

Evaluation of chewing efficiency of the mandibular implant supported overdenture with two types of low-profile attachment: Crossover study.

KARAM AA^{*}, Helalay OA^{**}, ALHADDAD DF^{***}

^{*}Assistant Lecturer, Removable Prosthodontic Department, Faculty of Dental Medicine, Al-Azhar University.

^{**}Lecturer, Removable Prosthodontic Department, Faculty of Dental Medicine, Al-Azhar University.

^{***}Professor, Removable Prosthodontic Department, Faculty of Dental Medicine, Al-Azhar University.

Abstract

Aim: The aim of this study was to evaluate chewing efficiency of the mandibular implant supported overdenture with OT Equator and mini ball and socket attachments. **Subjects and Methods:** From the removable prosthodontics department clinic, Faculty of Dental Medicine, (Boys, Cairo), Al-Azhar University, 10 completely edentulous patients were randomly chosen. The patients were divided into two groups, group I received mandibular overdenture supported by two implants with OT Equator attachment while group II received mandibular overdenture supported by two implants with mini ball and socket attachment. Chewing efficiency in terms of unmixed fraction (UF) was measured using chewing gum (after 5, 10, 20, 30 and 50 strokes). The measurements were performed at the time of insertion of overdenture (T1), after six months (T2) and after twelve months (T3).

Results: It was found that OT Equator attachment recorded a significant higher chewing efficiency than mini ball and socket attachment in all observation times.

Conclusion: OT Equator attachment is preferred regarding chewing efficiency in mandibular implant supported overdenture than mini ball attachment.

Date of Submission: 29-03-2021

Date of Acceptance: 12-04-2021

I. Introduction:

Complete edentulism is a clinical situation typical for the elderly people, defined by the total absence of one's own natural teeth, in one or both arches. With the loss of teeth there are a series of negative effects on the general social, and psychological status, frequently leading to a decrease in the quality of the individual's life, damage of the oral structure and disturbance of oral functioning, decreased ability to chew, compromising facial aesthetic, a negative influence on self-perception and diminishing of social interactions⁽¹⁻³⁾.

High long-term success rates and improved patients' quality of life were reported for implant-retained and -supported overdentures^(4, 5). A study found that after one year of follow-up, implant overdenture showed elevated implant and prosthetic survival rates, minimal complications, high patient satisfaction, and better biological parameters⁽⁶⁾.

Selection of an implant-retained overdenture attachment device depends on cost-effectiveness, appropriate amount of retention, anticipated degree of oral hygiene, bone availability, patient social position, patient perception, maxillomandibular relation, inter-implant distance and adversarial jaw status⁽⁷⁾.

Ball attachments are considered the simplest type of attachments for clinical application with tooth- or implant-supported overdentures⁽⁸⁾. Ball attachments could be less expensive, less sensitive to technique, less reliant on implant location, easier to clean and repair, easier to change and control the amount of retention, less inter-arch space, and better able to disperse functional forces compared to the bar/clip attachment overdenture⁽⁹⁾.

However, OT-Equators combines the simplicity of ball attachments, with the variety of retention levels and easy replacement options of Locators⁽¹⁰⁾. It provides many unique design advantages that are lacking from other systems: slightly lower height and smaller diameter, cleanliness construction and simple affordability⁽¹¹⁾.

The treatment with dentures retained or supported by mandibular implants has shown considerable improvements on masticatory efficiency in many studies⁽¹²⁾. Patients rehabilitated with traditional complete upper dentures and lower overdentures retained with two implants demonstrated higher levels of masticatory effectiveness, nearly 50% higher than those rehabilitated with conventional dentures⁽¹³⁾. This was explained by Fontijn-Tekamp⁽¹⁴⁾, who ensured that the involvement of denture stabilizing attachments decreases discomfort

and helps the patient to exert higher bite forces during function which can result in a higher chewing effectiveness.

This study aimed to evaluate chewing efficiency of the mandibular implant supported overdenture with OT Equator and mini ball and socket attachments. The null hypothesis of the study was that there is no difference between the chewing efficiency of the mandibular over denture with the two attachments.

