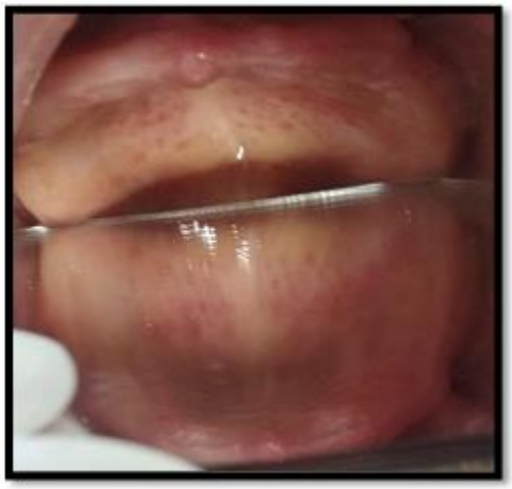


Figure 1: Maxillary arch

Figure 2: Mandibular arch

Figure 3: Maxillary primary impression

Figure 4: Mandibular primary impression

Figure 5: Maxillary primary cast

Figure 6: Mandibular primary cast

Figure 7: Maxillary secondary impression

Figure 8: Mandibular secondary impression

Figure 9: Jaw relation

Figure 10: Teeth arrangement

Figure 11: Insertion in patient's mouth

Figure 12: Measurement of retention with digital force gauge

GROUP II: Conventional Maxillary Denture and Implant Supported Mandibular Overdenture with O Ring

Figure 13: Maxillary primary impression

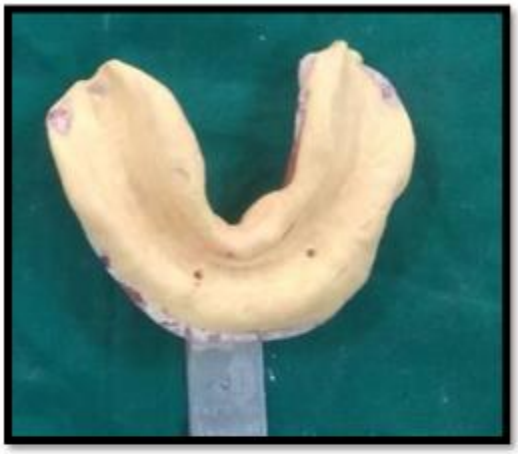


Figure 14: Mandibular primary impression

Figure 15: Maxillary primary cast

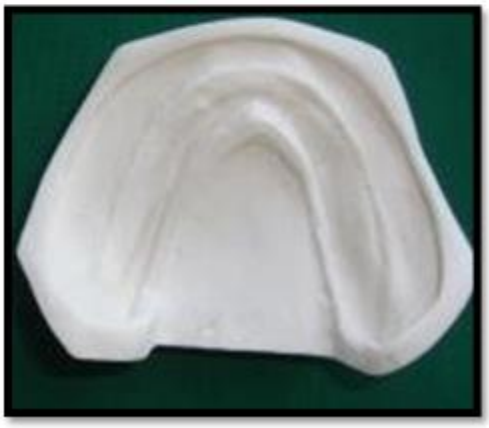


Figure 16: Mandibular primary cast

Figure 17: "O" ring abutment and attachments

Figure 18: "O" ring abutment in patient's mouth

Figure 19: Mandibular secondary impression

Figure 20: Maxillary secondary impression with O ring pick up

Figure 21: Mandibular secondary Cast with analog

Figure 22: Maxillary secondary cast

Figure 23: Jaw relation

figure 24: Try in

Figure 25: Final insertion

Figure 26: Measuring of retentionwith digital force gauge

Group III: Conventional Maxillary Denture and Implant Supported Mandibular Overdenture with Locator Attachment.

