Future Dental Journal

Volume 7 | Issue 2 Article 9

2021

Retention Loss of Locator Attachment System Different Retention Caps for Two Implant Retained Mandibular Overdenture.

Medhat Sameh Abdelaziz
teaching assistant of prosthodontics, faculty of oral and dental medicine-Future university in Egypt, 20184574@fue.edu.eg

Aya Fawzy
Lecturer of removable prosthodontics. Furture university in Egypt, A.mohamed@fue.edu.eg

Rami Maher Ghali
professor, Prosthodontics Department, Ain Shams University, Cairo, Egypt, Rami.maher@dent.asu.edu.eg

Hossam I. Nassar
associate professor of prosthodontics, faculty of oral and dental medicine-Future university in Egypt, hossameldin.ibraheem@fue.edu.eg

Recommended Citation

Abdelaziz MS, Fawzy A, Ghali RM, Nassar HI. Retention Loss of Locator Attachment System Different Retention Caps for Two Implant Retained Mandibular Overdenture.. *Future Dental Journal*. 2022; 7(2):120-126. doi: https://doi.org/10.54623/fdj.7029.

Future Dental Journal Volume 7, Issue 2 (2021) 120—126

Contents lists available at Arab Journals Platform

Future Dental Journal

Journal homepage: https://digitalcommons.aaru.edu.jo/fdj/

Retention Loss of Locator Attachment System Different Retention Caps for Two Implant Retained Mandibular Overdenture

Medhat Sameh Abdelaziz,[a,*] Aya Fawzy,[b] Rami Maher ghali,[c] Hossam I. Nassar,[d]

a Teaching Assistant of Prosthodontics, Faculty of Oral and Dental Medicine, Future University In Egypt
b Associate Professor of Prosthodontics, Faculty of Oral and Dental Medicine, Future University in Egypt
c Professor of Prosthodontics, Ain Shams University, Cairo, Egypt
d Associate Professor of Prosthodontics, Faculty of Oral and Dental Medicine, Future University in Egypt

ARTICLE INFO

Discipline:
Prosthodontics

Keywords:
Overdenture
Attachments
Implants
Locator.

* Corresponding author.
E-mail address:
20184574@fue.edu.eg
(Medhat Sameh Abdelaziz)

ABSTRACT

Purpose. The objective of this invitro study was to evaluate gradual loss of retention at different time intervals between four different colour coded retentive caps of locator R-TX attachment system through 3000 cycles resembling 3years of attachment usage.

Material and Methods. According to prosthetically driven implant placement, two implants were digitally planned and placed by 3D printed surgical stent in an epoxy model. Forty-eight mandibular complete dentures divided into four groups (12 dentures for each group) were constructed to compare Loss of retention between (12 pairs of locator R-TX each retention cap: zero retention, low retention, medium retention and regular retention), each was subjected to insertion and removal cycles resembling 3years of patient usage. Retention values at zero, one, two, three years were recorded using universal testing machine.

Results: Locator R-TX medium &low retention showed no statistically significant retention values through three years while locator R-TX regular retention cap showed better retention values at zero, first, second year of use.

Conclusion. Locator R-TX attachment systems low, medium, regular retention cap had no statistically significant different retention values at the end of third year of use while there were only statistically significant primary retention values.

Clinical Implications. The importance of difference retention caps appears only in the start of over denture treatment until complete patient adaptation to over denture treatment

1. INTRODUCTION

Implant retained over denture were proposed to overcome the drawbacks of conventional dentures especially in mandible including continuous loss of alveolar ridge, lack of retention and low patient satisfaction. Rissin et al. found that chewing efficiency in the over-denture patients is one-third higher than the complete denture.[1] Randomized and non-randomized clinical trials in periods from six months to nine years proved that placement of implants in mandibular retained and/or supported overdentures result in better quality of life compared to conventional complete [2–5]

The advantages of Implant-supported overdentures compared with conventional dentures are numerous such as improved stability, proprioception & retention, decreased rate of residual ridge resorption , improved masticatory function by 25% as patients can chew various types of foods significantly easier and need only about half the number of chewing cycles[6], better speech performance and improved patients psychological profile and emotional status[7,8] Even older denture wearers were more satisfied than younger ones.[9] In patients with severe vertical bone loss ;overdentures are more aesthetic than fixed restorations, as they mimic inter-dental papilla and allow ideal artificial teeth placement over denture flanges preserve the lost facial contour.[10]

