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Clinical evaluation of retention in mandibular complete overdenture with two different attachments

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Abstract

Aim: This study was conducted to compare the effectiveness of two different attachments, OT equator versus ball and socket, in retaining complete mandibular implant-overdentures. **Patients and Methods:** From the removable prosthodontics department clinic, Faculty of Dental Medicine, Al-Azhar University, 16 completely edentulous patients were randomly chosen and allocated into two groups, group I received implant-retained overdentures with OT equator attachments, while group II received implant-retained overdentures with ball and socket attachments. Retention was evaluated by digital weight gauge after two weeks (T1), six months (T2), twelve months (T3), and 18 months (T4). Statistical analysis was done using SPSS software version 20.0. Unpaired t-test was used for comparing the mean retention of the two groups. ANOVA test was used for comparison between T1, T2, T3 and T4 for each group. **Results:** Group I recorded significantly higher retention when compared to group II after 12 and 18 months. For both groups, the mean

retention decreased significantly at 12 and 18 months of follow-up periods. **Conclusion:** Within limitations of this study, it can be concluded that OT equator attachment is advised rather than ball and socket attachment for long term retention in implant-retained mandibular overdentures.

Key words: Ball and socket, Implant-overdenture, OT Equator, Retention.

Introduction

For certain patients, wearing complete dentures might be problematic and linked to several issues. The most common complaints concern stability and retention of complete dentures. On the other hand, mandibular dentures exacerbate these issues because of several physiological and anatomical variables. [1, 2]

The prognosis of treatment with complete dentures is affected by inadequate denture retention. Inadequate denture retention can lead to a number of complications, including irritated supporting tissues, chewing difficulties, speech impairments, and oral discomfort. [3]

Many authors provided tips and recommendations to improve the quality of complete denture retention. Also, the mandibular implant supported overdenturewas developed to solve these problems. [4]

The advantages of this implant rehabilitation kind are: providing good retentiveness ensuring stability to the prosthesis, improving facial support particularly with severely resorbed ridge, less expensive as it utilize only 2 implants, preferable oral hygiene procedures due to easy removal of the prostheses, and provides good occlusal stability for the opposed prostheses.[5]

Concerning implant overdentures, there are different concepts related to the type of implant used (conventional, narrow, mini implant), their number, placement or loading. Also, the attachment system used has an impact on the balance of the overdenture. [6]

There are several connection mechanisms available; ball, bar, and magnet attachments being the most popular. The choice of attachment is dependent upon the available space, the implant inclination according to jaw morphology and the required retention. The matrix material, the dimensions of the patrix, and the attachment system design all affect retention force. [7, 8]

Because they are inexpensive, simple to install, require little chair side time, and may be used with both implant- and root-supported prostheses, ball attachments are the most used type of stud attachment. [9, 10]

OT Equator® system (Rhein 83, Bologna, IT) launched in 2007 and derives its name from the OT dental laboratory (Bologna, Italy). It is considered the smallest with the least overall dimension of any attachment system available. With a 2.1 mm low vertical profile and a 4.4 mm diameter, it is intended to enable maximum retention and allow a variety of options for overdenture treatment planning when vertical space limitations are a consideration. It is indicated to correct divergence up to 28 degrees between implants without affecting the functionality of the nylon cap. [11, 12]

OT Equator is a resilient and self-aligning attachment system with stable retention. It combines the simplicity of ball attachments, with the variety of retention levels and easy replacement options of locators. However, little information is available about this product. [13]

It was estimated that 33% of prosthodontic complications are related to loss of retention. [14] Therefore, this clinical trial was conducted to evaluate the retention in mandibular overdentures retained by OT-equator in comparison to those retained by ball and socket attachment.

Patients and Methods

From the Removable Prosthodontics Department Outpatients Clinic, Faculty of Dental Medicine, (Boys, Cairo), Al-Azhar University, 16 completely edentulous patients were randomly chosen and allocated by closed envelope technique to receive two inter-foraminal implants (11.5 mm length and 3.5 mm diameter). Ethical approval was obtained from Research Ethics Committee, Faculty of Dental medicine Al-Azhar University (FDAzUC-REC 742/ 1911). All the patients have signed written consents after being informed about the treatment plan in details and the required follow-up appointments.