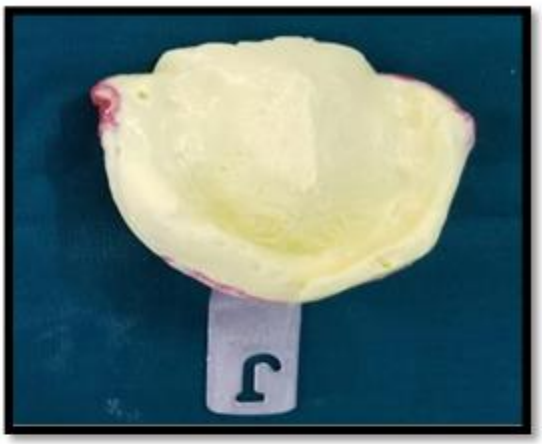


Figure 27: Maxillary primary impression

Figure 28: Mandibular primary impression

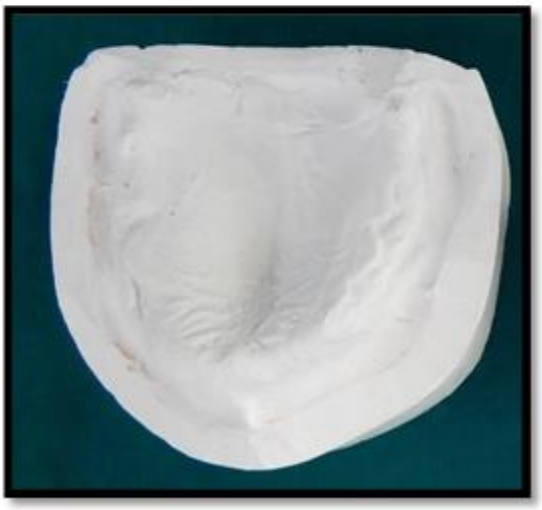


Figure 29: Maxillary primary cast

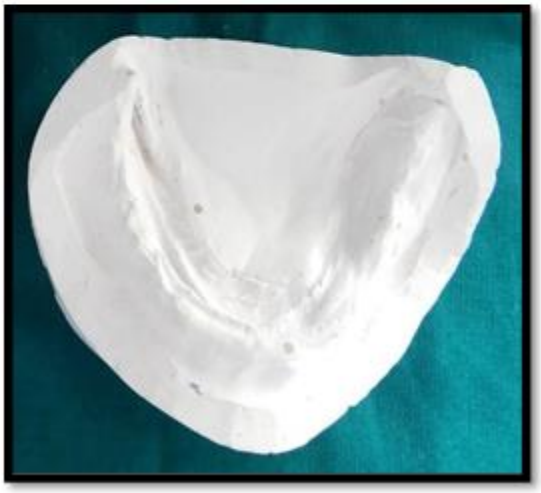


Figure 30: Mandibular primary cast

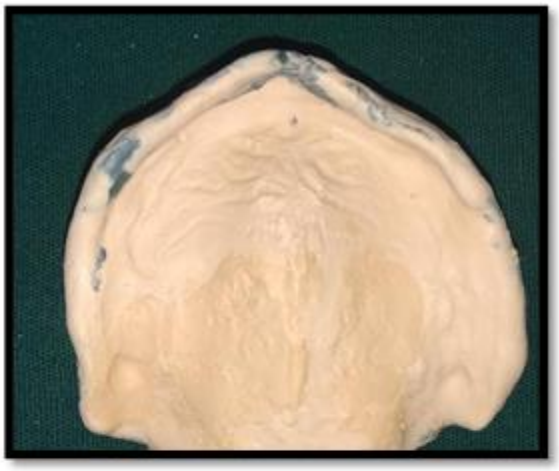


Figure 31: Maxillary secondary impression

Figure 32: Mandibular secondary impression with Locator analog

Figure 33: Master cast

Figure 34: Master cast with Implant analog

Locator abutment pick up

Figure 35: Jaw relation

Figure 36: Teeth arrangement

Figure 37: Measuring the retention with digital force gauge

Figure 38: Materials used

Figure 39: Green stick compound

Figure 40: Light body poly vinyl siloxane

Figure 41: Zinc oxide eugenol catalyst and paste

Figure 42: Armamentarium used

Figure 43: Digital force gauge with attachments

Groups	*N*	*Mean*	*Std. Deviation*	*F value*	*P value*
Control	20	976.00	83.849	**840.003**	**<0.001****
O ring	20	2659.65	364.229		
Locator	20	4614.65	311.719		
Total	60	2750.10	1524.620		

Table 2: Comparison of the retention values at baseline in terms of {Mean **(**SD**)**} in all the 3 groups using ANOVA test

(Tukey's post hoc analysis)

Comparison	P values
Control vs O ring	**<0.001****
Control vs Locator	**<0.001****
O ring vs Locator	**<0.001****

Groups		*N*	*Mean*	*Std. Deviation*	*t value*	*P value*
Control	***Baseline***	20	976.00	83.849	**23.012**	**<0.001****
	After 3 months	20	1366.75	49.827		
O ring	***Baseline***	20	2659.65	364.229	0.995	0.332
	After 3 months	20	2614.85	379.260		
Locator	***Baseline***	20	4614.65	311.719	0.528	0.604
	After 3 months	20	4616.00	315.284		