The attachment systems have made the removable prosthesis more acceptable for many patients and clinicians by improving the quality of prosthesis through enhancing retention and support of the removable prosthodontics

The use of Locator attachment has undergone many modifications in material and design which made it more resistant to wear in addition to its ability to correct implant angulation with a low-profile privilege

Many factors affect appropriate attachments selection such as: Jaw morphology, inter arch distance, the desired retention, prosthesis type, inclination & number of implants, patient manual dexterity, financial options and availability for maintenance recall visits. [8,11]

Locator legacy was introduced in 2001 by zest anchors (Zest Anchors; Zest Dental Solutions Escondido, CA, USA) established in 1973 by Max Zuest [12]when he developed an intra-radicular, resilient system named the Zest Anchor. Today, there are a variety of locator systems available[13–15] .

The first Locator design introduced consists of metal patrix on the implant and interchangeable nylon matrix. The attachment has dual retention in different retention values with the ability of self-alignment and different vertical heights. Their privilege of low profile height can be seen whenever vertical space is limited [8], beside they can compensate inter-implant angulation ranging between 0 and 20 degrees. [16]

Dual retention property in locator is that the patrix will retain from the inside and outside of the abutment resulting in greater retention due to the greater cross-section surface area available for frictional contact between attachments components. [17,18]

As any other stud attachment, locator attachment undergoes wear and loss of retention due to continuous insertion and removal in its inner recess of the patrix however their repair and replacement is simple and fast[16,19]

Locator legacy has undergone modification by the manufacturing company (Zest Anchors; Zest Dental Solutions Escondido, CA, USA) to overcome the problem of wear and loss of retention producing new attachment called Locator R-Tx. It is made from Titanium Carbon Nitride with DuraTec coating which has 32% harder 26% more wear resistance than conventional locator. [16]

R-Tx abutment design provides the same clinical handling as the earlier designs but with improved surface coating and with the property of a narrower coronal geometry, which offers an industrial standard hexagon that leads to a narrower central cavity reducing the possibility of food accumulation. [20]

It has the ability to correct implant angulation up to 30 degree for 1 implant as The shape of the head has been redesigned having dual-retentive surface with more pyramid-shape. [8,21]

The abutments have new pink colour which blends into the surrounding mucosal tissue with covering the attachment by thin layers of denture resin, The Locator R-Tx can be easily placed into any functional prostheses retained by the Locator Legacy attachment by only changing the abutment.[20]

Many researches tried to outline the most suitable material in mechanical properties, aesthetics and biocompatibility that can achieve the maximum retention with minimal need of maintenance and wear resistance[22,23]Less changes in retention force were recorded with plastic retentive matrix made of poly-oxy-methylene (POM) compared to metal ones, mainly due to its proper modulus of elasticity and high resiliency which made plastic clips widely used.[24]

The objective of this invitro study was to evaluate initial retention and gradual loss of retention at different time intervals between different locator R-TX attachment system retention caps retaining a mandibular overdenture.

2. MATERIALS AND METHODS

A- Model construction

A secondary mandibular impression for completely edentulous patient using zinc oxide eugenol impression material (Cavex Outline, Netherlands) was poured into stone model after boxing. Duplicating mold Fig. (1) using laboratory addition duplicating silicone material (REPLISIL 22N, dent-e-con, Germany) was used for stone model duplication into Clear epoxy resin (Swiss Chem; construction chemicals, Egypt).[25]

Figure (1) — Addition Silicon Duplicating Mold.

B-Surgical guide planning

Virtual denture was designed for surgical guide construction was planned to determine the best position for placing implant providing stresses distribution between the two implants according to prosthetically driven implant placement. The virtual denture designing was performed using (Exocad dental cad software) Fig. (2: A)

The DICOM file, STL file of the model and the virtual denture were imported to specific software (Real guide 5.0 software 3DIEMME; Italy)

The predesigned denture was used for implants planning between lateral incisor and canine bilaterally at a distance of 22mm and were insured to be parallel to each other and to the path of insertion while they are perpendicular to the occlusal plane as possible to distribute loading to the long axis of the implants[26] Fig. (2:B).

The implants diameter was chosen to be 3.8 mm according to the ridge width and the implant length was chosen to be 10.5 mm. (Internal tapered BIOHORIZONS dental implant)

C- Implant placement using surgical guide.