For each patient, an acrylic complete denture was designed according to the conventional steps for complete denture construction. Primary impressions were recorded using alginate impression material (Cavex, Holland). Secondary impressions were recorded using medium-consistency silicon impression material (Zermack, Italy) after border molding of special trays using green stick compound (Perfectin, Aragentina). Master casts were mounted to the semi-adjustable articulator (Bio art, Brazil) using an ear face bow (Bio art, Brazil), then artificial teeth (Eray, Turkey) were arranged for bilateral balanced occlusion. The lab work was continued until the dentures were finished and polished. It was inserted in the patient′s mouth. Esthetics, retention, stability and occlusion were verified. Post insertion instructions were given.

Mandibular alveolar ridge height, bone quality and the type of bone were evaluated by the cone beam computerized tomography. A stereolithography surgical template was constructed for each participant to be used in the implants installation.

Amoxicillin antibiotic was prescribeed 2 days before implant placement. After applying topical anesthesia (I-Gel-USA), bilateral mental nerve block and lingual infiltration anesthesia (Mepivacaine 3%-Egypt) was administered. A crestal incision was done by a scalpel number 15 on the crest of the ridge. A periosteal elevator was used to elevate the periosteum and to reflect the flap labially and lingually.

By the aid of the digital surgical guide, initial penetration was made through the cortex of the bone using a round bur through the hole of the stent which represented the planned position of the implant. Pilot drill was used to initiate the osteotomies to a depth of 10 mm at 800-1000 RPM with copious amount of saline. Sequence of larger drills in the selected surgical kit (nucleoss, menderes, izmir, turkiye) was used to prepare the osteotomy site to the required length and diameter of implant (3.5 mm diameter and 11.5 mm length).

After parallelism checking**,** implant fixtures and attachments were screwed (nucleoss, menderes, izmir, turkey). Flab repositioned and sutured. For group I patients, OT equator attachments were screwed into the fixtures and tightened using an equator driver**.** For group II Patients, ball attachments were screwed to the fixtures and tightened using a ball driver.

Metallic cap with pink nylon insert was placed over the male part of the attachment, and then its place was transferred to the denture by the aid of marker paste. Space was created in the fitting surface of the denture base correspond to implant site using a large carbide bur mounted to a straight hand piece. After blocking of undercut, direct pick up of the metal cap to the denture fitting surface was accomplished by self-cure acrylic resin (Acrostone, Egypt).

Reline was made in the holes created into the denture fitting surface and the denture was inserted into patient's mouth, then the patient was instructed to close in correct occlusion. After the setting of acrylic resin, the denture with the metal cap was removed from the mouth, inspected, and any excess material was removed. Overdenture was reinserted. Analgesics were prescribed, (Diclofenac Sodium 75mg) and patients were instructed to rinse three times daily with 0.2% Chlorhexidine mouthwash and clean their dentures with the brush. A soft diet was recommended for seven days.

Retention was evaluated by measuring the pull force needed to dislodge the overdenture in a vertical direction perpendicular to the occlusal plan by digital weight gauge. Two hooks were attached on each side between second premolar and first molar, an orthodontic wire was attached to the hooks. Each patient was asked to sit comfortably with his head on the headrest and the occlusal plane is parallel to the floor of the room. The lower denture was then inserted inside the patient's mouth, tongue freedom and loop position were checked and 3 minutes seating time was allowed before taking the measurements.

The metallic probe of the digital force-meter (Extech instruments 475040, Nashua, New Hampshire, USA) was then attached and a vertical pulling force was applied vertically upward until denture retention was lost and the prosthesis moved vertically. This force was measured in Newtons (N) and recorded to measure denture retention. Three readings were taken and the average value was recorded. Retention in both groups was assessed and recorded at baseline and after 2 weeks, 6 months, 12 months and 18 months following overdenture insertion.

The data was collected, tabulated and statistically analyzed using SPSS© Statistics Version 20 for windows. The data distribution test for normality was done by using the Shapiro-Wilk test. The test showed a normal distribution of data, unpaired t-test was used for statistical analysis for the difference between the two groups. One-way ANOVA test was used for comparison between retention at different follow-up periods for each group. The significance level was set at $P \leq 0.05$.

Results

The independent (unpaired) t-test revealed that there was no difference between the retention average of the (OT-equator and Ball &Socket) groups at baseline and after 6 months of follow-up period. But there were statistically significant differences after 12 and 18 months with P-values ($p<0.05$) as represented in **Table 1.** The statistical results revealed that the mean retention decreased significantly with time after 12 and 18 months of use in both groups as shown in **Table 1** and **Fig. 1**.

