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Original Article

Masticatory Efficiency and Maximum Bite Force of Patients Using Two- Implant Mandibular Overdentures Retained By Equator or Locator Attachments: A Crossover Study

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Abstract :

Aim: The aim was to compare the efficiency of mastication and maximum bite force of patients using two-implant overdentures with equator or locator attachments.
Subjects and methods: Twelve edentulous patients were recruited in the study. The patients were provided with new complete dentures and wore them for three months (CD, control group). Then two implants were installed bilaterally at the mandibular canine areas. Patients received overdentures that were attached to the implants with either equator (EOD) or locator attachments (LOD) randomly in a crossover design. The mixing ability test was used to assess chewing efficiency. The hue variation of mixed two different colored chewing gums was determined after five, ten, twenty, thirty, and fifty masticatory strokes. A digital bite force transducer was used to determine the maximum bite force. Both chewing efficiency and bite force were assessed after wearing CD, EOD, and LOD prostheses.
Results: Comparison between groups revealed a statistically significant difference ($p < 0.0001$) in hue deviation across groups for each masticatory stroke. The values for deviation in CD were the highest, followed by the EOD values. The values for deviation in LOD group were the lowest. There were statistically significant differences ($p < 0.0001$) in the mean values of maximum bite force between the groups. The greatest maximum biting force was found with LOD, followed by EOD, while the lowest biting force was found with CD. Regardless of attachment type, overdentures (EOD, LOD) had considerably greater maximum biting forces than complete dentures.
Conclusion: Within the limits of this study, it was concluded that overdentures retained with locator attachments have higher masticatory efficiency and maximum biting force than overdentures retained with equator attachments.
Keywords: Equator attachment, locator attachment, overdenture, maximum bite force, masticatory efficiency.

Introduction:

Traditional complete dentures, particularly the mandibular ones, frequently caused problems for edentulous patients. The denture-bearing area of the mandibular denture is small and its load-bearing capacity is low, resulting in poor denture stability and retention. This leads to psychological and functional limitations such as improper chewing function, poor nutrition, and reduced quality of life.[1-3] Based on the existing evidence, it seems that complete denture restoration of the edentulous mandible is no longer the recommended prosthodontic treatment and that implant overdenture should be investigated as the first line of treatment for edentulous patients.[4-6]

Implant-retained overdenture is an effective treatment option for edentulous individuals that is generally easy and minimally invasive. The advantages of mandibular implant overdenture therapy over complete denture treatment are widely recognised.[7,8] The implant overdenture compensates for the lack of stability and retention in traditional dentures. Also, it has been shown to be superior to conventional dentures in terms of patient satisfaction and masticatory performance. Furthermore, it is clinically successful, cost-effective for patients, and offers excellent retention for the prosthesis.[9,10]

For the purpose of retaining implant overdentures, many attachment types have been developed. These attachments are either unsplinted or splinted anchorage systems. Unsplinted attachments have been adopted in several implant overdentures because of the smaller space needs inside prostheses, easier maintenance requirements, and more inexpensive cost.[11,12] Furthermore, the self-standing attachments have the advantages of lesser sensitivity to techniques, easier repairability, and being able to be used in a small inter-arch space. Attachment system selection is affected by certain factors that should be decided on early in the treatment process. These include implant alignment, the amount of retention needed, and the condition of the edentulous ridge.[13-14]

When fabricating an attachment-retained implant overdenture, it is important to ensure that there is enough space for the components of the attachment system. Insufficient room for the attachment may result in an increased vertical dimension, an overcontoured denture, or fractured teeth next to the attachments. Also, the inadequate space may lead to attachment separation from the denture, fractured prosthesis, and patient dissatisfaction. So, prosthetic space analysis is important for planning a good mandibular overdenture.[15-17]