The guide was placed on the model after being checked stability and complete seating. Sequential implant drilling till desired implant width was done Fig. (2:C). The drill holes were cleaned with air tip to remove any epoxy debris resulting from drilling procedure. The implants were loaded through surgical guide be placed accurate in the planned position. Fig. (2:D).

D- Denture construction:

The epoxy model was duplicated into stone casts on which mandibular denture bases with waxed up acrylic resin teeth were flasked and packed with heat-polymerizing resin (Denture Base Material; Vertex-Dental B.V.) then finished and polished with rounded cylinder attached to denture geometric centre obtained at the cross of two imaginary line. The first is extending between right and left first premolar and the second is extending at the denture midline Fig. (5: A).

E- Loading of attachments and pick up in the denture.

Grouping of the tested attachments:

The tested groups (Locator R-TX Zest Anchors; Zest Dental Solutions Escondido, CA, USA) Fig. (3) were classified as follows:

Group 1: Locator R-TX zero retention. Fig. (4: A) **Group B:** Locator R-TX Low retention. Fig. (4: B) **Group C:** Locator R-TX medium retention. Fig. (4: C) **Group D:** Locator R-TX regular retention. Fig. (4: D)

The gingival height of all the attachments was chosen to be 2 mm. The attachments were screwed into the implant and tightened with a torque of 25 Ncm according to recommendations of the manufacturers. [27]

Light body rubber base was loaded into the denture, and the denture was tried on the model with abutments with the retention caps loaded on it, any pressure area preventing the denture from complete seating was removed with any areas responsible for denture frictional retention. The retromolar pads were used as a reference for complete seating of the denture base on the model.[7]

Pickup rubber ring spacer was applied on the abutment, Teflon material was used to block any remaining undercuts around the abutments. Escape holes were made on the denture lingual to the abutment, to act as an exit for the extra pickup material. The pickup was done by self -cured acrylic resin with the denture seated completely over the model using locator R-TX processing caps.

https://digitalcommons.aaru.edu.jo/fdj/vol7/iss2/9
DOI: https://doi.org/10.54623/fdj.7029

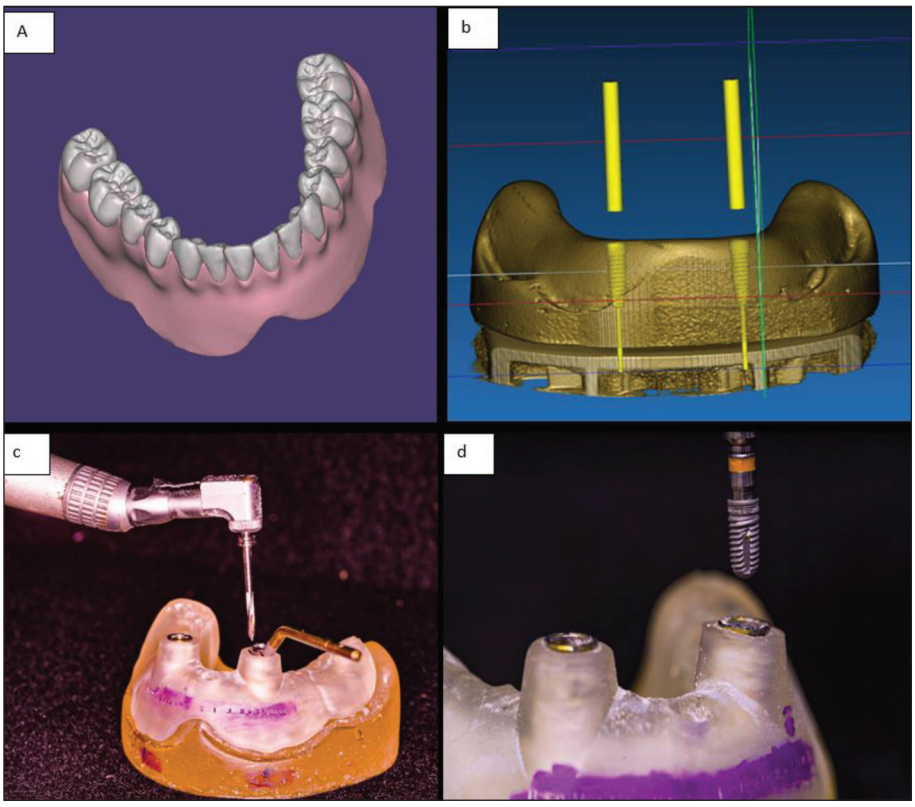

Figure (2)
A: Virtual Designed Denture to Place The Implants According to Prosthetically Driven Implant Placement.
B: Virtual Implant Planning At 22Mm Distance.
C: Drilling Through Surgical Guide.
D: Implant Placement Through Guide.