II. Patients And Methods:

From the Removable Prosthodontics Department Clinic, Faculty of Dental Medicine, (Boys, Cairo), Al-Azhar University, 10 completely edentulous patients were randomly chosen, with average age of 45-55 years free from any systemic diseases that might affect implant placement. After clarification of the technique prior to study enrolment, informed consents were obtained from all participants.

For each patient, an acrylic complete denture was designed according to the conventional steps for complete denture construction with bilateral balanced occlusion principle. The denture was inserted into the patient's mouth after polishing, and verification of esthetics, stability, retention, occlusion, high spots and any sharp or overextension that could cause pain were checked. Post insertion instructions were done; patients were instructed to wear the dentures till adaptation was acquired.

By the aid of conventional surgical stent an initial penetration was made through the cortex of the bone using a pilot drill through the hole of the stent which represented the planned position of the implant. Then the sequence of the drills in the selected surgical kit were used until the osteotomies were completed. Two dental implants fixtures (nucleoss, menderes ,izmir , turkiye) with implant length 10 mm and implant diameter 3.5 mm were placed at the osteotomy site in the canine region. After three months, healing abutment was secured to each implant to allow the mucosa healing around the abutment for two weeks. Then the patient were divided randomly in to two groups: group I:(Five patients) received complete dentures supported by two implants with OT-equator attachment system and group II (five patients) received complete dentures supported by two implants with mini ball and socket attachment system.

After one year the attachments were exchanged; patients who received dentures with OT-equator attachment system received ball and socket attachment system and vice versa.

Chewing efficiency evaluation:

Group I and group II were subjected to the chewing efficiency test developed by Schimmel et al.,⁽¹⁵⁾ using Trident® (Mondelez International Inc, Turkey (chewing gums) watermelon (pale red) and spearmint (light green) chewing gum. 30 mm long strips of chewing gum were cut from both colors and stuck together manually, so that the test sample was 30*18*3 mm in dimensions. Patients were sat upright and asked to chew both gums for 5, 10, 20, 30 and 50 chewing cycles respectively. For each chewing cycles a new sample of chewing gum was used. A pause of 2-3 seconds was reported between each chewing sequence. The operator counted the chewing cycles. The samples were then spit into clear plastic bags after chewing the gums, which were labelled with corresponding numbers of strokes. After flattening to 1 mm thick 'wafers', all samples were analyzed.

Using Adobe Photoshop Elements, unmixed pixels were counted to measure the ratio of unmixed green color to the total surface by scanning with iPhone smartphone the samples from both sides with a fixed resolution (500 dots per inch). The scanned image was then copied into a fixed pixel image (1175 to 925) and placed in the format of Adobe Photoshop (psd.). In each image (area of 4779 pixels), a scanned piece of unmixed gum has been copied as a reference scale.

To select the unmixed green sections of the picture, the 'magic wand' tool was used (tolerance 20,25,30). On each hand, the numbers of selected pixels were registered from the histogram, and each tolerance was then determined as the mean of those figures. Subsequently a ratio was computed for the unmixed fraction (UF) using the following formula:

$$UF = \frac{(\text{Pixels green side a} + \text{Pixels green side b}) - 2 \times \text{Pixels of scale}}{2 \times \text{Pixels all}}$$

The measurements were performed at the time of insertion of overdenture(T1), after six months (T2), after twelve months (T3).

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Quantitative data were described using mean, standard deviation for parametric data after testing normality using Shapiro-wilk test. Significance of the obtained results was judged at the 5% level. Student t test ; for parametric quantitative variables was used to compare between two studied groups. Paired t test was used for comparison between T1, T2 and T3.

III. Results:

Table (1): The mean levels of unmixed fractions among group 1 and group 2 at different stroke numbers at(T1),(T2) and (T3).