The locator attachment has been widely marketed over nearly the last decade since it is simple to use, has minimal starting expenses, and is compatible with implants from a variety of manufacturers. It has a dual retention, which comes from the inner and outer contact surfaces between the female and male parts, as well as the frictional retention from the male part being a bit bigger than the inner ring of the abutment.[18,19] Also, it is recommended because of its self-aligning capability, as the abutment round edges assist the denture during insertion, creating durable attachment while reducing wear. Furthermore, it has built-in angulation compensation as it can compensate for unparallel implants up to a 20-degree inclination in the standard type and up to a 40-degree inclination in the extended range type. It has the advantages of easy and fast replacement of its components and ease of insertion intra-orally by the patient. When compared to ball and magnetic attachments, it has been shown that locators offer much more stability and retention.[20-22]

The equator attachment was introduced in 2007, and it is available for all implant types, dimensions, and connections. It is a small dimension overdenture attachment, in terms of diameter and height. The maximum vertical dimension of the attachment, retentive cap, and housing is 2.1 mm with a diameter of 4.5mm.[23,24] The equator attachment is offered in different gingival heights, ranging from half to seven millimetres. It can correct implant divergence up to 25 degrees between implants without affecting the nylon caps. However, the system has not been extensively researched, and there are few references in the literature that test its clinical efficacy.[25,26]

Equator and locator attachments have a low-profile design, which offers multiple solutions for overdenture treatment planning when there is a limited inter-arch space.[27,28] Both types of attachments come in a variety of retention levels, and their retention caps must always be used in conjunction with metal housings to ensure ease of replacement.[29-31] Also, they have the benefit of being resilient, shifting the occlusal load away from the implants. They are cost-effective, simple, and easy to repair and maintain oral hygiene measures. [32,33] Cervino et al 2019[23] compared the retention of both attachments and found that the equator had a more gradual loss of retention than the locator attachment. They also claimed that both attachments have a high drop in retention that stabilized after about a year and a half of use. Fayad and Abd Alsamad 2017[34] compared the hard tissue response between both attachments and found insignificant differences in crestal bone height between both attachments and a significant increase in bone density in the locator group compared to the equator group after twelve months of prosthetic loading.

Masticatory efficiency, defined as the proportion of distributed food particle size after a certain count of chewing cycles, is used to measure the quality of mastication. Several factors, including the prosthesis type, the occlusal scheme, the number of teeth, and the maximum bite force, might influence the chewing efficiency.[35,36] Either a questionnaire or particle grinding and size reduction during mastication can be used to measure chewing efficiency. Particles used in testing may be natural foods or synthetic ones. The synthetic testing materials include condensation silicone, chewing gum, and modified gelatin.[37,38] Digital assessment of masticatory efficiency using a two-color mixing ability test has been widely used throughout the previous decade. To increase the reproducibility of the test results, the hues of chewing gum with two different colours are quantified using digital software.[39-41]

Bite force is described as "the force exerted by masticatory muscles on the occlusal surfaces of teeth." It has a significant impact on the masticatory system. Many instruments are used to record the biting force. Most of these devices employ force transducers such as strain gauges, piezoresistive, piezoelectric, optical fiber, and pressure-sensitive films.[42]

Reviewing the literature revealed no clinical studies that compared the masticatory efficiency and biting force between the equator and locator attachments in two implant overdentures. Hence, the purpose of this study was to compare the efficiency of mastication and maximum bite force of patients using two-implant overdentures with equator or locator attachments. The null hypothesis of the present study was that there would be insignificant differences in masticatory efficiency as well as maximum bite force between the two attachments.

Subjects and methods:

1- Participant selection and study design:

For this study, twelve completely edentulous patients (eight males and four females) with an average age of 60.3 ±4.4 (ranging from 54 to 68 years) were chosen from the outpatient clinic of the Removable Prosthodontic Department. Inclusion criteria include: Complete lower and upper edentulism with poor stability and retention of the mandibular denture, an Angle class I maxillo-mandibular relationship, sufficient bone in the mandibular inter-foraminal region that allowed implant installation with a minimum length of 13 mm and diameter of 3.7 mm, accepted to be treated with a two-implant overdenture, and agreed to attend the follow-up visits. Exclusion criteria involve: any medical condition that contraindicates the implant surgery; a history of chemotherapy or radiotherapy in the neck and head area; smoking habits; and uncooperative patients.