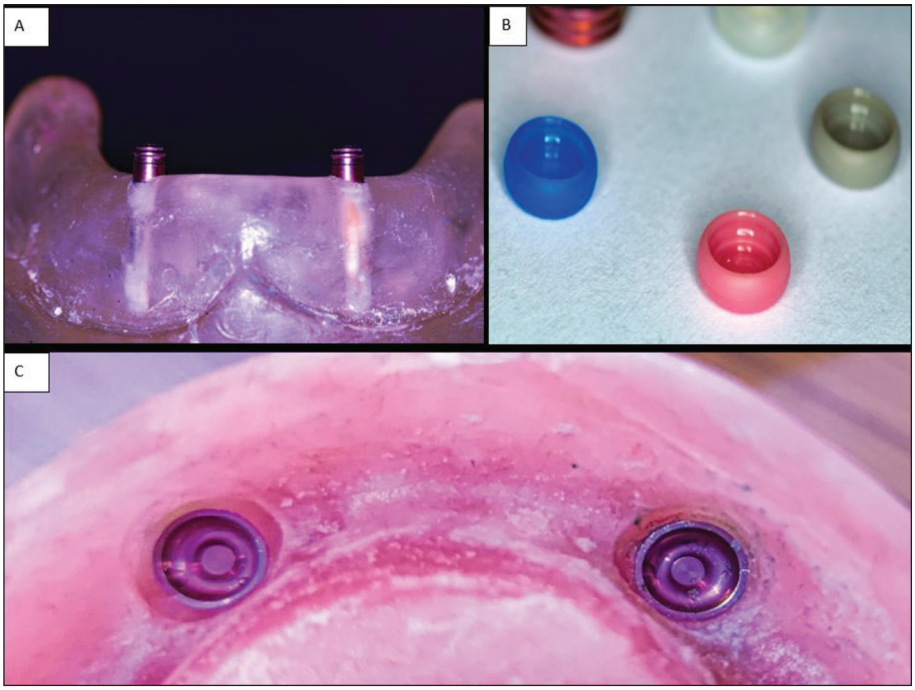

Figure (3)
A: Mounted Locator R-Tx Abutment On The Model. B: Different Locator R-Tx Colour Coded Retentive Caps. C: Picked Up Locator R-Txmetal Housing In The Denture Fitting Surface.

F- Universal testing machine.

The retention forces before and after insertion and removal were measured using Instron universal testing machine (model 3345; England). Data were calculated and recorded using computer software (bluehill Instron; England)

A 500 N load cell at a crosshead speed of 50 mm/min. [28] The removal cycles were performed in vertical direction using the universal testing machine. Fig. (5: B).

The achieved maximum values of retention force were recorded at the beginning of the study (initial retention).and after 1 year,2 years,3years

The experiment was repeated for 12 times for proper statistical sample sizing.

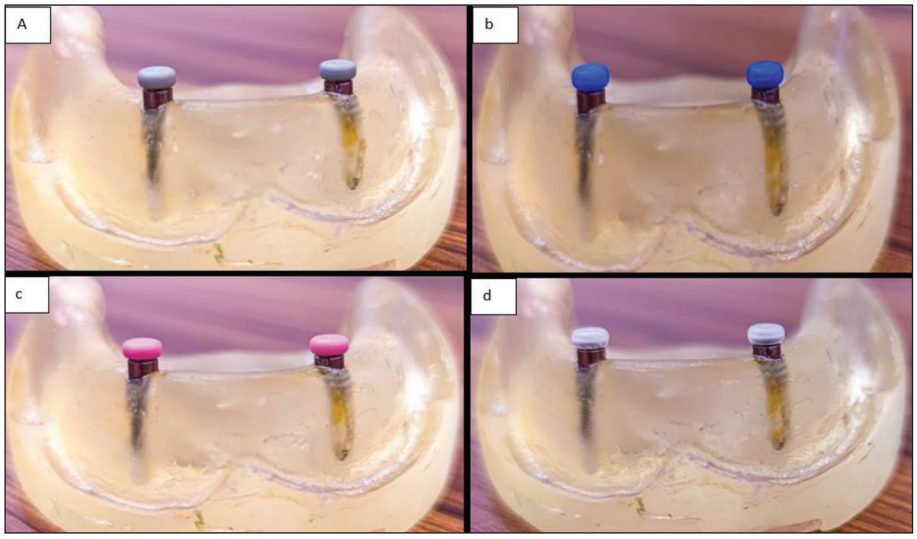

Figure (4)
A: Zero Retention(Grey) Locator R-Tx Caps. B: Low Retention(Blue) Locator R-Tx Caps .C: Medium Retention(Pink) Locator R-Tx Caps. D: Regular Retention(Transparent) Locator R-Tx Caps

