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COMPARING MASTICATORY EFFICIENCY OF MANDIBULAR BAR-SUPPORTED OVERDENTURES WITH DIFFERENT LOADING PROTOCOLS

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ABSTRACT

Purpose: The study aimed to compare progression of masticatory efficiency associated with mandibular bar-supported overdentures either retained by immediately or delayed loaded two implants.

Material and Methods: A total 12 completely edentulous patients with persistent complaints from their complete mandibular dentures were chosen. Each participant received two dental implants of (3.8 mm x 12 mm) bilaterally using computer-guided flapless surgery. The participants were grouped according to the bar attachment design into two equal groups. **Group SB:** six participants received mandibular overdenture supported by immediately loaded two implants connected with prefabricated SFI-Bar system. **Group CB:** six participants received mandibular overdentures supported by delayed loaded two implants splinted with conventional cast Co-Cr bar attachment. Glucose extraction method was performed to objectively measure the masticatory efficiency for each patient at different time points including; including; one week after implant-bar connections connections (T0), six months after implant-bar connections (T6), and 12 months after implant-bar connections (T12).

Results: There were statistically significant difference of masticatory efficiency between the (SB) and, (CB) (P=.004 and P=.001 respectively). Starting from T0, the findings showed highly statistical significance (P=0.000) in improving the masticatory efficiency at (T6) and (T12) respectively.

Conclusion Regardless the limitations of this clinical study, it can be conclude that restoring edentulous patient with mandibular overdenture assisted with bar improves the masticatory efficiency with a noticeable statistical improvement of masticatory efficiency for immediate versus delayed loading protocol.

KEYWORDS: Masticatory efficiency, immediately loaded implants, bar-supported overdentures.

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INTRODUCTION

Edentulism proclaims an oral disability for the elderly patients. With impaired oral functions, the patient is not able to chewand digest food properly. [1] Complete denture prosthesis is a widely used treatment option in dentistry. It is not quite solve the psychological and functional problems of edentulous patients. Reduced bite force, instability, and pain are problems that related to conventional mandibular denture. In addition, patient satisfaction, treatment success, masticatory performance, and oral health-related quality of life are paramount agents in prosthodontic considerations. [2]

Thus, the provision of dental implants to subjects with edentulous mandibles significantly improves subjective oral function.[3] Anchoring artificial teeth to the alveolar bone by dental implants has assumed to produce a (partial) sensory substitution for missing proprioceptive receptors of periodontal ligament from stimuli transmitted via the bone. [4] Restoring sensory feedback pathway is necessary for the physiological integration of the stomatognathic system. [5]

It was documented that connecting dentures to implants improved the neuromuscular activity of the masticatory system and adaptation to dentures especially in the mandible.[6] This treatment modality in edentulous jaws offers increased bite forces, better masticatory function and patients' satisfaction, and improved oral health-related quality of life. [7]

The type of overdenture support and design could play an important role in the chewing efficiency improvement through increasing maximum bite forces associated with the increased masseter muscle thickness.[8,9]

Several attachments can be used with implant-assisted overdentures: ball and socket, bar, and magnetic attachments. [10] Among these systems, bar attachment system provide greater stability and retention, permit splinting of implants, and can mask excessive residual ridge atrophy. [11] On the other hand, increased chair time and high cost of fabrication are problems in that system. In addition, for appropriate adaptation of the bar, soldering or laser welding procedure is often necessary to compensate the dimensional change due to the errors arising from some procedures at custom bar fabrication. [12] These problems can be solved by prefabricated bars, especially in cases of immediate loading. [13]

Evaluating masticatory efficiency in mandibular bar-supported implant ovedentures may provide knowledge about patients' particular needs required for better patient-related clinical outcomes. Different strategies for testing chewing efficiency in the literature, assessments include either objective (laboratory) or subjective (patient-based) methods.[14] Fragmenting tests still regarded as the gold standard for assessment of masticatory efficiency. [15]

This study aimed to compare maticatory progression and efficiency associated with mandibular bar-supported overdentures either retained by immediately or delayed loaded two implants. The null hypothesis was that there would be no difference between treatment protocols in improving masticatory efficiency.

MATERIALS AND METHODS

Patients' criteria

The study was submitted and approved from the Dental Research Ethic Committee, Faculty of Dentistry – Mansoura University. A total 12 completely edentulous patients (8 men and 4 women) with a mean age of 50 years (range: 40-60yr). with persistent complaints from their complete mandibular dentures were chosen for this academic work. After authorization from every patient, expressed in term of informed consent, patients were enrolled in this study according to the following inclusion criteria; participants were selected with mandibular bone width and height

enough for placement of 2 implants as verified by cone beam computed tomography. Patients had sufficient restorative space (at least 12 mm from the soft tissue covering residual ridge to proposed occlusal plane), free from any intra-oral or systemic diseases, nonsmokers, and class I maxillo-mandibular relationships. The exclusion criteria included patients with history of temporo-mandibular dysfunction, since it may interfere with chewing and biting patterns and abilities.