The sample size was calculated considering masticatory efficiency as the primary outcome. It was determined by the findings of a previous crossover trial[43] (effect size =0.82, α =0.05, β =0.95). To account for potential dropouts, the sample (10 patients) was raised to 12 patients. The power analysis was done using computer software (G. Power 3.1.5).

The selected participants were informed about the surgical and prosthodontic procedures and the prosthetic options before signing the informed consent form. The research was carried out in accordance with Helsinki ethics rules and was authorized by a local ethical review board. The guidelines of CONSORT (Consolidated Standards of Reporting Trials) were followed.

All selected participants received a new complete denture (CD, control), and after three months of neuromuscular adaptation, the evaluations of masticatory efficiency and maximum bite force were performed. Two implants were installed in the mandibular inter-foraminal region. Three months later, the patients were rehabilitated with overdentures retained with either equator attachments (EOD) or with locator attachments (LOD). Using random numbers in a Microsoft Excel spreadsheet, participants were randomly allocated to two sets: (EOD-LOD) group: consists of six patients who received EOD and then LOD. (LOD-EOD) group: consists of six patients who received EOD and then LOD. An independent dentist who was blind to the type of overdenture performed the randomization.

After three months of using the first attachment, chewing efficiency and maximum bite force were measured. This was followed by a one-month washout period during which the attachments were removed and the patients received a conventional mandibular denture. After this wash-out phase, the patients were given the second attachment. The parts of the attachment that were screwed to the implants or embedded in the denture fitting surface were changed using a predetermined crossover sequence. After three months of using the second attachment, chewing efficiency and maximum bite force were assessed. Randomization was used to prevent the influence of the sequence of attachment on the study's outcome measures.

II- **Surgical and prosthodontic procedures:**

The conventional method was used to construct new maxillary and mandibular conventional complete dentures with a bilateral balanced occlusal concept for each participant.[44] Alginate impression material (Cavex, Holland, Netherlands) was used to make a preliminary impression. A custom acrylic resin tray (Cold cure resin, Acrostone, Cairo, Egypt) was fabricated on the study cast and then border molded using green stick compound (Perfectin, S.A.I.C., Hubac, Buenesaires, Argentina). The final impression was performed using zinc-oxide impression paste. (Cavex non-eugenol impression paste, Hollad, BV, Netherlands).

The record bases with occlusal rims were fabricated and utilized to register the maxillary-mandibular jaw relationship. Using a face-bow record, the maxillary cast was affixed to a semi-adjustable articulator (Hanautm Wide; Whip Mix Corporation, Farmington Ave, Louisville, KY, USA). A centric jaw-relation record was used to mount the mandibular cast on the articulator. A protrusive record was taken in order to adjust the articulator's condylar guidance. Semi-anatomic acrylic teeth (Acrostone, Cairo, Egypt) were used to provide a bilateral balanced occlusion.

Following the try-in visit, the denture was given to the participants. The patients were scheduled for three follow-up visits for denture and occlusal adjustments. Participants were instructed to wear their complete dentures for three months prior to implant insertion (CD, control) to allow for neuromuscular adaption.

Duplication of mandibular dentures was performed to create a radiographic template. At the buccal and palatal surfaces of the mandibular duplicate dentures, radiopaque markers (gutta-percha) were applied to the polished surface. Each participant had a dual scan technique utilizing CBCT (Vatech, Seoul, Korea). The first scan was carried out while the patient wore the upper complete denture and the lower duplicate denture and was closed in a centric occlusion. The second scan was only for the mandibular denture alone. Using computer planning software, the two scans were merged into a 3-dimensional picture of the edentulous mandible (OnDemand3D, Cybermed Inc., Seoul, Korea). The program was utilized for virtual planning of the implant's position and angulation. The implants were inserted bilaterally in the canine region. The virtual plan was saved as an STL file and used to make a stereolithographic surgical guide for flapless implant placement that was supported by the mucosa.