Table 3: Comparison of the retention values in terms of {Mean **(**SD**)**} at different time intervals in all the 3 groups using paired t test

Figure 2: Comparison of the retention values at baseline in terms of {Mean **(**SD**)**} in all the 3 groups using ANOVA test

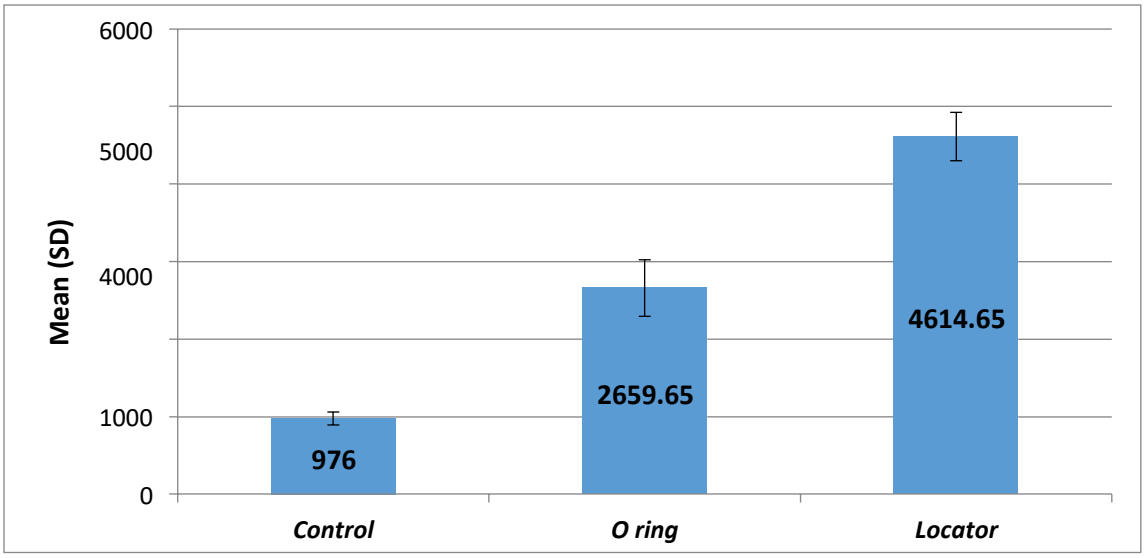


Figure 3: Comparison of the retention values after 3 months in terms of {Mean **(**SD**)**} in all the 3 groups using ANOVA test