		5 strokes	10 strokes	20 strokes	30 strokes	50 strokes
T1	GP (I) X±SD	0.324±0.0387	0.24±0.0806	0.1464±0.0548	0.0832±0.06	0.052±0.0656
	GP(II) X±SD	0.364±0.0412	0.28±0.049	0.254±0.0424	0.206±0.0387	0.178±0.0424
	P-value	0.1525	0.3707	0.0084*	0.0049*	0.0068*
T2	GP (I) X±SD	0.348±0.0361	0.252±0.0412	0.1722±0.052	0.1202±0.0721	0.0762±0.076
	GP(II) X±SD	0.372±0.0447	0.306±0.0566	0.298±0.0529	0.234±0.0346	0.202±0.0447
	P-value	0.3772	0.1228	0.0052*	0.0130*	0.0127*
T3	GP (I) X±SD	0.368±0.0265	0.276±0.0469	0.212±0.0624	0.202±0.0728	0.11±0.0678
	GP(II) X±SD	0.384±0.0173	0.3±0.06	0.304±0.0387	0.282±0.0447	0.23±0.051
	P-value	0.2188	0.5014	0.0256*	0.0695	0.0133*

Significant difference if (p≤0.05), values marked with (*) are significant.

As shown in Table (1), the mean levels of group I at the time of attachment connection were (0.324±0.0387, 0.24±0.0806, 0.1464±0.0548,0.0832±0.06 and 0.052±0.0656) at 5, 10, 20, 30 and 50 strokes respectively. The mean for group II were (0.364±0.0412, 0.28±0.049, 0.254±0.0424, 0.206±0.0387 and 0.178±0.0424) at 5, 10, 20, 30 and 50 strokes respectively. After 5 and 10 strokes, the differences between the two groups were statistically non significant with P>0.05 while after 20, 30 and 50 strokes, the difference was significant with P<0.05.

At six months from the time of attachment connection T2, the mean levels of group I were (0.348±0.0361, 0.252±0.0412, 0.1722±0.052, 0.1202±0.0721 and 0.0762±0.076) at 5, 10, 20, 30 and 50 strokes respectively. The mean levels of group 2 were (0.372±0.0447, 0.306±0.0566, 0.298±0.0529, 0.234±0.0346 and 0.202±0.0447) at 5 , 10, 20, 30 and 50 strokes respectively. After 5 and 10 strokes ,the difference was statistically non significant with P>0.05. At 20 strokes, 30 strokes and 50 strokes, the difference was significant with P<0.05.

At twelve months from the time of attachment connection T3, the mean levels of group I were (0.368±0.0265,0.276±0.0469, 0.212±0.0624, 0.202±0.0728 and 0.11±0.0678) at 5, 10, 20, 30 and 50 strokes respectively. The mean levels of group 2 were (0.384±0.0173, 0.3±0.06, 0.304±0.0387, 0.282±0.0447and 0.23±0.051 at 5 , 10, 20 , 30 and 50 strokes respectively.

After 5 ,10 and 30 strokes ,the difference was statistically non significant with P>0.05. At 20 strokes and 50 strokes, the difference was significant with P<0.05 .

IV. Discussion:

Due to its relative simplicity and minimal invasiveness, the implant-retained mandible overdenture is a highly effective prosthetic treatment and increases retention, stability, improved function, and overall patient satisfaction⁽¹⁶⁾.

Mandibular implant overdenture contributes to improved stability, support and retention, reducing the movement of dentures and helping to achieve greater chewing performance and bite force of mastication. Depending on age and type of food, the chewing performance with complete denture is reduced to one-fourth to one seventh of the performance of dentate subjects. Denture wearers therefore need seven times more chewing cycles to minimize food to half of its original size⁽¹⁷⁾.

The two-implant-retained mandibular overdenture treatment modality has been reported as the standard of care for edentulous mandibles^(18,19) , especially when finances prohibit more implant to be placed⁽²⁰⁾.

In this study, each patient in group I received mandibular overdenture retained by OT Equator attachment to improve denture retention and stability. Ammar et al.,⁽²¹⁾ assumed that OT-Equator attachment be recognized as a predictable and successful treatment option.