Using a flapless surgical procedure, two implants, each 13 mm long and 3.7 mm in diameter (Tapered screw vent, Zimmer Dental, Carlsbad, CA, USA) were installed in the region of the mandibular canines. After implant insertion, a periapical radiograph was done to evaluate the implant's location. This was followed by screwing the healing abutments and relieving the mandibular dentures, then relining with a tissue conditioning material (Visco-gel, Dentsply, Weybridge, Surrey, UK). After three months, implant osseointegration was evaluated both clinically and radiographically.

The equator attachment used was the OT equator (Rhein, Bologna, Italy). The vertical height and the diameter of the attachment, retentive cap, and housing are 2.1 mm and 4.5 mm, respectively. The kit consists of an OT equator abutment, a stainless-steel housing, a protective disc, metal housings, and retentive caps (a pink cap that provides 1200 g soft retention was selected for the study). The locator attachment used was the standard range type (Zest Dental Solution, Escondido, CA, USA). The attachment has a 4.5 mm diameter and 3 mm cuff height. The kit consists of a female part that is screwed to the implant. While the male replacement used was the one with a pink color that provided light retention. Also, there was the metal housing, black processing male, and blocking rings that were used during picking up the attachment. Both attachments were screwed into their fixture with a tightening force of 35Ncm. ***(Fig.1 A) (Fig. 2 A)***

Under the closed-mouth technique, direct picking-up was done. The mandibular denture's fitting surface opposing the abutments was adequately relieved. Two small vent holes were cut into the denture’s lingual surface for escaping excess resin during the pick-up technique. Protective discs and blocking rings were placed over the Equator and Locator attachments, respectively, to minimize resin infiltration. For equator attachment, the metal housing with the nylon caps were snapped over their abutments, then picked up to the fitting surface of the lower denture using self-curing resin while the patient was closed in centric relation. For locator attachment, the metal housing with the black processing rings was positioned over their corresponding abutments and picked up using the same technique as equator attachment. Then the black processing rings were replaced by pink male nylon caps. In both attachments, once the resin is hardened, the denture is cleaned and polished, then inserted, and pressure areas were identified using pressure indicating paste. To provide a balanced occlusion in a centric relation free of anterior tooth contact, occlusion was evaluated on the articulator and intraorally.

III. Outcomes assessment

1. Assessment of masticatory efficiency:

The colour mixing ability test was used to assess chewing efficiency. Chewing samples were prepared using chewing gum in two different colors (Trident watermelon and Spearmint flavor, Mondelez Global,USA). To create a test sample (45mm x10mm x 3mm), the two different colored gums (red &white) were manually adhered to each other. Each participant was given five test gum samples to chew it for five (S1), ten (S2), twenty (S3), thirty (S4), and fifty (S5) chewing strokes separated with thirty-minute breaks to prevent muscular fatigue. The chewed sample removed, dried, put between pair of cellophane sheets. Then it was pressed until it had a consistent thickness of one millimeter. A digital camera (Nikon D5600/22.2 MP, Sony, Thailand) was used for photographing both sides of each sample under controlled lighting conditions. To standardize the sample-camera distance, the camera was mounted on a tripod. The picture dimension specification was set at 7200 x 4800 pixels with a resolution of 600 dpi. Both sides' photos were blended into a single image file.

