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REPERCUSSION OF 2 DESIGNS OF LINGUALIZED OCCLUSAL SCHEMES ON EMG ACTIVITY MUSCLES IN MANDIBULAR IMPLANT SUPPORTED OVERDENTURE RANDOMIZED CONTROLLED CLINICAL STUDY

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ABSTRACT

Objectives: This study intended to investigate masticatory muscle activity in patients treated with two different designs of lingualized occlusal schemes in implant mandibular overdenture prosthesis.

Methodology: Twenty completely edentulous male patients were selected and two implants were inserted for each patient. After 3 months of installation, the patients were equally divided into two groups; group I: patients were received complete denture with conventional lingualized (LO) concept and group II: patients were received complete denture with Gerber lingualized occlusion(GC). Muscle activity was measured after one week of denture insertion, one month and 3 months after overdenture insertion.

Results: The results revealed that muscle activity was significantly higher in Gerber concept than the conventional lingualized concept along the whole follow up periods with both hard and soft food and both muscles (masseter and temporalis)

Conclusion: Gerber lingualized concept was found to exert more freedom of muscles activity compared to conventional lingualized concept .

KEYWORDS Lingualized occlusion, Gerber occlusion ,Dental implants, Overdenture, Muscular activity.

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INTRODUCTION

Completely edentulous patients represent a great challenge for most clinicians due to the dynamic nature of surrounding structures that tend to be displacing for the conventional complete denture (CCD). With all the attempts done to construct a successful CCD yet most patients whether they are good candidates for implant supported overdenture or not are always aiming for this treatment option.[1]

Mandibular implant overdenture treatment is a successful treatment modality in completely edentulous patients to improve the overall qualities of the prosthesis beside patient satisfaction regarding function and esthetics.[2] One of the important factors in completely edentulous patient rehabilitation with dental implants is the occlusal scheme encountered to ensure the efficiency of the overdenture as regarding masticatory function and stresses transmitted to the supporting structures.[3,4] Khamis and colleagues highlighted that the occlusal anatomy of the teeth is directly related to the chewing efficiency. Their study considered the effects of three different occlusal forms (zero-degree teeth, 30-degree teeth, and lingualized occlusion) on the denture-bearing structures, and masticatory performance, in participants rehabilitated with mandibular implant overdentures. Wismeijer and colleagues proposed that the lingualized occlusion concept better considered when conventional maxillary dentures opposing 2 implant mandibular overdentures.[5,6] The palatal cusps of the maxillary teeth are in continuous contact with the fossae and inclines of the mandibular teeth during eccentric movements of the mandible. The lingualized occlusal scheme allows for freedom of movement in centric relation, and even contact during lateral and protrusive movements.[7,8]

Lingualized occlusion was the standard occlusal scheme to be used for implant overdentures, Prof. Dr. A. Gerber established the functional relationship between the shapes of the temporomandibular joints and the occlusal surfaces of artificial teeth and as a result, innovated the Condyloform tooth on this basis.[8,9]The modern Condyloform II NFC+ offers anatomically good occlusion design with age-adapted morphological and natural occlusal proportions and functional areas.[9] The mortar and pestle principle according to Prof. Dr. A. Gerber is also incorporated. It enables autonomous chewing stability of each individual posterior tooth, as the upper palatal cusp occludes in the central fossa of its main antagonist.[10] The Gerber occlusal concept utilizes semi anatomic mandibular posterior teeth (10^0- 20^0) this occlusal configuration will gain the benefit of less stresses provided by lingualized concept and the masticatory efficiency of the bilateral balanced occlusion. It was again emphasized that there were currently no evidence-based, implant-specific concept of occlusion, and future clinical studies in this area were encouraged.[11]

Electromyography was introduced for dental research; several investigators have examined the relation between dental conditions and jaw muscle electrical activity.[5]Surface electromyography represents an effective method used for the normalization of masticatory muscle balance with different treatment objectives.[12]

So, the aim of this research was to evaluate levels of EMG to indicate the chewing efficacy provide by each design of the lingualized and Gerber occlusal scheme with implant overdentures.