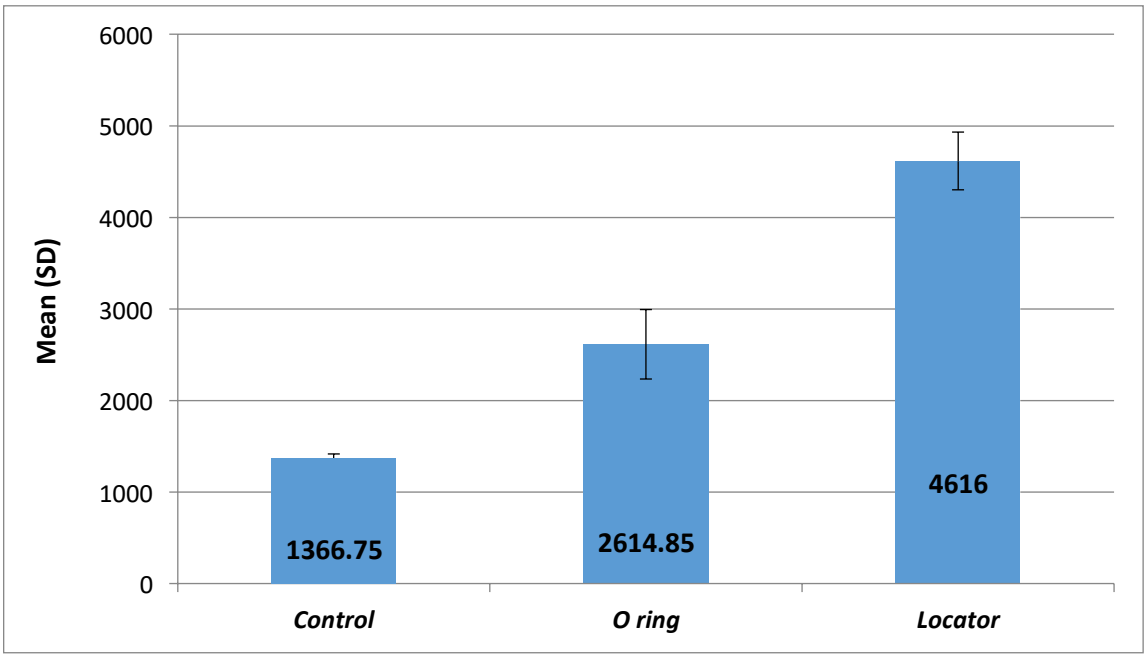
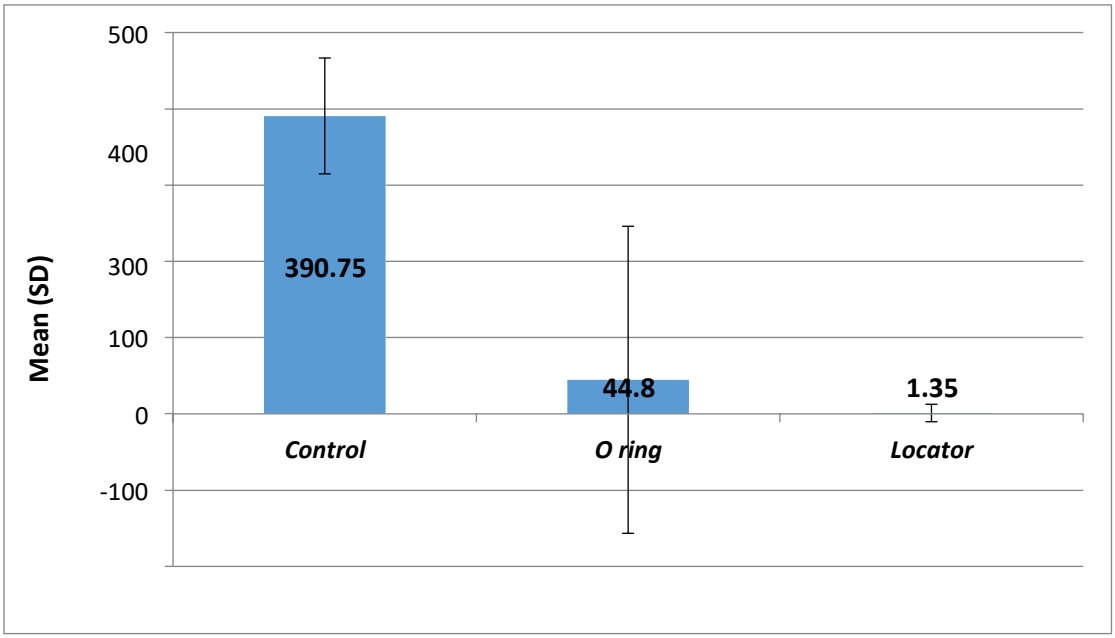


Figure 4: Comparison of the mean difference of retention values **(**Baseline - after 3 months**)** in terms of {Mean **(**SD**)**} in all the 3 groups using Kruskal Wallis test



Discussion

Residual ridge resorption is a multifactorial disease and is an inevitable process. Although implant prosthesis has provided with increased retention, patient satisfaction and reduced the residual ridge resorption, there are many attachments available in the market which can be incorporated in implant supported overdenture, the choice of selection depends upon various factors such as type of retention required, amount of interarch space available, type of arch and angulation of implants.

In case of a two-implant supported overdenture, it not only maintains the bone in the anterior region but also aids in retention when an overdenture attachment is used over it. An implant-supported overdenture limits lateral movements and consequently minimizes soft tissue trauma. During mandibular movement it remains in place, which allows the tongue and perioral musculature to resume a more normal function since they are not required to control mandibular denture movement. **(**16,17**)**

An implant supporting a prosthetic restoration is loaded by axial and horizontal forces. It has been long documented in literature that implants handle loads along the long axis very well on long term but, lateral loads are not well managed and can lead to bone loss, mobility and eventual loss of the implant. 18 One of the factors which influence the amount of load transferred to the implant is the choice of

attachment used for connection to the denture. All the connection approaches distribute occlusal forces through the overdenture to the implants and the posterior edentulous ridges. **(**18**)**

