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Masticatory Efficiency Evaluation in Implant Retained Complete Overdenture With Different Occlusal Schemes

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ABSTRACT

Objective: This study was conducted to evaluate the masticatory efficiency in immediately loaded implant retained mandibular complete over denture with two different occlusal schemes namely opposing conventional maxillary complete denture. **Patients and Methods**: Fourteen completely edentulous patients with age ranged from 51-61 years were selected from outpatient clinic of Removable Prosthodontics, Faculty of Dental Medicine, Al-Azhar University. One stage octa titanium implants with 3.75mm diameter and 14mm length were used. All Patients sharing in this study receive immediately loaded implant reteined mandibular overdenture. They were randomly divided into two equal groups (7 patients in each), the first group had the artificial teeth arranged in a median lingualized occlusio, while the second group had the artificial teeth arranged in a bilateral balanced occlusion. Masticatory efficiency measurements were taken at the first time of overdenture placement and after six months of over denture use. Paired t-test was used to evaluate the masticatory efficiency before and after adaptation period for each group. Independent t-test was used to compare the masticatory efficiency measurements between both groups. **Results:** At the time of denture placement, there was no significance difference in masticatory efficiency measurements between both groups. Masticatory efficiency was increased considerably after six months of denture use, and it was significantly higher than masticatory efficiency recorded at the time of new prosthesis placement in the same group. After six months of denture use, there was a significance difference in masticatory efficiency measurements between both groups. **Conclusions:** It was concluded that using lingualized occlusion concepts was resulted in increased masticatory efficiency more than bilateral balanced occlusion after six months of denture use in patients received immediately loaded implant retained mandibular overdenture with ball and socket attachment.

KEYWORDS

Masticatory efficiency;
acrylic dentures,
bilateral balanced occlusion,
median lingualized occlusion.

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INTRODUCTION

Effective masticatory function is one of the important goals of prosthodontic rehabilitation [1].Reduced masticatory efficiency is one of major complaints of edentulous patients wearing conventional dentures. In addition, the complex neuromuscular skills required to overcome the limitations of dentures diminish with aging. Although there has been an increase in rehabilitation with osseo-integrated implants, treatment with conventional complete dentures still remains the most common treatment for edentulous patients especially in low developed countries[2].

The low masticatory efficiency of denture prostheses impairs the ability of wearers to consume high-fiber foods. Hence, dentures with high masticatory efficiency are required [3].it also has consequences on both physical measures of general health and perceived general health status, as measured using generic health-related quality of life instruments[4] .

Chewing function can be assessed using chewing tests and questionnaires or personal interviews[4,5]. Methods used for evaluating masticatory performance have been broadly divided into either subjective methods or objective methods. The former are implemented through various questionnaires, while the latter indicate the condition of the chewed mastication material with a numerical value[6].

Though a number of objective methods of evaluating masticatory performance have been attempted, they require specific instruments, materials, or complicated procedures [7-10]. Both natural foods, such as peanuts, almonds and carrots, and synthetic materials have been used as test materials in experiments determining the masticatory performance[5].

Another method to determine masticatory performance, which is now widely used, evaluates the ability to mix and knead a food bolus. Two-coloured chewing gum and paraffin wax have been used as test foods for the quantification of the masticatory performance [5, 11].

Color-changeable chewing gum has been developed by a Japanese research group to allow for a simple measurement of masticatory performance through the color change of the chewing gum. The material is specially developed for that purpose (Masticatory Performance Evaluating Gum XYLITOL; Lotte Co., Ltd., Tokyo, Japan)[12].

Tarkowska et al.[13], mentioned that a measurement technique by means of a color-changeable chewing gum seems most likely to fulfill masticatory efficiency test requirements due to its simplicity and its reported superior differentiability.

Chewing gums that changes its color as it is chewed were chosen as a test food for evaluating masticatory performance as it is used easily by the dentist at the chair side in the clinic with better compliance from patient[14]. Colorimetric methods using color scales are inexpensive and simple to use. Furthermore, this method offers the advantage that the subjects can evaluate their own masticatory performance at any location[6].

Color-changeable chewing gum can be used as a stand-alone instrument for perceived chewing ability evaluation because it is a valid and reliable method for the evaluation of masticatory function[6, 13] . These tests have proven more accurate than subjective questionnaire-based methods that collect information on the opinions reported by both patient and professional[15].