Image assessment was done using software (View Gum, Greece) that automatically predicts the hue value of each pixel in a picture by transforming the image to hue saturation. Using the selection tool, multiple yellow dots were drawn to select only the foreground of the photos. while the "Shift" key was used to draw the red dots to recognize the background of the photo. [45] The average, standard deviation and the number of pixels of mixed color were then determined. The hue deviation was regarded as the measurement parameter for the colour blending effect. High magnitudes of hue axis standard deviation, suggested insufficient colour mixing (lower chewing efficiency), whereas low standard deviation values indicated proper mixing (higher chewing efficiency). ***(Fig. 3)***

2. Assessment of maximum bite force:

A digital force transducer was used to measure the maximum biting force (GM10, Nagano Keiki,Tokyo japan). This device calculates the biting force and displays it digitally.[43,46] It contains a gauge that is pressure-sensitive with a vinyl portion for biting and is contained in a disposable plastic occlusal cap. The device occlusal cap, was placed in the first molar area, between the occlusal surfaces of teeth. For a few seconds, the patient was asked to bite on the transducer as hard as he could. The reading was repeated three times for both sides, and the mean was determined in Newton (N).***(Fig. 4)***

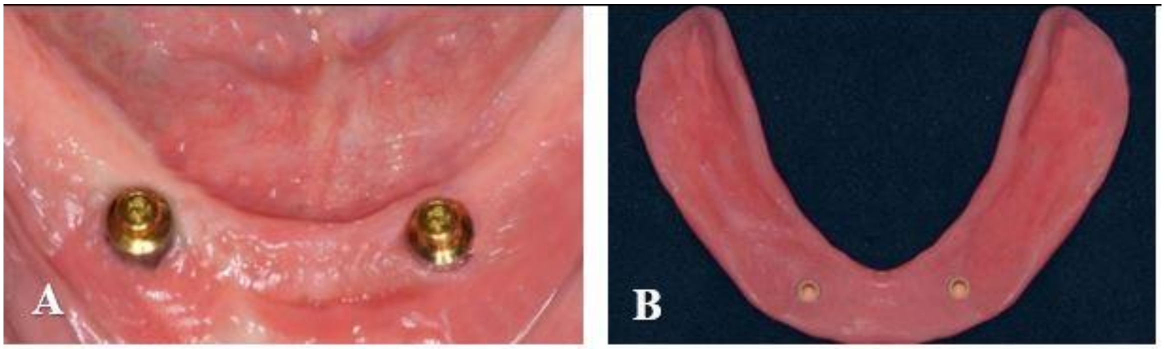

Fig. 1 (A): The equator attachments are screwed into the implants.**(B)** The metal housings with the retentive caps of the equator attachment are attached to the fitting surface of the overdenture.

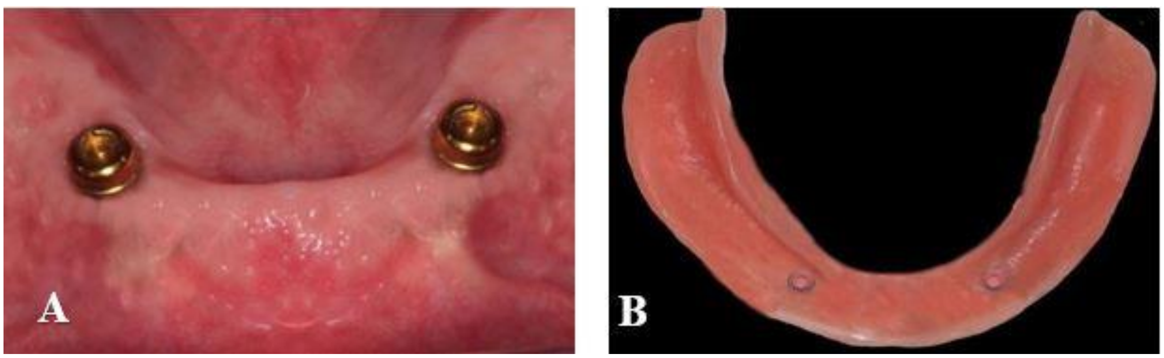

Fig. 2 (A): The locator attachments are screwed into the implants.**(B)** The metal housings with the retentive caps of locator attachment are attached to the fitting surface of the overdenture.