MATERIALS AND METHODS

Twenty completely edentulous patients were selected from the outpatient clinic, Faculty of Dentistry, Cairo university. The study was conducted in accordance with the Helsinki Declaration of 1975 for medical studies.

Inclusion criteria: Male patients only were included in the study to avoid any hormonal factor that may affect bone quantity or quality around the installed implants. Patients with class I Angle's

classification to avoid any abnormal forces on the implants. Sufficient interarch space for overdenture placement (not less than 15mm)

Exclusion criteria: Patients with any systemic disease affecting bone quantity and quality, smokers, patients with TMJ problems.

The procedure was explained to the patients and then a written consent was obtained from them.

New conventional complete dentures were constructed for all patients.

Dentures construction:

Preliminary impressions with irreversible hydrocolloids impression material (Tropicalgin, Zhermack, Italy) were made. The custom tray was fabricated on study cast in auto-polymerizing acrylic resin (DPI Bombay Burmah Trading Corporation Ltd.), then, border molding was done by manual and functional movements using low fusing compound (green stick), and the secondary impression was made with Zinc oxide Eugenol impression paste (DPI). One dental technician was responsible for all procedures concerning the study for standardization of laboratory procedures. Maxillary face bow record was made to mount the upper cast on a Semi adjustable articulator HANAU H (Arcon, Louisville, KY USA 40209), the Mandibular cast was mounted according to a centric relation record obtained from the patient using the check bite technique.

Randomization was done using the closed envelope method for patients grouping.

After jaw relation registration was done, the setting of artificial teeth was done in the following manner:

For group I :10 patients received complete denture with conventional lingualized concept that utilized anatomic teeth for the maxillary denture and modified nonanatomic for the mandibular denture. The anterior teeth were arranged with adequate horizontal overlap and vertical overlap in order to avoid interference during protrusive and lateral movements. Buccal cusps of maxillary posterior were reduced 1mm for elimination of the buccal contact in both centric and eccentric jaw relations. The palatal cusps of the upper posterior teeth were arranged to articulate with the modified nonanatomic lower posterior teeth in both centric working and non-working mandibular position.

For group II: 10 patients received complete denture with Gerber lingualized occlusion in this concept the teeth were set up according to the "condyle theory" formulated by GERBER. As the posterior teeth in tooth-to-tooth occlusion were chosen consistently following the GERBER concept. That utilized anatomic teeth with modifications (Teeth paired a very esthetic 30° maxillary anatomic occlusal with a 10° to 12° mandibular semi anatomic occlusal surface).

The mandibular teeth were modified by flattening the ridges and reducing the cusps to make the lower occlusal table a V-shaped trough. That means the lower teeth are semi anatomical teeth and the upper posterior teeth were modified by reducing the buccal cusps (taking them out of occlusion) and making the lingual cusps more conical in all directions. This created an occlusion in which only the palatal cusps of the upper posterior teeth contacted the semi-anatomical lower teeth. and artificial teeth occluded lingually according to the mortar-pestle principle. This approach is based on the condyle theory that the occlusal surfaces reflected the inverse mirror image of the condyle-fossa relationship. The lower teeth were significantly further in lingual position during the setting up in order to direct the force on the antagonist teeth and to the middle of the ridge. The palatal cusps effective as support cusps so that force will be always directed perpendicular to the residual alveolar ridge. Patients received complete denture constructed by conventional technique and follow up was done for two weeks before surgery.

Dentures were duplicated and a radio opaque acrylic radiographic resin stent was done for each patient.

Implant Installation

Patients received conventional complete maxillary dentures opposed by mandibular over dentures supported and retained by two implants of 4mm diameter and 10 mm length (Multisystem implant Italy) placed in the inter-foraminal region.

For both groups broad spectrum antibiotics and anti-inflammatory drugs were administered to all patients. Patients were asked to rinse the oral cavity with chlorhexidine-digluconate (0.2%) for 1 minute prior to the surgery.