In complete denture wearers, the ability to comminute food during mastication is reduced compared to adults with natural dentition, depending on the individual's age and type of food chewed owing to the biomechanical characteristics of exclusively mucosa-supported dentures[15].

The chewing forces used by denture wearers may be limited by the discomfort and the pain that happens when one or both of the dentures lose their retention, or even by the fear of such pain [16].

In an effort to improve the masticatory efficiency of complete denture wearers, three principal factors; retention, stability, and support should be considered for successful complete dentures. Treatment alternatives that aid in increasing retention and stability for improving denture function should be considered when conventional denture therapy is inadequate[17].

Some people do not succeed in acquiring new skills with their dentures and thus suffer psychologically because of impaired function, comfort, self-image and social interaction. These patients can be successfully treated with implant-retained overdentures. Several studies reported the clear benefits of overdenture treatment, versus the conventional denture for a number of aspects such as: aesthetics, speech, chewing, fit and retention, function and quality of life specially the lower ridge[18].

The two-implant mandibular overdenture provides greater retention than does a conventional mandibular denture and, due to its efficacy, can significantly improve an edentulous patient's quality of life[19].

The stability of the overdentures retained by two implants was excellent, and the lingual dimensions of the denture could be reduced to the level of the mylohyoid line to provide more space for the tongue[20].

The combination of a mandibular implant-supported or implant retained overdenture and maxillary conventional complete denture (CD) provides significant improvement in masticatory performance compared to CDs in both the mandible and maxilla[21, 22].

A study of chewing efficiency compared wearers of conventional complete dentures with wearers of implant-supported overdentures. The complete denture group needed 1.5 to 3.6 times the number of chewing strokes compared with the overdenture group[23, 24].

Bilaterally balanced occlusion provides primary stability of the dentures during functional loading and favors equilibration of occlusal loads due to simultaneous contacts on the working and nonworking sides[25, 26].

lingualized occlusion has many advantages as it applies to implant supported removable restorations include; occlusal forces that are centered over the ridge crest in centric relation, effective transfer of forces more "lingual" to the ridges during working side excursions and minimized occlusal disharmonies created from errors in jaw registrations, denture processing changes and / or eventual settling of the denture base. Additionally, the "mortar and pestle" type of occlusion minimizes the occlusal contact area and provides more efficient bolus penetration, while minimizing destructive horizontal forces [27-29].

The main advantages attributed to a lingualized occlusion are the absence of deflective occlusal forces between opposing teeth and the relatively natural appearance of the semi-anatomical posterior teeth [30, 31].

The present study is one of the few studies comparing masticatory efficiency between median lingualized occlusion and bilateral balanced occlusion in implant retained mandibular complete over denture opposing maxillary denture at the time of new denture placement and after six months.

PATIENTS AND METHODS

Fourteen completely edentulous patients with age ranged from 51-61 years (mean 53 Y) were selected from Removable Prosthodontic Out patient clinic, Faculty of Dental Medicine, Al-Azhar University. Informed consent was obtained from all subjects after an explanation of the methodology prior to enrolment in the study. The patients were free from any systemic or local diseases that make the placement of the dental implants contraindicated.

Patients sharing in this study were randomly divided into two equal groups: Group A: Patients recived a new complete denture with a bilateral balanced occlusion. Group B: Patients recived a new complete denture with a balanced median lingualized occlusion. (figure 1)

Fig. (1) Finished denture in place with median lingualized occlusion.

Fig. (2) The two ball attachments in place.

New upper and lower complete dentures were constructed as usual manner with specific occlusal scheme according to the patient group. The patient received the new conventional complete denture with even occlusion and free from discomfort. Patient was left for two months to be adapted to the new denture.

The following procedures were carried out for each patient: Diagnostic casts were made in alginate impression (Cavex, Holland) with dental stone (Elite Rock, Zhermack, Italy), and panoramic X-Ray film was taken (Vatech,Yongin-si, Korea) to aid in analysis of jaw relationships, inter arch distance as well as positions of implant.

Each patient received two immediately loaded implants (SwishPlant, Implant Direct, Las Vegas, USA) with 3.75 mm diameter and 14mm length. The implant is cylinder with reversed screw and hydroxyapetite coat.