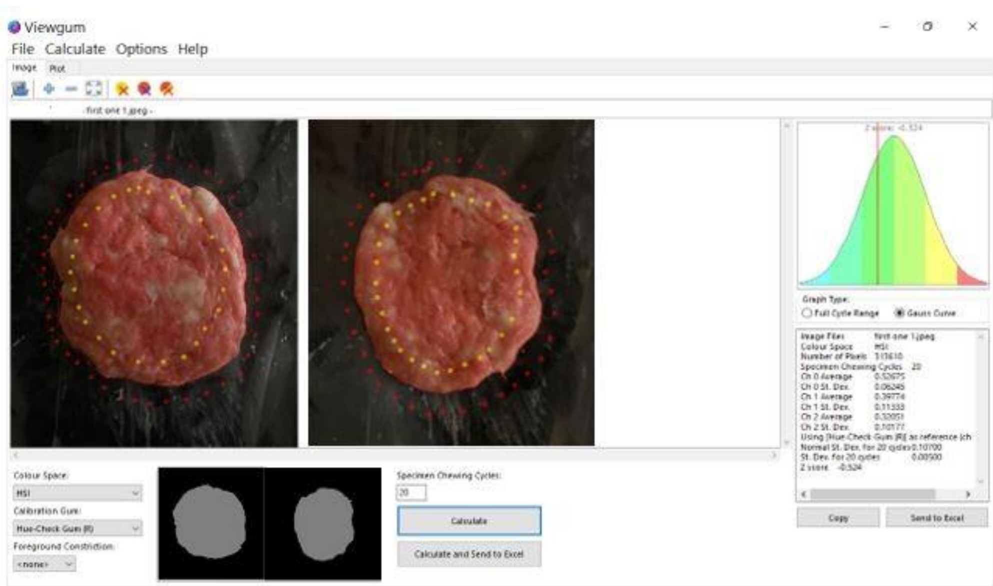

Fig. 3: Assessment of hue deviation of a chewing gum sample with a software.

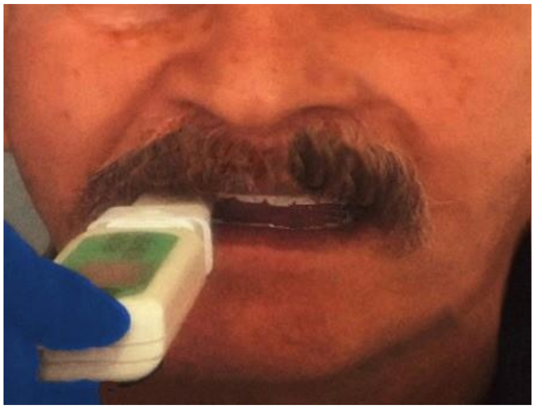

Fig. 4: Measurement of maximum bite force using force transducer.

IV- Statistical analysis:

To determine the normal distribution of the evaluated parameters, the Shapiro-Wilk test was performed. The findings of the study followed a normal distribution and were parametric. Chewing efficiency was analyzed using repeated-measures ANOVA to make group (CD, EOD, LOD) comparison and chewing-stroke (S1, S2, S3, S4, and S5) comparisons. To compare the maximum bite force between groups, one-way ANOVA was used. The Tukey test for multiple comparisons was performed after both tests. For data analysis, SPSS software (version 22.0) was utilised. The threshold for statistical significance was set at $p < 0.05$.

Results:

During the course of the study, no implants were lost. All the participants had osseointegrated implants with a 100% survival rate at one-year follow-up, and no patients dropped out of the follow-up visits.

I- Results of masticatory efficiency:

Table 1 compares the chewing efficiency as expressed in hue deviation across groups and chewing stroke counts. Within each group, the hue deviation differs significantly in terms of the number of masticatory strokes ($p < 0.0001$). The greatest value was at S1, followed by S2, S3, S4, while the lowest value was at S5. The hue deviation tended to diminish as the number of masticatory cycles became higher. There was no significant difference in hue deviation across groups at S4 and S5 strokes.

Comparison between groups revealed a statistically significant difference ($p < 0.0001$) in hue deviation across groups for each masticatory stroke. The values for deviation in CD were the highest, followed by the EOD values. The values for deviation in LOD group were the lowest.