The stabilization of the lower denture with two interforaminal implants has provided reliable and predictable treatment outcomes. It is regarded as the minimum standard of care for edentulous patients. When two implant supported overdenture treatment is considered, although it halts the process of resorption, posterior bone loss can be an issue, which requires relining procedure of the lower denture and also patient's hygiene and follow-up visits plays pivotal role in the long-term success of the prosthesis. **(**19,20**)**

Schwartz-Arad et. al found that 70 percent of their patients with implant-supported overdentures lost less than 0.2mm bone in the first year.21Misch found that only 0.6mm of bone will typically be lost over a five-year period and long-term resorption may remain as low as 0.1mm per year in patients with overdentures supported by multiple implants. **(**21**)**

The success of implant-retained overdentures primarily depends on the retentive capacity of its attachment element to sustain its long-term functionality. A change in the 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. **(**22,23**)**

The present study compared the retention in mandibular implant supported overdenture using "O" ring and Locator attachment system.

In the present study a metal "O" ring abutment attached to the implant and a cap incorporated in the fitting surface of the prosthesis that connects to the "O" ring abutment was used. The study compared retention in mandibular implant supported overdenture using "O" ring and Locator attachment system. Patients who had only completely edentulous maxillary arch opposing edentulous mandibular arch were designated to standardize the amount of force on mandibular implant supported overdenture.

The superior effect of an implant supported overdenture over conventional denture were explained to the patient and only those patients who were motivated enough for the treatment were selected for the study.

The highest retentive value for Group 1 at baseline was 1112 N and after 3 months it was 1393 N **(**Table 1**)**. The lowest retentive value at baseline was 831 N and after 3 months it was 1316 N **(**Table 1**)**. The mean retentive value at baseline was 976 N and after 3 months it was 1366.75 N **(**Table 2 and Table 3**)**.

However, the highest retentive value obtained for Group 2 at baseline and after 3months was 3290 N and lowest value obtained at baseline and after 3 months was 2110 N **(**Table 1**)**. The mean retentive value at baseline was 2659.65 N and 2614.85 N after 3 months **(**Table 3, figure 1**(**b**))**. There was statistically insignificant difference for "O" ring attachment at baseline and after 3 months, substantiating that the "O" ring attachments were highly retentive and effective irrespective of the time interval.

The highest retentive value for Group 3 at baseline and after 3 months was 5000 N. The lowest retentive value at baseline and after 3 months was 4160 N **(**Table 2**)**. The mean retentive value at baseline was 4614.65 N and 4616 N after 3 months **(**Table 5, Table 6 and figure 1**(**c**))**. There was statistically insignificant difference for Locator attachment at baseline and after 3 months, substantiating that Locator attachments were highly retentive and effective irrespective of the time interval.

There was statistically significant difference observed between Group 1, Group 2 and Group 3 at baseline as compared to the retention values obtained after 3 months **(**Table 1, Figure 1, 1, 3**)**. Group 2 showed significantly superior results than Group 1 at baseline and after 3 months **(**Table 2 and Table 3**)**. Statistically significant difference was found between Group 3 and Group 1**(**Table 2, Table 3 and Figure 4**)**. This was because in Group 1, there was increased salivary secretion immediately after denture insertion and lack of patient's knowledge to utilize tongue to stabilize the denture. While after 3 months the retention values for Group 1 improved as excess salivary secretion reduced and patient learned to place his tongue without disturbing the conventional denture.

However, the time period of 3 months was comparatively less but this standardized the evaluating criteria for all the patients.

For Group 2 and Group 3, at baseline level and after 3 months the retention values were unchanged **(**Table 3 and Figure 4**)**. This was because an implant supported overdenture acquires most of its stability from attachment so anatomical limitations doesn't much play a role in the retention of the denture and hence the retention values were same for baseline and after 3 months.

When the retentive values of Group 2 were compared with Group3, statistically significant difference was observed for both at baseline and after 3 months because "O" ring attachment tends to wear more than Locator attachment as the later has dual retention with combined inside and outside retentive features.

Hence the null hypothesis was rejected since statistically significant difference was observed between "O" ring attachment and Locator attachment. The results of the present study interpreted that the retention obtained from locator attachment is superior to "O" ring attachment which is superior to conventional complete denture.

Conclusion

Within the limitations of this in vivo study, the following conclusions were drawn:

1. Mandibular implant supported overdenture gives superior retention as compared to conventional complete denture.
2. Based on results obtained, overdenture with Locator attachment gave higher retention values than overdenture with "O" ring attachment and conventional complete denture.
3. Locator attachments are clinically much efficient than "O" ring attachments.