Surgical and prosthetic procedures

For each participant, conventional complete denture was constructed.. The surgical procedures were done under local anesthesia. Each participant received two dental implant 12 mm length and 3.8 mm width (BioHorizons implant systems Inc.), that were surgically inserted in the canine regions bilaterally. Stereolithographic surgical guide was placed in the patient mouth and the implant position was marked, Tissue punch was used to cut through the soft tissue down to the crest of the ridge. Successive color coded implant drills were used to prepare implant site osteotomies gradually until the prescribed implant diameter was attained. The implant was inserted manually into the prepared implant site by hand ratchet. A minimum of 40 Ncm insertion torque was used. In case of soft bone, the final drill was not used and the implant inserted to condense the bone to obtain sufficient primary stability and to increase the insertion torque. The patients were prescribed 1gm amoxicillin combined with potassium clavulenate antibiotics (Augmentin tab) and 50 mg analgesic (Declophenac tab) twice daily. Antiseptic mouth wash (0.2% chlorohexidine) was used and the patients were instructed for soft food.

The participants in this study were grouped according to the bar attachment design into 2 equal groups. **Group SB:** in which six participants received mandibular overdenture supported by immediately loaded two implants connected with prefabricated SFI-Bar system (Cendres + Métaux SA, CH-2501 Biel/Bienne) (fig. 1). **Group CB:** in which six participants received mandibular overdentures supported by delayed loaded two implants splinted with conventional cast Co-Cr bar attachment (fig.2)..

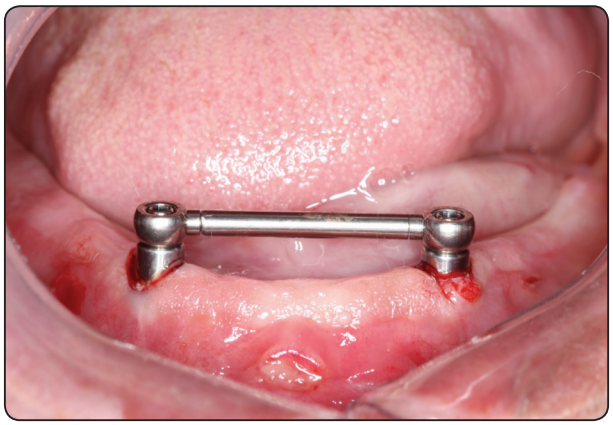

Fig. (1) Mandibular overdenture retained to the implants with prefabricated (SFI bar) bar attachment

For **SB group**, all participants received overdentures supported by SFI-Bar system connected to implants at the same day of implant surgery. Implants adapters with 3 mm gingival height were screwed and torqued into the implants with 20 Ncm. Bars was directly adapted and secured to the implants.[16] Mandibular denture was hollowed out lingually, to allow denture seating over SFI-Bar without any interference. After blocking-out all undercuts around and beneath the bar baseplate wax, (fig. 2), a single T-clip was picked-up directly to the denture by using autopolymerized acrylic resin in maximal intercuspation. Occlusion of denture was verified after finishing and polishing.

For **CB group**, all participants received overdentures supported by cast Co-Cr bar attachment after three months osseointegrating period during which the implants were submerged. At the second surgery, implants were uncovered and healing abutments of 3mm gingival height were screwed for 2 weeks.

Fig. (2) Cast Co-Cr bar connected to the delayed loaded implants

Autopolymerized mandibular custom tray with open holes at implant sites was constructed for each patient. After border molding, an impression of posterior residual ridge distal to the implants was made with non Eugenol-ZO impression paste (Cavex impression past, Holland). Long transfer copings were screwed into the implant fixtures protruding from tray holes. Polyether impression material (Impregum, 3M ESPE, Germany) at the interimplant distance to obtain a final dual phase selective impression.[17] The implant analogues were screwed to the transfer copings. The impression was poured to obtain master cast. Plastic bar pattern (Rhein 83. Italy) was cut into appropriate length and secured the position by using fast set resin pattern (GC resin pattern, America PNC. USA). A 2mm space was maintained between the alveolar ridge crest and the bottom of the bar. Wax bar assembly was sprued, and cast in Co-Cr alloy. The bar assembly was tried on the master cast, fitted intraorally to the implants and one-test screw was performed radiographically to ensure passive fit. After construction of new mandibular denture for group CB, direct pick-up procedures were done.