II-

III- Results of maximum bite force:

Maximum bite forces, measured in Newtons (N), are compared between groups in ***Table 2***. There were statistically significant differences ($p < 0.0001$) in the mean values of maximum bite force between the groups.The greatest maximum biting force was found with LOD, followed by EOD, while the lowest biting force was found with CD. Regardless of attachment type, overdentures (EOD, LOD) had considerably greater maximum biting forces than CD.

Discussion:

The crossover study design was used in this study to standardize patient characteristics such as age, sex, muscular tone, ridge relationship, and morphology. This ensures a more accurate assessment of masticatory efficiency as well as bite force.[43,47] After inserting new dentures, the muscles of mastication return to their original activity level after a 3-month adaptation time, which was justified as providing satisfactory neuromuscular adaptation for complete denture wearers.[48] There is some debate about the best timing for neuromuscular adaptation after replacing missing teeth with implant overdentures.[49] Some authors reported that one month was regarded as adequate for establishing well-coordinated muscular activity. Others evaluated the masticatory abilities of implant-supported prostheses during a two-month adaptation period.[50] Van Kampen et al[51] found excellent neuromuscular control may be achieved three months after implant overdenture therapy when maximal bite force is comparable to that of dentate participants. Therefore, it was planned to give all of the prostheses tested a three-month adaptation period.

Table 1: Hue deviation across groups at various chewing stroke counts.

	S1		**S2**		**S3**		**S4**		**S5**		**P**
	/X	**D**	**/X**	**D**	**/X**	**D**	**/X**	**D**	**/X**	**D**	
CD	0.581A	0.052	0.504A	0.084	0.437A	0.046	0.418A	0.039	0.372A	0.013	<0.0001*
EOD	0.418B	0.073	0.339B	0.041	0.262B	0.086	0.255B	0.078	0.236B	0.033	<0.0001*
LOD	0.277C	0.015	0.228C	0.055	0.169C	0.022	0.157C	0.011	0.142C	0.009	<0.0001*
P	<0.0001*		<0.0001*		<0.0001*		<0.0001*		<0.0001*		

/X: mean ; D: standard deviation.
* Significant if P equal or less than 0.05 according to ANOVA test
Variation in letters within a single column denotes statistically significant differences across groups.
CD: Complete denture; EOD: Equator overdenture; LOD : Locator overdenture.
S1: 5 strokes; S2: 10 strokes; S3:20 strokes; S4: 30 strokes; S5:50 strokes.

Table 2: Group comparison of maximum bite forces.

	/X	**D**	**M**	**Min**	**Max**
CD	70.64 A	4.99	70.00	61.00	79.50
EOD	101.14 B	3.64	100.85	95.50	106.60
LOD	107.42 C	5.06	108.90	98.80	116.00
ANOVA test P value	P<0.0001				

/X: mean ; D: standard deviation; M: median; Max: maximum, Min: minimum.
* Significant if P equal or less than 0.05.
Variation in letters within a single column denotes statistically significant differences across groups.
CD: Complete denture; EOD: Equator overdenture; LOD : Locator overdenture.

Chewing gum has several advantages when used to assess chewing efficiency. The absence of ground food particles that may become lodged underneath overdentures or ingested and lost during testing.[36] Furthermore, the gum has an elastic nature that allows for maximum muscular action. Chewing gum is also generally accessible, stockable, and reasonably priced.[43]The digital evaluation of chewing gum with two different colors by the mixing ability test was used to assess the chewing efficiency because it has several advantages, such as ease of application, cost effectiveness, and reduced time required to process chewed test samples. Also, since the hue variance was assessed, the drop in the gum volume didn't change the results.[45] Moreover, no food substances escape during chewing through the denture bases or get ingested. [52,35]