Figure (5)
A: Denture With Cylinder Attached To Geometric Centre. B: Insertion And Removal Cycles At Universal Testing Machine

G- Statistical methodology

Data were collected and entered to the computer using SPSS (Statistical Package for Social Science) program for statistical analysis (ver 25)[29]

Kolmogorov-Smirnov test of normality revealed no significance in the distribution of the variables, so the parametric statistics was adopted.[30]

Comparisons were carried out between more than two independent normally distributed subgroups using one-way Analysis Of Variance (ANOVA) test[31]. Post-hoc multiple comparisons[32] was done .[33]

Percentage change was calculated as follows:

$$\textbf{\textit{Percentage change}}\ (\%) = \frac{Measurement\ (after) - Meaurement\ (before)}{Meaurement\ (before)}\ x\ 100$$

An alpha level was set to 5% with a significance level of 95%, and a beta error accepted up to 20% with a power of study of 80%.

3. RESULTS

Comparisons in retention the studied groups show statistically significant difference in mean retention at the initial retention test p=0.000* Fig. (6) -Table (1)

There was no statistically significant difference in retention values between low, medium and regular retention caps after 3 years of use p=1.000- Table (2)

An increase in percentage of retention for low, medium and regular retention caps after 1 year of use was noticed compared to primary retention as well as regular retention caps showed increase in retention after 2 years of use by 11% compared to primary retention. Table (3)

Table 1:

Retention in (Newton) between the studied groups at different time of measurement

	Zero retention caps (M±SD)	Low retention caps (M±SD)	Medium retention caps (M±SD)	Regular retention caps (M±SD)	P value
T0	10.765±.742	13.661±0.68	13.121±.751	14.323±.805	0.000*
T1	9.321±.56	14.231±0.93	14.073±.52	16.266±.79	0.000*
T2	8.941±.52	10.54±0.53	10.773±.84	15.944±.418	0.000*
T3	4.321±.94	9.321±0.88	9.323±.93	9.501±.671	0.000*

T0: at time of over denture insertion
T1: after 1 year of use
T2 after 2 years of use
T3 after 3 years of use NS: Statistically not significant (p≥0.05)

https://digitalcommons.aaru.edu.jo/fdj/vol7/iss2/9
DOI: https://doi.org/10.54623/fdj.7029

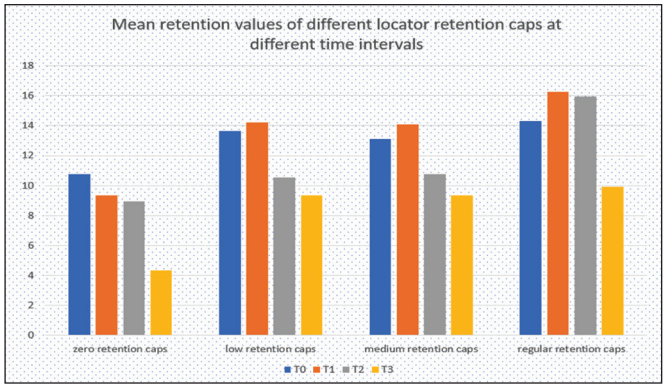

Figure (1) — Addition Silicon Duplicating Mold.

Table 2:

Post hoc multiple comparisons between the four types of locator R-TX retention caps

Retention caps		P. value at T0	P. value at T1	P. value at T2	P. value at T3
Zero retention	Low retention	.000*	.000*	.000*	0.000*
Low retention	Medium retention	.084 N.S.	1.000 N.S.	.169 N.S.	1.000 N.S.
Medium retention	Zero retention	.000*	.000*	.000*	0.000*
Regular retention	Zero retention	.000*	.000*	.000*	0.000*
Regular retention	Low retention	.022 N.S.	.000*	.000*	1.000 N.S.
Regular retention	Medium retention	.003*	.000*	.000*	1.000 N.S.