Assessment of masticatory efficiency

Glucose extraction method was performed to objectively measure the masticatory efficiency for each patient at different time points including; one week after implant-bar (T0), six months after implant-bar connections (T6), and 12 months after implant-bar connections (T12).

Glucose extraction method was used to assess masticatory efficiency according to Tanaka et al. [5] The extracted glucose was measured after chewing the readymade gum-like specimen. After rinsing the patient's mouth with water, a supplied gum-like specimen, with a height of 10 mm, contains 5% glucose (Glucosensor Gummy, GC, Japan) was placed on patient's tongue. Patients were asked to chew on the cube for 20 seconds without swallowing. The patient expectorated the chunked chewed specimen into a cup with a plastic mesh filter to catch the debris. Then, patient rinsed his/her mouth with 10 ml of water and spitted into the same cup. Glucose concentration (mg/dl) in the filtrated cup was measured using Glucose Sensor Set (Glucosensor GS-II, GC, Japan), (fig. 3). The measured concentration of glucose was used as indicator for masticatory efficiency.

Fig. (3) Gluco Sensor Set. a, sensor tips package; b, measuring set; c, chewing specimen; d, chewing specimen package; e, plastic filter

Statistically Analysis

Data of glucose concentration measurement were analyzed using the SPSS statistical software SPSS

Statistics 23.0, (SPSS IBM Inc., England). The data followed a normal distribution, the comparison between groups were analyzed using the Student's t-test ($p \leq .05$), Comparison between Time intervals for both types of bar were compared with ANOVA and post-hock test.

RESULTS

The descriptive analysis of the masticatory efficiency mean values generated from immediately loaded prefabricated bar overdenture and, delayed loaded conventional cast Co-Cr bar attachment are shown in figure 4.

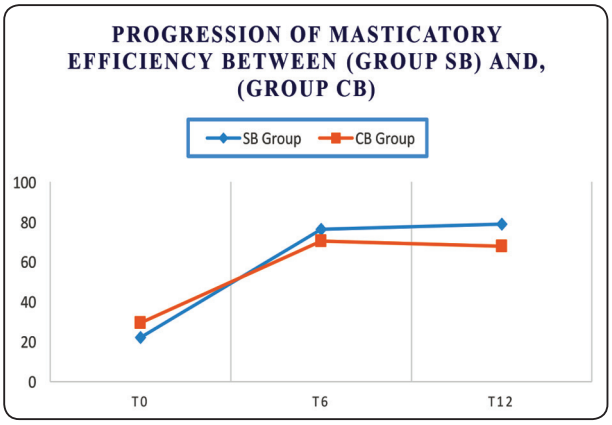

Fig. (4) Descriptive analysis of the mean values of the masticatory efficiency generated from immediately loaded prefabricated bar overdenture and, delayed loaded conventional cast Co-Cr bar attachment overdenture

Statistical analysis of masticatory efficiency data values between (Group SB) and, (Group CB) at different time intervals investigated in this study were summarized in the Table 1. Applying repeated measure ANOVA followed by post-hoc Bonferroni, significant statistical difference was observed between (Group SB) and, (Group CB) for the times T0 ($P = 0.004$) and T12 ($P = 0.001$) and showed no differences between both groups for the times T6 ($P = 0.083$). In post-hoc Bonferroni test, statistical significant differences between time intervals were observed for (Group SB) between the times T0 and T6 (P1= .000), between the times T0 and T12 (P2= .000), and between the times T6 and T12 (P3= .011). In the same line, for (Group CB) there were, statistical significant differences between the times T0 and T6 (P1= .000), between the times T0 and T12 (P2= .000), and between the times T6 and T12 (P3= .011).

TABLE (1) Comparisons of the masticatory efficiency values between (Group SB) and, (Group CB) at different interval times

		Time intervals			Paired interval comparison significance		
		T0	T6	T12	T0- T6	T0- T12	T6 - T12
SB Group	Mean	22	76.18	78.73	.000	.000	.011
	±SD	±3.84	±8.67	±6.51			
CB Group	Mean	29.33	70.33	67.83	.000	.000	.034
	±SD	±5.06	±6.3	±5.96			
P		p0.004**	0.083	0.001**			

SD: standard deviation P:Probability *:mild significance <0.05 **: Moderate significance ***: High significance

DISCUSSION

Complete dentures are not sufficient for reestablishing the oral function either in relation to chewing efficiency or in relation to bite force. [18] Therefore, masticatory efficiency was recognized to be negatively affected by patient's resorbed mandible and utilization of conventional dentures. In the light of the evidence-based dentistry, anchoring the removable dentures to dental implants leads to improved masticatory efficiency because of better stability and retention. [8, 9,19,20] Therefore, treatment with mandibular implant-supported overdentures was documented in the literature to improve the masticatory efficiency to chew all kind of food, reduce pain during chewing, and to increase the denture retention values as well.[14, 18]

Several studies assessed the improvement in the masticatory function through the comparison between conventional mandibular dentures and implant supported overdentures, [21] attachment techniques [22], or timing of implant loading [3,23.24]. In the contrary, the present study assessed the masticatory efficiency at different time points with specific treatment of implant overdentures by only using bar attachments.