In our study, the number of chewing strokes was shown to be inversely related to hue deviation across all groups. As the number of chewing strokes increases, there is a statistically significant decrease in the hue variance. This showed that the gum's colour mix and the ability of food mixing were improved. Similar results were observed in other crossover studies that compared various mandibular implant overdentures using different types of attachments.[43,47] When the frequency of masticatory strokes was increased, the gum shrank as the sweetener was extracted. This results in a smaller hue deviation.[38]

Masticatory efficiency can be measured by the decrease in chewing gum volume and color mixing.[53,54] As a result, an individual's chewing efficiency is increased when the hue deviation is reduced. But after thirty strokes of chewing, the hue variance was statistically insignificant across groups. Other studies also showed a similar finding.[47,36] Therefore, a total of thirty strokes of chewing are required to compare the masticatory performance of various prostheses.

The results of this study indicated that there were significant differences between the three types of prostheses regarding chewing efficiency as well as maximum bite force. The reduced masticatory performance of CD compared to EOD and LOD might be due to movement of the lower dentures and retention of food particles beneath the denture base . This shifting of mucosally supported CD cause limitation of the action of muscles and potentially causing pain or discomfort while chewing.[55]

Comparing the three prostheses used in this study, the EOD and LOD have significantly higher chewing efficiency than the CD. This could be attributed to implant placements that enhance osseo-perception, activate the brain in the same way that natural teeth do, [56] and improve tactile sensation. All of which may account for the improved chewing efficiency.[57] Compared to CD, implants offer better stability, support, and retention of the denture, as well as more consistent occlusal contact and more comfort while chewing.[58] The patient was also better able to grind food while chewing because the implants made the mandibular denture more stable and retentive. [59]

Elsyad et al [35,60] found that implant-supported prostheses resulted in significantly increased activity of the muscles of mastication compared to CD. Similar results have been obtained by Muller et al[55] who found that implant overdentures exceeded CD in terms of chewing efficiency. The higher chewing efficiency of EOD and LOD than CD might be due to the presence of attachments, which improve the denture's retention and stability and reduce patient discomfort while allowing him to apply greater biting force during chewing. Several authors [43,59,61] reported an increase in maximum bite force following implant overdenture therapy. This type of therapy allows for increased use and training of the muscles of mastication. Furthermore, there was no longer a need to fix an unretentive denture after implant therapy, so this will result in an increase in muscle thickness with a reduction of the resting muscular activity.

The results of this study revealed that the masticatory efficiency and biting force of overdentures retained by equator or locator attachments differ significantly. As the LOD had much superior chewing efficiency and maximal biting force than the EOD. The increased retention and stability of the locator attachment compared to equator might explain this result. Some authors [62,63] confirmed the locator's initial higher retention values when compared to the equator. This increased retention might increase the efficiency of mastication as well as the maximum biting force. This is in agreement with van der Bilt et al[64] who affirmed the impact of prosthesis retention and stability as well as the type of attachment on maximum bite force and chewing efficiency.

The locator attachment exceeded the equator attachment in terms of retention because of its dual retention feature and its nylon insert's relatively larger surface area, both of which aid in amplifying the impact of friction between both locator's components. This is in accordance with Satti[65] who compared the locator with the equator attachment. Also, Hegazy et al[66] found that the retention values of locator attachment overdenture were significantly greater than the retention registered by equator overdenture. They attributed these results to the locator attachment's design where the male nylon component grabs the inside and outside contours of the locator's abutment. This distinguishing quality doubles the available surface area for retentive grip. The equator, on the other hand, offers a wide range of retention levels but with no doubling of the surface area for retention.[67]

Generally, the null hypothesis of no significant differences in masticatory efficiency as well as maximum bite force between the equator and locator attachments was rejected. However, the present investigation is constrained by its limited sample size and brief duration of follow-up. In order to assess the chewing performance of different attachments retaining implant overdentures, further clinical research should be undertaken with larger cohorts and longer evaluation intervals.

Conclusion:

Within the limits of this study, it was concluded that overdentures retained with locator attachments have higher masticatory efficiency and maximum biting force than overdentures retained with equator attachments.

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Conflict of Interest:

The authors declare no conflict of interest.

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