Table (1): Comparison of retention difference in (N) regarding the type of attachment and follow-up period.

Variable	2 Weeks Mean±SD	6 Months Mean±SD	12 Months Mean±SD	18 Months Mean±SD	F ratio	p-value
OT Equator	11.17± 2.12	10.81± 2	8.04± 1.07	4.91± 1.05	15.64	<0.0001*
Ball& socket	12.02± 2.64	11.12± 2.43	5.27± 0.89	3.08± 0.81	222.91	<0.0001*

t-value	0.5645	0.27555	2.72162	4.6534		
P-value	0. 2939 ^{ns}	0.839 ns	0.0130 *	0.0008 *		

SD;standard deviation, *;statistically significant.,ns; non-significant.

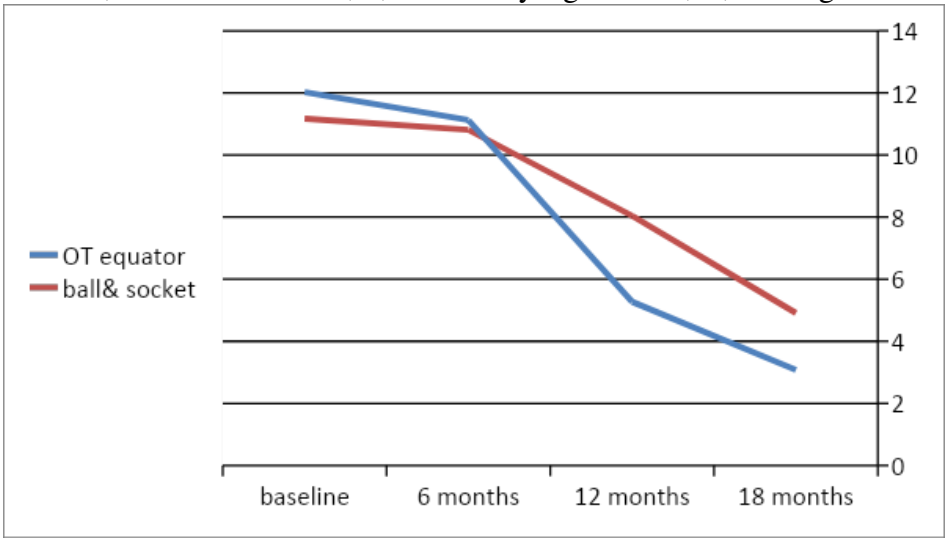

Fig. (1): linear chart of retention (N) regarding the follow-up periods for both OT Equator and ball& socket.

Discussion

Retention of attachments is derived from frictional contact which is a result of dimensional misfit between the slightly oversized male and the smaller diameter of the female abutment. [15] Rattanadech et al. [16] showed that there's difference in retention between nylon retentive components, the violet cap is the most retentive, followed by the white, the pink, the yellow and finally the black cap. These weight color-code retentive caps indicated different levels of retention varied from 6.16 ± 0.44 N. to 33.24 ± 1.52 N.

Descriptive statistics of the results regarding retention at baseline revealed that there was no significant difference between the two attachments which is in agreement with a previous laboratory study that aimed to evaluate retention and wear resistance of OT equator versus ball attachment at baseline and after cyclic loading equivalent to one year of function. [17]

Tomás et al. [13] obtained the mean initial retention value of pink female component 16.36 N. which is higher than our study at 11.17 N. While Marin et al. [18] demonstrated greater baseline retention at 22 N. These discrepancies might be caused by manufacturing process, differences in design, implant position and position of attachment systems. [19] In addition to different designs of experimental models and color-coded retentive inserts. [20]

There was a significant and progressive decrease in retention values for both groups with time (after 12 and 18 months of follow up). These findings agreed with Passia et al. [21] who explained that the higher wear of both attachment systems may be due to the various geometries of the plastic matrices that may resulted in higher friction forces or lower wear resistance of the retentive male components.