T0: at time of over denture insertion
T1: after 1 year of use
T2 after 2 years of use
T3 after 3 years of use
*: Statistically significant ($p<0.05$)
NS: Statistically not significant ($p\geq0.05$)

Table (3):

Percentage of retention loss in (Newton) between the studied groups at different time of measurement Primary retention vs one, two and three years of use.

			Zero retention caps (M±SD)	**Low retention caps (M±SD)**	**Medium retention caps (M±SD)**	**Regular retention caps (M±SD)**	P value
			Percentage change				
T1**(%)**	vs	T0	-13.41%	+4.17%	+7.25%	+13.56 %	0.000*
T2**(%)**	vs	T0	-16.94%	-22.84%	-17.89%	+11.31 %	0.000*
T3**(%)**	vs	T0	-59.86 %	-31.76%	-28.94%	-30.87%	0.010*
T2**(%)**	vs	T1	-4.07 %	-25.93%	-23.44%	-1.97 %	0.000*
T3**(%)**	vs	T2	-51.67%-	-9.65	-13.45%	-37.9%	0.000*

T0: at time of over denture insertion
T1: after 1 year of use
T2 after 2 years of use
T3 after 3 years of use
*: Statistically significant ($p<0.05$)
NS: Statistically not significant ($p\geq0.05$)

4. DISCUSSION

The study model used in present study was made from epoxy resin to prevent any mechanical failure in the research steps or implant detachment during force application in the insertion and removal cycles. [25]

A computer guided implant placement was chosen using computer guided surgical stent to ensure the complete parallelism of the two implants in the predetermined position. This would decrease any possibility of retention caps wear, that could occur due to lack of implant parallelism leading to retention loss.

The concept of prosthetically driven implant placement was clear in mind during testing procedure. The implants were placed through surgical guide for standardization of implant placement to ensure implant parallelism for better load distribution on the long axis of both implants. Thus, decreasing the possibilities of attachment wear and loss of retention due to improper angulations. The implants were planned to be positioned at the canine region bilaterally at an inter-implant distance equals 22mm [26].

The guided kit drills length of 24 mm was chosen, this length corresponded to the implant length and the sleeve offset.

Any areas responsible for denture frictional retention were removed by diamond stone to avoid any false results concerning the attachment retention which may affect the accuracy of the experiment.

Crosshead speed of 50 mm/min is used in universal testing machine which represents to the estimated speed of denture removal during chewing until complete separation. All the tensile forces applied were in vertical direction for standardization and decreasing the wear possibility to attachment. [34,35]

One year of denture use was represented by 1000 insertion & removal cycles per year based upon patients' average 3 times insertion and removal per day. [34,35]

The result showed statistically insignificant difference after 3 years values between regular, medium and low retention caps. Which was reported by Rutkunas et al[36] that different color-coded attachments' plastic capes do not necessarily provide different retention forces after testing attachments for fifteen thousand insertion and removal cycles.

It is also reported by Rutkunas, V et al that the attachments inserts providing relatively greater retention seem to have more wear and deformation of the attachments. They attributed attachments retentive force changes to dimensional changes and surface alterations.[36] for this reason regular retention caps was equal in retention force to low retention caps after 3 years of insertion & removal cycles, although regular caps had higher primary retention than low retention caps.

Zero retention cap is below the minumum required retention to retain an over denture of 5 N after 3 years While the low, medium and regular retention caps met the minimum value of 5 N, required for the stability of overdenture.[17] [37] [38] [35]

Maniewicz, S. *et al* tested the novel locator R-TX invitro and reported that retentive forces showed promising a successful clinical use in implant overdentures, even with extremely angulated implants, with no significant loss of retention before five years of a simulated use.[39]

The increase of locator R-TX low,medium,regular retention caps after 1 year compared with primary retention coincide with what is reported by Botega et al in-an invitro study through microscopical examination of nylon retentive caps that thermal expansion during the test leads to increase in values of retention force.[37]

It was also reported by Marin, D et al that increase in attachment retention during the initial period of loading was due to increased matrix surface roughness which is a result of surface deterioration decreasing the diameter of the internal retentive ring, which in turn leads to more micro-mechanical friction that increases the attachment retention.[34]

5. CONCLUSIONS

With the limitations of this study, it could be concluded that:

1. The new design named: locator R-TX attachment systems showed good retention for implant overdentures.
2. The retention values of low and medium locator retention caps are only different at primary retention.