In this study, each patient in group II received mandibular overdenture retained by mini ball and socket attachment. High implant and prosthetic survival and success levels were shown by implant overdenture retained or supported by ball attachment systems. In the mid-term follow-up, a low number of complications, high patient satisfaction and successful biological parameters were experienced⁽²²⁾.

Chewing efficiency can be assessed objectively using clinical tests (masticatory efficiency, masticatory performance) or subjectively by means of questionnaire (masticatory ability), Most tests for chewing efficiency or performance evaluate the particle size dissolution of food stuffs after a given number of chewing cycles. The method used in evaluating chewing efficiency in this study (using two-colored chewing gums) was more

practical and had several advantages including; no special equipment and enabled assessment of the bolus formation and the degree of blending of the two-colored specimen proved was able to detect changes in dental state⁽²³⁾.

In the present study image processing for the two-color chewing gum mixing test developed by Schimmel et al.,⁽¹⁵⁾ was applied using a commercially available software package. Anastassiadou⁽²⁴⁾ stated that the use of chewing gum for chewing efficiency test had many advantages, during chewing there was no comminution of particles which might get stuck under dentures or were swallowed and therefore lost, for availability in stocks, cheap price and its chewing properties were familiar to most persons. Performing the two-color chewing gum test with visual assessment of the bolus was quick, simple and could be performed by nursing staff after minimal training.

The mean UF ratio decreased as the number of chewing strokes increased, which indicated an improvement in the patients' degree of color mixture and mixing capacity. A similar observation was noted in another crossover study⁽²⁵⁾. The 50 chewing cycles showed the less amount of variation of hue (high homogeneity of the hue). This fact was supported by Schimmel et al.,⁽¹⁵⁾ who said that the number of chewing cycles are inversely proportional with the variation of hue. Weijenberg et al.,⁽²⁶⁾ stated that increasing the number of chewing cycles for the same patient results in more mixing between particles of two-colored chewing gums and less UF which concomitant with our results.

The 20 and 30 cycles test seemed to be the most reasonable amount of cycles which can be used for comparison. This fact was confirmed by Schimmel et al.,⁽¹⁵⁾ who mentioned that the visual assessment scale was moderate to almost perfect at 20 chewing cycles. Schimmel et al.,⁽²⁷⁾ in another study confirmed that moderate to substantial inter-examiner agreement occurred in the specimen which was chewed for 20 or 30 cycles.

Statistical analysis of the results showed that the chewing ability of implant supported over denture with OT equator attachment is significantly higher than mini ball attachment.

It could be said that chewing efficiency is directly proportional with retention of the denture. The type of attachment used in implant supported mandibular overdentures may influence the retention and stability of the prosthesis and thus, masticatory function improved.

These findings agreed with Van kampen et al.,⁽²⁸⁾ who examined the hypothesis that greater retention and stability of the overdenture improve the masticatory function. They added that the attachment type in implant- supported mandibular overdentures may influence the retention and die stability, and thus the oral function, of the prosthesis.

In line with this explanation, Geertman et al.,⁽²⁹⁾ suggested that the increased retention and stability of the mandibular denture, rather than the degree of support by implants or alveolar mucosa, determine the wearer's ability to comminute food during mastication. This is in agreement with Van der Bilt et al.,⁽³⁰⁾ who affirmed that good oral function depends on the retention, stability and the attachment of the denture.

The chewing efficiency decreased with time in both attachments. This could be attributed to wear of resilient overdenture attachments that resulted in decrease in the retention values.

According to Rutkunas et al.,⁽³¹⁾ retention loss with equator attachment was mainly due to wear and permanent dimensional changes of the nylon inserts. This finding was also in agreement with Abi Nader⁽³²⁾.

According to Passia et al.,⁽³³⁾ and Ludwig et al.,⁽³⁴⁾ resilient attachments exhibit wear under functional loading or after many cycles of insertion and removal which may be due to friction between male and female components.

These finding agreed with Tomás et al.,⁽³⁵⁾ who explained in an in vitro study that the higher wear of both locator and OT equator attachment systems may be due to the various geometries of the plastic matrices of the two attachment systems that may resulted in higher friction forces or higher wear resistance of the retentive male components.