In the present study, the statistics revealed that there was insignificant retention difference between both groups P>0.05 at baseline and after 6 months, while revealed significant difference after 12 and 18 months of function, in other words equator group was significantly higher than ball group. This may be due to higher

friction forces and wear patterns of the female internal components of the ball attachment that resulting in more retention loss. [22, 23]

OT Equator is an abutment container that, thanks to a tilting mechanism with a rotation fulcrum, allows passive insertion even in extreme divergences up to 30°. This allows forces passivation and better predictability characteristics. [24] Ball attachment do not allow divergence angles up to 30°, and it is, therefore, possible that residual forces are created in our prosthesis, or in the structure, or on dental implants' position. Residual forces could damage mechanical components or cause biological damages. [25]

Satti et al. [26] compared retentive properties of the ball attachment and OT equator attachment and concluded that the latter offers more advantageous features. Maximum wear resistance is provided by the titanium nitride (TiNi) coating, together with a compact metal housing and interchangeable nylon covers that offer different retention levels. Retention caps can be replaced easily within seconds.

In the current study, retention loss percentage for Equator attachment was 28% while for ball attachment was 56% after 1 year of function. A previous clinical study reported that ball attachment lose 30-50% of their initial retention, which is in accordance with our result. This could be a result of increased deformation in nylon inserts. [22]

OT-Equator nylon components are made of polyamide which offers light weight, smooth surface, chemical resistance, dimensional stability and flexibility. However, the nylon components have a high sensitivity to wear during long term function due to several factors which consequently lead to decrease in retentive force. As a result, the change of morphology and wear of attachment component due to nonparallel implant and recurrent loading overtime could lead to loss of retention. [27]

The proper period of time to replace the attachments of implant overdenture is not well defined.(29) Different studies revealed that retention to stabilize mandibular overdenture ranging from 5-7 N is acceptable.[28, 29]

According to the results of this study, it can be assumed that OT equator until 1-year of function can still provide adequate retention ranging from 7.16 to 9.72 N. However, after1.5 years retention recorded values from 3.82 to 6.32 N. This was lower than that referenced by different authors. Therefore, the attachment may require 1-year of maintenance and may be replaced by a new retentive insert.

Conclusion

Within limitations of the present study, the following conclusions can be drawn:

1- OT equator attachment is better than ball and socket attachment regarding retention of implant supported overdenture.

2- Both attachments showed a significant decrease in retention values over the time.

3- Implant-assisted overdenture with OT-equator attachments may be seen as a reliable and effective therapy alternative for ball& socket attachment.

References

1. Bilhan H, Geckili O, Ergin S, Erdogan O, Ates G. Evaluation of satisfaction and complications in patients with existing complete dentures. J Oral Sci 2013;55:29-37.
2. Ribeiro JA, de Resende CM, Lopes AL, Farias-Neto A, Carreiro Ada F. The influence of mandibular ridge anatomy on treatment outcome with conventional complete dentures. Acta Odontol Latinoam 2014;27:53-7.

3. Alabbas A. Jar, Abdullah A. Khormi, Norah A. Al-khamiss, Atheer A. Alnaim; The effect of dentures on oral health and the quality of life. Int J Community Med and Public Health. 2023;10:12.
4. Thomason JM, Kelly SA, Bendkowski A, et al. Two implant retained overdentures—a review of the literature supporting the McGill and York consensus statements. J Dent 2012;40:22–34.
5. de Almeida HCR, de Santana ETS, dos Santos NAT, de Araújo YRF, de Martinez MEM. Clinical aspects in the treatment planning for rehabilitation with overdenture and protocol-type prosthesis. RGO, Rev Gaúch Odontol, Porto Alegre. 2015;63:271-276.
6. Preoteasa E, Imre M, Preoteasa T. A 3-Year Follow-up Study of Overdentures Retained by Mini–Dental Implants. Int J Oral Maxillofacial Implant. 2014;29:1170-76.
7. Satheesh Kumar P, Satheesh KK, John J, Patil G, Patel R. Force transfer and stress distribution in an implant-supported overdenture retained with a hader bar attachment: a finite element analysis. ISRN dentistry. 2013;2013:1-13.
8. 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;16:159-66.
9. Kleis WK, Kämmerer PW, Hartmann S, Al- Nawas B, Wagner W. A comparison of three different attachment systems for mandibular two- implant overdentures: one- year report. Clinical Implant Dent Related Res. 2010;12:209-18.
10. ELsyad MA, Elhaddad AA, Khirallah AS. Retentive properties of O- ring and locator attachments for implant- retained maxillary overdentures: an in vitro study. J. Prosthodont. 2018;27:568-76.
11. Gandhi PV, Kalsekar BG, Patil AA, Kandi NS. A low-profile universal attachment system with housing welded to metal reinforcement framework to retain mandibular implant overdenture: A clinical report. J Indian Prosthodont Soc. 2019;19:374-378.
12. Alammari MR, Tayel SB. The outcome of in vivo use of Equator attachment systems with implant-supported maxillary overdenture on patients‘ satisfaction and biochemical measuring of MMP-8. International J Oral Care and Res. 2018;6:21.
13. Mínguez-Tomás N, Alonso-Pérez-Barquero J, Fernández-Estevan L, Vicente-Escuder Á, Selva-Otaolaurruchi EJ.In vitro retention capacity of two overdenture attachment systems:Locator® and Equator®. J Clin Exp Dent 2018;10:681-6.
14. Wakam, Raphaël, Ramalingam, Srilakshmi and Mawussi Kwamivi; Retention loss and wear assessment of three attachment systems for implant retained-mandibular overdentures: An in vitro study; J. of Mech . Behavior of Biomed Mater. 2023; 150; 106269.
15. Tallarico M, Rodriguez Y Baena, R.., Ortensi, L.,Martinolli, M., Casucci, A.; Ferrari, E., Malaguti, G.; Montanari, M., Scrascia, R.,Vaccaro, G.,Venezia, P., Xhanari, E., Implant overdentures delivered with different design and attachment systems: results between one and 17 years of follow-up. Dent. J. 2018; 6, 71.
16. T. Rattanadech, W. Aunmeungtong, P. Khongkhunthian; Effects of cyclic dislodgement on the retentive force reduction of different OT-equator caps and removal torque of the retentive components of a mini dental implant systme. Oral & Implantology - Anno XII – N; 2019;2.
17. Doaa Amr Rostom and Nourhan Ahmed Ragheb; Retention And Wear Characterstic Assesment Of OT Equator With Smart Box Attachment Versus Ball