After 48 hours of implant insertion, ball head abutment driver was used to insert ball head abutment with 2mm colar. The metal housing with rubber O-rings were incorporated into the ball abutments and the mandibular denture was checked for stability over the two ball abutment. Undercuts under the sockets were blocked out with soft wax. Immediately loaded implant with ball and socket attachment. (Figure 2)

Denture insertion

The mandibular denture was prepared for reciving the ball and socket attachment then inserted into the patient mouth and the patient was asked to bite forcibly on the mandibular denture at centric occlusion with Pink self cured acrylic resin (Vertex, Vertex-Dental B.V. Asia Pte Ltd, Zeist, Netherlands) in socket holes until complete setting of the acrylic resin.

Masticatory effieviency evaluation

The test item used for this study was a colour-changeable chewing gum (XYLITOL; Lotte Co., Ltd., Tokyo, Japan) The gum inside the packaging. (Fig. 3) The chewing gum (dimensions, 70 × 20 × 1 mm; weight, 3.0 g) initially shows a yellowish-green colour. The color of chewed gum was compared to the color scale provided by the manufacturer[14].

Measurement of masticatory performance using color changeable chewing gum

I- First measurement was done using chewing gum after first time of overdenture placement.

II- Second measurement was done after six months of overdenture placement as Goiato[2]suggested that more than five months was needed to evaluate patient adaptation and functional capacity with new complete dentures.

Fig. (3) Colour-changeable chewing gum (Masticatory Performance Evaluating Gum XYLITOL*).

The patients were instructed to, "Please chew the chewing gum well", without being given any instructions with regard to chewing side. Each subject was instructed to chew the gum irrespective of chewing side, for the instructed number of strokes. The patients rinsed their mouths with water for 15 s before chewing the gum for 100 strokes on their preferred side at a rate of one stroke per second, and this sequence was repeated three times with 30minutes' intervals. A mean value of three trials was used in analysis. After each trial the subjects were asked to rinse their mouth with water. The chewing gum was picked immediately after chewing then compressed between two glasses to evaluate its color [14, 32, 33].

The chewed bolus was assigned numeric scores according to the degree of color change; 0 %(green), 25 %(yellow), 50% (pale pink), 75% (pink), and 100% (red). One examiner performed all of color reading. The difference in masticatory efficiency after sex months was calculated and the mean of two groups was compared. Statistical analysis was completed using SPSS software V.20.

RESULTS

The masticatory efficiency with different occlusal schemes in implant retained mandibular complete over denture was evaluated.

First measurement

The mean value of color scale scores with bilateral balanced occlusion was 35.7 ±12.07. The mean value of color scale scores with median lingualized occlusion was 36.3±12.25. The independent t-test revealed that there was **no statistical difference** was found between both groups (p>0.05), at the time of new denture placement. (Table 1, Fig. 4)

Table (1) *Masticatory efficiency evaluation at the time of denture placement.*

Grouping		Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Mast_0	G1	35.75	12.07	1.9	.819
	G2	36.37	12.25	1.9	

G1: Bilateral balanced occlusion.

G2: Median lingualized occlusion.

Second measurement

The mean value of color scale scores with bilateral balanced occlusionwas39.3±14.8. The mean value of color scale scores with median lingualized occlusion was 47.5±11.03. After six months, the independent t-test revealed that there was a **statistical difference** was found between both groups (p>0.01). (Table 2, Fig. 4)

Table (2) *Masticatory efficiency evaluation after six months of denture placement.*

	Grouping	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Mast_6	G1	39.37	14.85	2.34	. 0.007*
	G2	47.50	11.03	1.74	

G1: Bilateral balanced occlusion.

G2: Median lingualized occlusion.

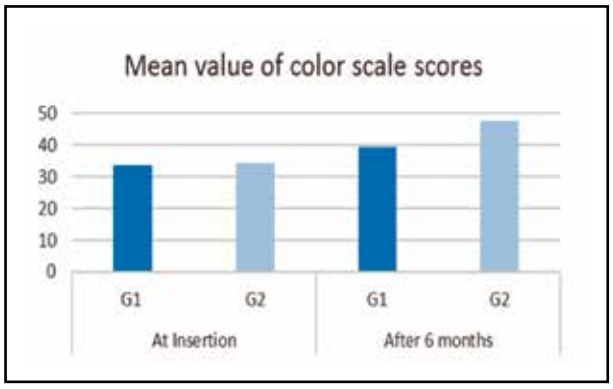

Fig. (4) Mean value of color scale scores for the two groups at denture insertion and after six months.