References

1. Ueda T, Kremer U, Katsoulis J. Long-term results of mandibular implants supporting an overdenture: implant survival, failures, and crestal bone level changes. Int J Oral Maxillofac Implants 2011;26:365-72.

2. Misch C.E. Contemporary implant dentistry. 3rd ed. St. Louis: Elsevier; 2008

3. Juan-F et. al. Rehabilitation with implant-supported overdentures in total edentulous patients: a review. J Clin Exp Dent 2013;5**(**5**)**:267-72.

4. Nordenram G. et al. Qualitative studies of patients' perceptions of loss of teeth, the edentulous state and prosthetic rehabilitation: a systematic review with meta- synthesis. Acta odontologica Scandinavica.2013;71:937–95.

5. Wicks R A. A systemic approach to treatment planning for osseointegrated implants prostheses. J Prosthodont 1994;3:237-242.

6. Samyukta et al. Residual Ridge Resorption in Complete Denture Wearers. J Pharm. Sci Res 2016;8**(**6**)**:565-569.

7. Atwood D.A. Reduction of residual ridges: A major oral disease entity. J Prosthet Dent 1971;26:266-279.

8. J.M. Thomason, S.A.M. Kelly, A. Bendkowski J. Two implant retained overdentures– –A review of the literature supporting the McGill and York consensus statements. Journal of dentistry 2012; 40:22 – 34.

9. Carpentieri J, Tarnow D. The Mandibular Two-Implant Overdenture: First Choice Standard of Care for the Edentulous Denture Patient. Pract Proceed Asethet Dent 2003 Nov-Dec;15**(**10**)**:750-2.

10. Schmitt A, Zarb G. The notion of implant-supported overdentures. J Prosthet Dent 1998;79:60-65.

11. Feine JS, Carlsson GE, Awad, MA. The McGill consensus statement on overdentures. Int J Oral Maxillofac Implants 2002;17:601-602.

12. Awad MA, Lund JP, Dufresne E. Comparing the efficacy of mandibular implant- retained overdentures and conventional dentures among middle-aged edentulous patients: Satisfaction and functional assessment. Int J Prosthodont 2003;16:117-122.

13. Al-Ghafli SA, Michalakis KX, Hirayama H. The in vitro effect of different implant angulations and cyclic dislodgement on the retentive properties of an overdenture attachment system. J Prosthet Dent 2009;102:140-7.

14. Walton et al. A randomized clinical trial comparing patient satisfaction and prosthetic outcomes with mandibular overdentures retained by one or two implants. Int J Prosthodont 2009;22:331-9.

15. Yadav B, Jayana M, Yadav H. Comparison of different final impression techniques for management of resorbed mandibular ridge: a case report. Case Reports in Dent 2014 Aug;96**(**1**)**:1-6.

16. Yamada et al, Implant-Supported Overdentures. The Standard of Care for Edentulous Patients. Periodont Letter 2016:15:125-32.

17. Thompson GW, Kreisel PS. The impact of the demographics of aging and the edentulous condition on Dental care services. J Prosthet Dent 1998;79:56-9.

18. Heckmann SM, Winter W, Meyer M. Overdenture attachment selection and the loading of implant and denture-bearing area. Part 2: A methodical study using five types of attachment. Clin Oral Implants Res 2001Dec;12**(**6**)**:640-647.

19. Jemt T, Carlsson L, Boss A. In vivo load measurements on osseointegrated implants supporting fixed or removable prostheses: a comparative pilot study. Int J Oral Maxillofac Implants 1991Dec;6**(**4**)**:413-417.

20. Petropoulos VC, Smith W, Kousvelari E: Comparison of retention and release periods for implant overdenture attachments. Int J Oral Maxillofac Implant 1997;12:176-185.

21. Satpathy S, Babu S, Shetty S. Stress distribution patterns of implant supported overdentures-analog

versus finite element analysis: A comparative in-vitro study. J of Ind Prosthodont Soc. 2015 Jul-Sep:15**(**3**)** 30-35.

22. Petropoulos VC, Smith W, Kousvelari E: Comparison of retention and release periods for implant overdenture attachments. Int J Oral Maxillofac Implant 1997;12:176-185.

23. Burns DR, Ward JE: Review of attachments for removable partial denture design: 1. Classification and selection. Int J Prosthodont 1990;88**(**3**)**: 98-102.