Attachment For Mandibular Two Implant Assisted Overdenture. In-Vitro Study. E.D.J; 2021; 67; 3525-3532.
18. Marin DOM, Leite ARP, Oliveira Junior NMd, Paleari AG, Pero AC, Compagnoni MA. Retention force and wear characteristics of three attachment systems after dislodging cycles. Brazilian Dent J. 2018;29:576-82.
19. Rutkunas V, Mizutani H, Takahashi H, Iwasaki N. Wear simulation effects on overdenture stud attachments. Dent Mater J. 2011;30:845– 53
20. Aroso, C., Silva, A.S., Ustrell, R., Mendes, J.M., Braga, A.C., Berastegui, E., and Escuin, T. Effect of abutment angulation in the retention and durability of three overdenture attachment systems: An in vitro study. J Adv Prosthodont. 2016; 8: 21-9.
21. Passia N, Ghazal M, Kern M. Long-term retention behaviour of resin matrix attachment systems for overdentures. Journal of the mechanical behavior of biomed mater. 2016;57:88-94.
22. Trakas T, Michalakis K, Kang K, Hirayama H. Attachment Systems for Implant Retained Overdentures: A Literature Review. Implant Dent. 2006; 15:24-34
23. Abi Nader S, De Souza R, Fortin D, De Koninck L, Fromentin O, Albuquerque Junior R. Effect of simulated masticatory loading on the retention of stud attachments for implant overdentures. J Oral Rehab. 2011;38:157-64.
24. Bramanti, E.; Cervino, G.; Lauritano, F.; Fiorillo, L.; D'Amico, C.; Sambataro, S.; Denaro, D.; Famà, F.; Ierardo, G.; Polimeni, A.; et al. FEM and Von Mises Analysis on Prosthetic Crowns Structural Elements: Evaluation of Different Applied Materials. Sci. World J. 2017, 2017, 1–7
25. Cicciù, M.; Beretta, M.; Risitano, G.; Maiorana, C. Cemented-retained vs screw-retained implant restorations: an investigation on 1939 dental implants. Minerva Stomatol. 2008, 57, 167–179.
26. Satti AA. Comparison of Retentive properties of two Attachment Systems in Mandibular Overdentures-An in vitro study. Master thesis.2013.
27. Awad Ma, Lund Jp, Dufresne E, Et Al. 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.
28. Pigozzo, M.N., Mesquita, M.F., Henriques, G.E., and Vaz, L.G. The service life of implant-retained overdenture attachment systems. J Prosthet Dent. 2009; 102: 74-80.
29. Besimo, C., and Guarneri, A. In vitro retention force changes of prefabricated attachments for overdentures. J Oral Rehab. 2003; 30: 671-8.