6. RECOMMENDATIONS

It is recommended to perform clinical in vivo studies for locator R-TX attachment systems.

7. REFERENCES

1. Louis Rissin, James E. House, R.S. Manly KKK. Clinical comparison of masticatory performance and electromyographic activity of patients with complete dentures, overdentures, and natural teeth. J Prosthet Dent 1978;39(5):508–11.
2. Stoumpis C, Kohal RJ. To splint or not to splint oral implants in the implant-supported overdenture therapy? A systematic literature review. J Oral Rehabil 2011;38(11):857–69.
3. Thomason JM. The McGill Consensus Statement on Overdentures. Mandibular 2-implant overdentures as first choice standard of care for edentulous patients. In: The European journal of prosthodontics and restorative dentistry. 2002. page 95–6.
4. Doukas D, Michelinakis G, Smith PW, Barclay CW. The influence of interimplant distance and attachment type on the retention characteristics of mandibular overdentures on 2 implants: 6-month fatigue retention values. Int J Prosthodont [Internet] 2006;21(2):152–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18546771
5. Kawai Y, Murakami H, Shariati B, Klemetti E, Blomfield J V, Billette L, et al. Do traditional techniques produce better conventional complete dentures than simplified techniques? J Dent 2005;33(8):659–68.
6. Geckili O, Bilhan H, Mumcu E, Dayan C, Yabul A, Tuncer N. Comparison of patient satisfaction, quality of life, and bite force between elderly edentulous patients wearing mandibular two implant-supported overdentures and conventional complete dentures after 4 years. Spec Care Dent 2012;32(4):136–41.
7. Savabi O, Nejatidanesh F, Yordshahian F. Retention of implant- supported overdenture with bar/clip and stud attachment designs. J Oral Implantol 2013;39(2):140–7.
8. Yilmaz B, Ozkir E, Johnston WM, McGlumphy E. Dislodgement force analysis of an overdenture attachment system. J Prosthet Dent [Internet] 2020;123(2):291–8. Available from: https://doi.org/10.1016/j.prosdent.2018.11.009
9. Kuoppala R, Näpänkangas R, Raustia A. Quality of Life of Patients Treated With Implant-Supported Mandibular Overdentures Evaluated With the Oral Health Impact Profile (OHIP-14): a Survey of 58 Patients. J Oral Maxillofac Res 2013;4(2):2–7.
10. Sholkamy A, Hassan AGA, Agamy EMT, Sholkamy A. Evaluation of implant supported mandibular overdenture retained by different telescopic crowns :(PEEK) versus Cobalt Chromium telescopes. J Crit Rev 2020;7(18):4436–9.
11. Nissan J, Oz-Ari B, Gross O, Ghelfan O, Chaushu G. Long-term prosthetic aftercare of direct vs. indirect attachment incorporation techniques to mandibular implant-supported overdenture. Clin Oral Implants Res 2011;22(6):627–30.
12. Shastry T, Anupama NM, Shetty S, Nalinakshamma M. An in vitro comparative study to evaluate the retention of different attachment systems used in implant-retained overdentures. J Indian Prosthodont Soc 2016;16(2):159–66.
13. Scherer MD, McGlumphy EA, Seghi RR, Campagni W V. Comparison of retention and stability of two implant-retained overdentures based on implant location. J Prosthet Dent [Internet] 2014;112(3):515–21. Available from: http://dx.doi.org/10.1016/j.prosdent.2014.03.003
14. Epstein DD, Epstein PL, Cohen BI, Pagnillo MK. Comparison of the retentive properties of six prefabricated post overdenture attachment systems. J Prosthet Dent 1999;82(5):579–84.
15. Anchors Z. Zest anchor advanced generation (ZAAG) technique manual. Escondido (CA). 1997;
16. Merve DEDE, Prof. Dr. Onur GEÇKİLİ PDFÜ. SINGLE ATTACHMENT SYSTEMS IN IMPLANT SUPPORTED OVERDENTURE PROSTHESES. Aydın Dent J 2020;6(2):139–46.
17. Reda KM, El-Torky IR, El-Gendy MN. In vitro retention force measurement for three different attachment systems for implant-retained overdenture. J Indian Prosthodont Soc 2016;16(4):380–5.
18. W S. A comparative in vitro study on the retention and stability of implant-supported overdentures. Quintessence Int 2009;40(313-9.).
19. Salehi R, Shayegh SS, Johnston WM, Hakimaneh SMR. Effects of interimplant distance and cyclic dislodgement on retention of LOCATOR and ball attachments: An in vitro study. J Prosthet Dent [Internet] 2019;122(6):550–6. Available from: https://doi.org/10.1016/j.prosdent.2018.12.023
20. Srinivasan M, Kalberer N, Maniewicz S, Müller F. Implant overdentures retained by self-aligning stud-type attachments: A clinical report. J Prosthet Dent [Internet] 2020;123(1):6–14. Available from: https://doi.org/10.1016/j.prosdent.2019.03.009
21. Guedat C, Nagy U, Schimmel M, Muller F S. Clinical perfor- mance of LOCATOR(R) attachments: A retrospective study with 1-8 years of follow-up. Clin Exp Dent Res 2018;4:132-45.
22. Tekin S, Cangül S, Adıgüzel Ö, Değer Y. Areas for use of PEEK material in dentistry. Int Dent Res 2018;8(2):84–92.
23. Quinn JB, Sundar V LI. Influence of microstructure and chemistry on the fracture toughness of dental ceramics. Dent Mater 2003;19:60.
24. Fromentin O, Lassauzay C, Abi Nader S, Feine J de AJR. Testing the retention of attachments for implant overdentures – validation of an original force measurement system. J Oral Rehabil 2010;37:54-62.
25. Hosny mostafa saeed. Evaluation of retention of implant over denture attachment , an in vitro study. 2018;
26. Choi J-W, Yun B-H, Jeong C-M, Huh J-B. Retentive Properties of Two Stud Attachments with Polyetherketoneketone or Nylon Insert in Mandibular Implant Overdentures. Int J Oral Maxillofac Implants 2018;33(5):1079–88.
27. Gonuldas F, Tokar E, Ozturk C. Evaluation of the retention characteristics of various stud attachment systems for implant retained overdenture. Acta Bioeng Biomech 2018;20(4):135–41.
28. Li P, Hasselbeck D, Unkovskiy A, Sharghi F, Spintzyk S. Retentive characteristics of a polyetheretherketone post-core restoration with polyvinylsiloxane attachments. Polymers (Basel) 2020;12(9):1–9.
29. Corp I. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.
30. A. F. Discovering Statistics Using IBM SPSS Statistics. 4th ed. London, California, New Delhi: SAGE Publications Ltd. 2013.