V. Conclusion:

OT Equator attachment is preferred regarding chewing efficiency in mandibular implant supported overdenture than mini ball attachment.

References:

- [1]. Lee JS, Weyant RJ, Corby P, Kritchevsky SB, Harris TB, Rooks R, et al. Edentulism and nutritional status in a biracial sample of well-functioning, community-dwelling elderly: the health, aging, and body composition study. *The American journal of clinical nutrition*. 2004;79:295-302.
- [2]. Emami E, de Souza RF, Kabawat M, Feine JS. The impact of edentulism on oral and general health. *International Journal of Dentistry*. 2013;13:1-7.
- [3]. Fromentin O, Lassauzay C, Abi Nader S, Feine J, de Albuquerque Junior R. Testing the retention of attachments for implant overdentures—validation of an original force measurement system. *Journal of Oral Rehabilitation*. 2010;37:54-62.
- [4]. Cune M, Burgers M, van Kampen F, de Putter C, van der Bilt A. Mandibular overdentures retained by two implants: 10-year results from a crossover clinical trial comparing ball-socket and bar-clip attachments. *International Journal of Prosthodontics*. 2010;23:310-17.
- [5]. Gargari M, Prete V, Pujia A, Ceruso F. Full-arch maxillary rehabilitation fixed on 6 implants. *Oral and implantology*. 2013;6:1-4.