The aim of this study was to compare the improvement in masticatory efficiency of mandibular overdentures supported by immediately loaded implants with prefabricated bar or delayed loaded implants connected with conventional Co-Cr cast bar. The results of this study rejected the null hypothesis that simulated masticatory function is the same for immediate or delayed treatment protocols.

The method used in the present study for assessment of masticatory efficiency is acceptable and simple to use in a clinical patient setting and was validated in a previous studies in comparison to a sieve methods.[5, 25] The test specimens had the same characteristics of typical sweets that contain glucose.

The initial measurements were started one week after connecting the implants to the denture to avoid discomfort caused by post-operative pain with implant placement in SB group or need for adjusting new dentures in CB group. This time was reported as the optimal time for measuring the improvement of masticatory performance. Furthermore, three months of adaptation may be required for reorganization of the neuromuscular system which requires significant time for functional improvement. [22] Such masticatory function could be stable over a 2-years interval period following rehabilitation with mandibular two-implant overdentures according to Jabbour et al. [26]

For both groups; the study revealed an improvement in the masticatory efficiency measurements that was increased with time obviously. These results may be explained by the better overdenture stability provided by the bar attachments with the ability to generate more regular shape, larger and uniform chewing cycles. [27, 28]

The surprising statistical significance difference between treatment groups in favor of immediate loading protocol may be attributed to neuromuscular adaptation of patients in group SB to their existing mandibular dentures. [22] In these patients, use of bar attachments markedly improve the situation and could provide further stability by vertical rigid walls. On the other hand, patients in group CB who received new mandibular prosthesis may need more time for restoring sensory feedback pathway.[3]

In this line, patients with more stable and comfortable prostheses had the ability to exert higher force on the examination specimens.[3,27] Moreover, spatial control of jaw movements during chewing may be improved with increasing time as a progression of neuromuscular control.[29] The significant difference between time points within each group may be attributed to the allowing more time for neuromuscular reorganization that resulted from more effective power-strokes and long-term exercise effect. [30]

The current study reported that SB group with immediate loading showed higher improvement in comparison to CB group with delayed loading after 12 months from connecting the dentures to bars. These findings may be due to the increased number of mechanoreceptors and free nerve endings in the immediate vicinity of the immediately loaded implants. [31] These mechanoreceptors were known to play an important role for neuromuscular adaptation and prostheses stability regardless the type of implant attachment. [22,24]

For CB group, the results revealed decreasing measurements after 12 months in comparison to 6-months measurements. A significant increase was observed with SB group at the same time points which may be attributed to the nature of bar attachment material. Significant decreases in retentive force were thought to result from the permanent deformation of the clip and wear of the attachment during function. [32] The slight decrease in improvement of masticatory performance and bite force after 1 year from insertion of implant overdentures was also reported in a previous study. [21] For Co-Cr, the high elastic modulus, toughness, and hardness resulted in more wear of the nylon clips that necessitate replacement after 6 months. [33] Consequently, the reduction in denture retention force may affect motor coordination of the chewing muscles after denture stabilization by means of dental implants. [34]

In this line, SB group showed better improvement in measurements overtime that may result from prolonged retentive forces provided by SFI-Bars. This prolonged retention may result from the following reasons; 1) Round-shaped titanium bars with their round plastic clips allowed more rotational movements of the overdenture than other types of bars [32] ; 2) Nylon inserts in T-clip might show deformation after 2-3 years of clinical use as reported in an in vitro study [35]; 3) Prefabricated titanium bars have smooth homogenous surfaces that reduce wear and plastic deformation of the clip. [11,32]

The small sample size and the short-term follow-up period should be recognized as limitations of this study. Furthermore, this study design is permitted only by the cross-sectional analysis of treatment strategies that may introduce mistaken conclusion of the study. [14] So that, a program of future clinical research with larger population and long-term follow-up is recommended for proposed similar studies. Future biomechanical studies, tissue health outcomes, and patient–reported questionnaires may be of important values.

CONCLUSION

Regardless the limitations of this clinical study, it can be conclude that restoring edentulous patient with mandibular overdenture assisted with bar improves the masticatory efficiency; with a noticeable statistical improvement of masticatory efficiency for immediate versus delayed loading protocol.

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