The flap area was identified. Using bard-parker blade No. 15, two mid crestal incisions in the lateral-canine areas extending 2mm mesially and distally without crossing the midline were made at the proposed implant sites with relaxing incision extending labially from the crest of the ridge to the depth of the vestibule.

A full thickness mucoperiosteal flap was reflected using a sharp mucoperiosteal elevator. The lingual mucoperiosteum was also slightly dissected. Irregularities on the crest of the ridge were smoothened using bone file. The surgical stent was seated in the patient's mouth and under copious saline irrigation, drilling started with point drill with light intermittent finger pressure and at speed of 1000 rpm and 30 N/cm torque for marking the insertion point of the implant on the alveolar ridge.

The implant was threaded into the bone in a clockwise direction under saline irrigation until its top flushed with the bone surface using the torque wrench. The abutments were then screwed into position to the fixtures, The mucoperiosteal flaps were repositioned and sutured with 3-0 black silk interrupted sutures and patients were recalled seven days after surgery to remove the sutures.

Prior to the pick-up of the metal housings, in both groups, block-out shim was adapted to each abutment to block out the undercut areas inferior to the ball abutments (sub-housing area),

Patients were recalled after 3 months of osseointegration. Healing abutments were attached to the dental implants for 10 days to promote soft tissue healing around the implants.

The cover screw was removed and the ball attachment was screwed into the fixture and firmly tightened with torque wrench at 30 Ncm. Direct pick up procedure by relieving areas of the fitting surface of the denture over the implant sites and were filled with self-cure acrylic resin. The denture was seated, and the patient was instructed to bite gently on it during the setting of the acrylic resin.

After the resin sets the denture was removed and the metal housing inside the denture was examined.

Measuring the masticatory activity Muscular activity, measured in voltage and represented by the root mean square value (RMS), was evaluated by using a digital electromyogram (EMG) (Nihon Kohden, America, INC. USA).

Measuring was made 1 week, 1month and three months after insertion.

The patients were seated in an upright relaxed position during the measuring procedure.

Muscle activity was recorded during chewing equal sized tablets (Bredent, Germany) of hard and soft consistencies. Five minutes were left between each record to avoid muscle fatigue. When the EMG rhythm became more stable data were recorded after the first 3 cycles of chewing, when the EMG rhythm became more stable. Five records of the root mean square for each muscle, which represented the total integrated muscle activity, were obtained for each of the above-mentioned performances. After which the mean of the 5 records for each performance was calculated regarding each muscle at the different follow-up periods. A transparent template was prepared to be used at each subsequent follow-up visit to aid in repositioning of surface electrodes in their exact position. Measurements were displayed and saved on a computer.

Data was collected, statistically analyzed using SPSS statistical package (Version 17, Chicago, IL) and represented in tables and figures. Three-way ANOVA test was used to detect the difference in