https://digitalcommons.aaru.edu.jo/fdj/vol7/iss2/9
DOI: https://doi.org/10.54623/fdj.7029

31. I. John Wiley & Sons; Experiments with a Single Factor: The Analysis of Variance. Design and Analysis of Experiments. In: Montgomery D. 2001. Page Chapter 3.
32. Lowry R. One Way ANOVA–Independent Samples. Vassar edu
33. Ruxton GD BG. Time for some a priori thinking about post hoc testing. Behav Ecol 2008;19((3)):690–3.
34. Marin DOM, Leite ARP, de Oliveira Junior NM, Paleari AG, Pero AC, Compagnoni MA. Retention force and wear characteristics of three attachment systems after dislodging cycles. Braz Dent J 2018;29(6):576– 82.
35. Kamal Emera R, Elgamal M, Altonbary G. Retention force of all- zirconia, all-polyetheretherketone, and zirconia-polyetheretherketone telescopic attachments for implant-retained overdentures: In vitro comparative study. J Dent Implant 2020;10(2):78.
36. Rutkunas V, Mizutani H, Takahashi H, Iwasaki N. Wear simulation effects on overdenture stud attachments. Dent Mater J 2011;30(6):845– 53.
37. Botega DM, Mesquita MF, Henriques GEP, Vaz LG. Retention force and fatigue strength of overdenture attachment systems. J Oral Rehabil 2004;31(9):884–9.
38. Burns DR, Unger JW, Elswick RK Jr BD. Prospective clinical evaluation of mandibular implant overdentures: Part I-retention, stability, and tissue response. J Prosthet Dent 1995;73:354-63.
39. Maniewicz S, Badoud I, Herrmann FR, Chebib N, Ammann P, Schimmel M, et al. In vitro retention force changes during cyclic dislodging of three novel attachment systems for implant overdentures with different implant angulations. Clin Oral Implants Res 2020;31(4):315–27.