The paired t test showed that there was a **statistical significance difference** was found between the mean value of color scale scores recorded at new denture placement and after six months in both groups. (Table 3)

Table (3) *Paired Samples Statistics for both groups.*

		Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Pair 1	Bilateral_0	35.75	12.07	1.90	
	Bilateral _6	39.37	14.85	2.34	0.010*
Pair 2	Lingualized_0	36.37	12.25	1.93	0.000**
	Lingualized _6	47.50	11.03	1.74	

DISCUSSION

At the first thought, natural test foods may be considered advantageous because of their consumption in daily lives and familiarity with them. However, this issue can vary according to seasonal and geographical factors.(34)In order to avoid this kind of variability in assessing chewing function, some researchers report that the use of synthetic food is a good alternative [35-37].

Plesh et al. [38] preferred chewing gum as the test material because of the uniform density during chewing cycle. Hayasaki et al.[39] and Shiga et al.[40] also used chewing gum in their studies. Tokmakci et al. [34] mentioned that chewing gum is a material with uniform properties so it can be reliably reproduced and provide an ideal test bolus for the scientific study of masticatory effectiveness. In some previous studies, Blissett et al.[41]; Mazari et al.[42] used chewing gum to simplify and standardize the test procedures.

Tokmakci et al. [34] offered sugar-free chewing gum to participants, as it can be applied easily and being sugar- and/or sweetener-free it will not cause salivary stimulation that can influence the mastication function. Further, with its uniform properties in terms of weight and shape, this type of test food has also helped us standardize masticatory efficiency measurements.

The result of the present study found that there was statistical significant difference of the masticatory efficiency between bilateral balanced occlusion and median lingualized occlusion on using color changeable gum (at six months after denture placement). while at the time of denture insertion there was no statistical significant difference between the two groups.

The result of the present study could be explained by the studies of Slagter and Fontijn-Tekamp, they found that masticatory function of the complete-denture wearers is quite poor in comparison with that of healthy dentate subjects [43, 44].

Mancuso[45]mentioned that the occlusal design and cusp angulations have a direct effect on masticatory efficiency as well as stress transmission into the bone.

Complete-denture wearers need up to 7 times more chewing strokes than subjects with a complete natural dentition to reduce the food to half of the original particle size. Oral function significantly improves after mandibular implant overdenture treatment. Most studies on implant treatment and oral function showed a significant improvement

of the objective masticatory performance in the mandibular overdenture.[46]

The significant lower masticatory efficiency in patients rehabilitated with bilateral balanced occlusion (G1) has been reported in other studies[47].

Chen et al. [48] assessed the comparative masticatory efficiency (CME) of mandibular implant-supported overdentures (ISOs) to tooth-supported overdentures (TSOs) and complete dentures (CDs)and they found that the ISO provided the greatest degree of efficiency, followed by the TSO and then the CD group.

The effect of flexible acrylic resin on masticatory muscle activity in implant-supported mandibular overdentures was evaluated and it was found that the use of bilateral balanced occlusion in implant-supported mandibular overdentures resulted in decreased masticatory muscle activity [49].

A significant improvement was observed in the masticatory function with bilateral balanced occlusion and median lingualized occlusion after six months, this may be attributed to increase adaptation and subsequent stability of the denture after six months of denture use.

A statistically significant difference was found after six months between the two groups. These results were in accordance with the study conducted by Hazari et al.[50]. These findings may be attributed to the features of median lingualized occlusion and it provides a significant improvement in terms of stability and retention for patients with severe adaptation problems to conventional mandibular dentures. these results were in accordance with the study conducted by Berretin-Felix et al.[51] who mentioned that the type of dental treatment used has a direct relationship with masticatory efficiency.

It is also important to emphasize the diagnostic factor and previous planning before denture construction. The human factor in planning and technical performance are decisive for the success of rehabilitations.

CONCLUSION

Within the limitations of the present study, the median lingualized occlusion after six months of overdenture placement showed better masticatory efficiency with statistically significant difference than bilateral balanced occlusion in implant retained complete overdenture.

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