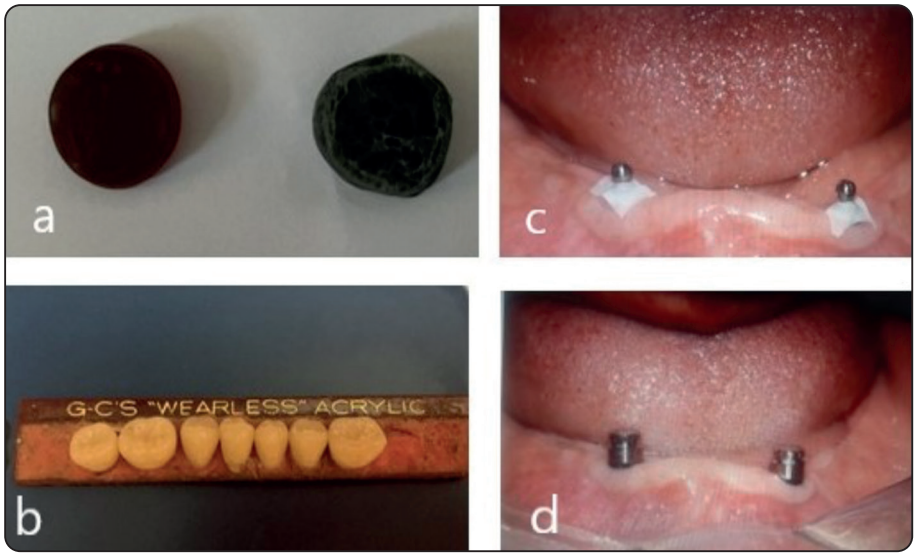

Fig. (1) (a,b,c&d) Chewing tablets, Gerber's teeth, ball attachment and metal housing

the two occlusal schemes and their effect on the muscles (masseter and temporalis) and Tukey's post hoc test.

RESULTS

All data and results were represented in tables (1&2) figures (2&3)

The data was expressed as root mean square (RMS) values in micro voltage (mv).

A) Effect of Occlusal Scheme With Both Muscle And Both Hard and Soft Food:

Within the same group GERBER lingualized concept showed statistically significant increase in muscle activity along the whole follow up periods with both hard and soft food and both muscles (masseter and temporalis) $p \leq 0.001$.

Between both groups also GERBER lingualized concept showed statistically significant difference with conventional lingualized concept along the whole follow up periods with both hard and soft food and both muscles (masseter and temporalis) $p \leq 0.001$

B) Effect of Muscle Activity with Different Occlusal Schemes and Different Types of Food:

Masseter muscle showed higher activity (***µvolt)*** compared to the temporalis muscle through the whole follow up periods (1week, 1month and 3 months) $p \leq 0.001$ when chewing both soft and hard food with both (conventional lingualized and GERBER'S lingualized) occlusal schemes.

C) Effect of Time on Muscle Activity with Different Occlusal Schemes:

At the time interval (1w versus 1m) both masseter and temporalis muscle showed significant change in its activity with both occlusal schemes in case of both soft and hard food p value ≤ 0.001; except that masseter muscle with GC in case of hard food there was no statistically significant change in muscle activity (p value 0.991) and temporalis with hard food when using LO p value 0.058

At the time interval (1m versus 3m) both masseter and temporalis muscle showed significant change in its activity with both occlusal schemes in case of both soft and hard food p value ≤ 0.001.

D) Effect of Type Food on Muscle Activity

When chewing both hard and soft food masseter muscle didin't show significant change in its activity in case of GC with p value 0.013

On the other hand temporalis muscle showed significant change in its muscle activity with GC when chewing both hard and soft food p value ≤ 0.001

TABLE (1): Showing mean and standard deviation with both occlusal schemes and both muscles with hard food

	Masseter			Temporalis		
	1W	1M	3M	1W	1M	3M
LO	264.4±8.22	280.8±8.94	317.5±11.44	172.5±4.55	218.4±8.24	251±7.46
GC	255.6±9.11	304.4±9.03	330.4±19.01	240.5±11.94	248.1±5.78	285.3±5.63

TABLE (2): Showing mean and standard deviation with both occlusal schemes and both muscles with soft food

	Masseter			Temporalis		
	1W	1M	3M	1W	1M	3M
LO	227.2±10.19	294.3±12.19	329.3±10.46	169.6±12.77	219.6±13.05	261.8±12.45
GC	235.8±9.91	289.2±5.57	312.4±12.67	209.9±4.67	247.7±7.42	289.2±5.57

Fig. (2): Showing the effect of both occlusal schemes with both muscles when chewing soft food

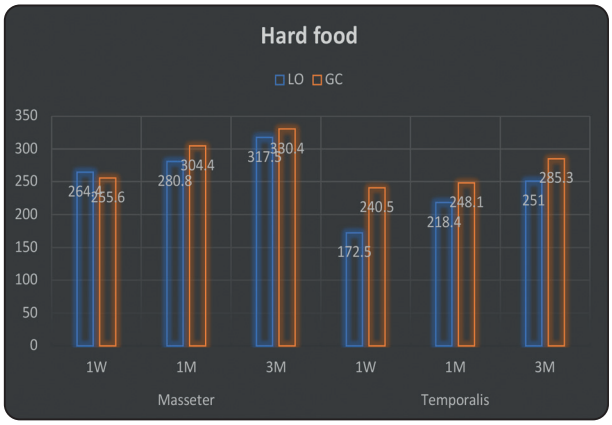

Fig. (3): Showing the effect of both occlusal schemes with both muscles when chewing hard food

Also when chewing both hard and soft food temporalis and masseter muscles didin't show significant change in their activity with LO p value =0.788.