- [6]. Scrascia R, Martinolli M, Venezia P, Casucci A, Ortensi L, Tallarico M. Feasibility of Low Profile Attachments to Improve Quality of Life on Patients with Implant-Retained Mandibular Overdenture: 1-Year Preliminary Results of a Multicenter Prospective Case Series Study. *J oral health dental manag.* 2018;17:1-5.
- [7]. Mombelli A, Van Oosten M, Schürch Jr E, Lang N. The microbiota associated with successful or failing osseointegrated titanium implants. *Oral microbiology and immunology J.* 1987;2:145-51.
- [8]. Becerra G, MacEntee MJT. A classification of precision attachments. *The Journal of prosthetic dentistry.* 1987;58:322-7.
- [9]. Sadowsky, Steven J. The implant-supported prosthesis for the edentulous arch: design considerations. *The Journal of prosthetic dentistry.* 1997;78:28-33.
- [10]. Rhein83 USA Product Catalog. 2017.
- [11]. Xhanari E, Scrascia R, Kadiu B, Tallarico M. Two implants supporting a mandibular overdenture to rehabilitate Cawood and Howell Class V and VI patients: A proof-of-concept study. *J Oral Science Rehabilitation.* 2017;3:52-9.
- [12]. Pan Y-H, Lin T-M, Liang C-H. Comparison of patient's satisfaction with implant-supported mandibular overdentures and complete dentures. *Biomedical journal.* 2014;37(3):156-62.
- [13]. Laner B R, Cesar B, Selma S, Marcelo P, Wilson Jr M, Osvaldo dF, et al. Bite force and masticatory efficiency in individuals with different oral rehabilitations. *Open Journal of Stomatology.* 2012;2: 21-6.
- [14]. Fontijn-Tekamp F, Slagter A, Van Der Bilt A, VanT Hof M, Witter D, Kalk W, et al. Biting and chewing in overdentures, full dentures, and natural dentitions. *Journal of dental research.* 2000;79:1519-24.
- [15]. Schimmel M, Christou P, Miyazaki H, Halazonetis D, Herrmann FR, Müller F. A novel colourimetric technique to assess chewing function using two-coloured specimens: validation and application. *Journal of Dentistry.* 2015;43:955-64.
- [16]. Park JC, Kim HD, Kim SM, Kim MJ, Lee JH. A comparison of implant stability quotients measured using magnetic resonance frequency analysis from two directions: a prospective clinical study during the initial healing period. *Clinical Oral Implants Research.* 2010;21:591-7.
- [17]. Koc D, Dogan A, Bek B. Bite force and influential factors on bite force measurements: a literature review. *European journal of dentistry.* 2010;4:223-32.
- [18]. Thomason JM, Feine J, Exley C, Moynihan P, Müller F, Naert I, et al. Mandibular two implant-supported overdentures as the first choice standard of care for edentulous patients-the York Consensus Statement. *British dental journal.* 2009;207:185-6.
- [19]. Feine J, Carlsson G, Awad M, Chehade A, Duncan W, Gizani S, et al. The McGill Consensus Statement on Overdentures. Montreal, Quebec, Canada. *The International journal of prosthodontics.* 2002;15:413-414.
- [20]. Khalifa AK, Abdel-Khalek EA, El Mekawy N. Comparing masticatory efficiency of mandibular bar-supported overdentures with different loading protocols. *Egyptian Dental Journal.* 2018;64:1159-67.
- [21]. Ammar NA, El-Khodary NM, Abdelhamid AM. Clinical Evaluation of the Implant Retained Overdenture with OT-Equator Attachments. *International Journal of Science and Research.* 2013;14:643-47.
- [22]. Ortensi L, Martinolli M, Borromeo C, Ceruso FM, Gargari M, Xhanari E, et al. Effectiveness of Ball Attachment Systems in Implant Retained-and Supported-Overdentures: A Three-to Five-Year Retrospective Examination. *Dentistry journal.* 2019;7:84-92.
- [23]. Ahmad SF. An insight into the masticatory performance of complete denture wearer. *Annals of Dentistry University of Malaya.* 2006;13:24-33.
- [24]. Anastassiadou V, Heath M. The development of a simple objective test of mastication suitable for older people, using chewing gums. *J Gerodontology.* 2001;18:79-86.
- [25]. Elsyad MA, Khairallah AS. Chewing efficiency and maximum bite force with different attachment systems of implant overdentures: a crossover study. *Clinical oral implant research.* 2017;28:677-82.
- [26]. Weijenberg R, Scherder E, Visscher C, Gorissen T, Yoshida E, Lobbezoo F. Two-colour chewing gum mixing ability: Digitalization and spatial heterogeneity analysis. *Journal of oral rehabilitation.* 2013;40:737-43.
- [27]. Schimmel M, Christou P, Herrmann F, Müller F. A two-colour chewing gum test for masticatory efficiency: development of different assessment methods. *Journal of oral rehabilitation.* 2007;34:671-8.
- [28]. Van Kampen F, Van Der Bilt A, Cune M, Fontijn-Tekamp F, Bosman F. Masticatory function with implant-supported overdentures. *Journal of dental research.* 2004;83:708-11.
- [29]. Geertman M, Slagter A, Van Waas M, Kalk WJ. Comminution of food with mandibular implant-retained overdentures. *Journal of Dental Research.* 1994;73:1858-64.
- [30]. Van Der Bilt A, Van Kampen FM, Cune M. Masticatory function with mandibular implant-supported overdentures fitted with different attachment types. *European Journal of Oral Sciences.* 2006;114:191-6.
- [31]. Rutkunas V, Mizutani H, Takahashi H, Iwasaki NJ. Wear simulation effects on overdenture stud attachments. *Dental materials journal.* 2011; 30:845–853.
- [32]. 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. *Journal of oral rehabilitation.* 2011;38:157-64.
- [33]. Passia N, Ghazal M, Kern M. Long-term retention behaviour of resin matrix attachment systems for overdentures. *Journal of the mechanical behavior of biomedical materials.* 2016;57:88-94.
- [34]. Wolf K, Ludwig K, Hartfil H, Kern M. Analysis of retention and wear of ball attachments. *J Quintessence international.* 2009;40:405-12
- [35]. Mínguez-Tomás N, Alonso-Pérez-Barquero J, Fernández-Estevan L, Vicente-Escuder Á, Selva-O. In vitro retention capacity of two overdenture attachment systems: Locator® and Equator®. *Journal of clinical and experimental dentistry.* 2018;10:681-86.

KARAM AA, et. al. "Evaluation of chewing efficiency of the mandibular implant supported overdenture with two types of low-profile attachment: Crossover study." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(04), 2021, pp. 01-05.