DISCUSSION

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 mandible. Ball attachment retained implant overdenture was selected for this study due to the resilient properties of the attachment so it will decrease the forces applied on the posterior edentulous area in addition to preventing overloading of the implants installed.[16] Improved retention and stability of implant retained mandibular overdentures consequently provides a considerable improvement in muscular activity and mandibular movements, mainly because of their association with a more stabilized occlusion,

satisfaction and comfort of patients.[17,18] Mastication is a highly coordinated neuromuscular function involving fast, effective movements of the jaw and continuous modulation of force.[18] Also it is affected by the contact between the antagonist teeth. In addition, the denture base and retention influence better occlusion.

Emg is one of the methods used to measure the muscle activity indicating the efficiency of certain prosthesis in restoring the masticatory efficiency of edentulous patients.

For both groups the muscle activity increased gradually through the treatment follow up period which is due to the gradual buildup of adaptation and confidence in the prosthesis so which was reflected in the improved activity of both muscles.[19,20]

The results of this study showed significant reduction in muscle activity of conventional lingualized occlusion when compared with GERBER lingualized occlusion, these results are in agreement with the finding of other studies. [21-23] They pointed out that the reduction in masticatory efficiency of the monoplane occlusion could be attributed to the decrease in the cutting efficiency of non-cusped teeth. Less force has been observed to penetrate through the bolus of food with teeth having cusps than with zero-degree teeth. The teeth with cusps had a reduced surface area of contact compared with zero-degree teeth, and so zero-degree teeth required a slower muscle activity to penetrate food. [24,25]

Also, the result of this study showed higher muscle activity in Group II (GERBER lingualized occlusal scheme) when compared with Group I (conventional lingualized concept) that may attributed to the set-up of the artificial teeth in GERBER lingualized occlusal concept in which the premolars were arranged closest to the canines, the lower supporting buccal cusps only have a punctiform contact in the upper fossa.[22] This leads to autonomic occlusal stability of the individual teeth or implants also it relieves the condyle and disk as an anterior ball joint. Thus allowing more freedom of muscle activity. As the first premolars are set up such that the forces are shifted to a central area of the alveolar ridge located further back which is more suitable for masticatory loading, prosthesis stability is increased.

More over in GERBER lingualized occlusal scheme the lower teeth was significantly arranged in lingual position in order to direct the force on the antagonist teeth and to the middle of the ridge and the palatal cusps directed the forces perpendicular to the residual alveolar ridge. This artificial teeth setting up in combination with the stability and retention of the prosthesis attributed to the ball attachment retained over denture will achieve autonomous chewing stability manifested by better muscle activity. [26,27]

For both groups the muscle activity increased gradually through the treatment follow up period which is due to the gradual buildup of adaptation and confidence in the prosthesis so less interference with muscles to perform their function. [28]

CONCLUSION

Masticatory efficiency was statistically better in patients provided with overdentures fabricated with Gerber lingualized occlusion than with conventional lingualized occlusion due to the fact that Gerber lingualized occlusal technique resulted in functionally better complete dentures as compared to the ones made by lingualized occlusal technique as in Gerber lingualized occlusion it was occluded with semi anatomical mandibular teeth rather than non anatomical mandibular teeth in conventional lingualize occlusion thus lead to higher ability of food crushing and chewing properly with ease and comfort all of that in a conjunction with the prosthesis stability that lead to show a higher masticatory efficiency .

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