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ELECCTROMYOGRAPHIC EVALUATION OF CANINE GUIDANCE OCCLUSION AND BILATERAL BALANCED OCCLUSION IN THERMO-PLASTIC COMPLETE DENTURES

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ABSTRACT

The purpose of this study was to evaluate the effect of two occlusal schemes; canine guidance occlusion and bilateral balanced occlusion on the masseter and temporalis muscle activity in thermoplastic complete dentures. Ten male completely edentulous patients whose ages ranged from 55 to 70 years were selected. Half of the selected patients received a thermoplastic complete denture with canine guidance occlusal scheme and the other half of the patients received a thermoplastic complete denture with bilateral balanced occlusal scheme. Electromyographic evaluation of the masseter and temporalis muscles, during chewing banana, peanut and carrot, was conducted on the patients after using their dentures for one month. Each occlusal scheme was then converted into the other scheme using the same dentures, and the procedure of evaluation was repeated after another one month. The data were collected, tabulated and analyzed by using Paired sample t-test. The results of this study showed that there was no significant difference between the canine guidance occlusal scheme and the bilateral balanced occlusal scheme in the electromyographic activity of both masseter and temporalis muscles during chewing all test foods. It was concluded that both bilateral balanced occlusion and canine guidance occlusion can be used successfully in thermoplastic complete dentures without affecting the masseter or temporalis muscle activity.

KEYWORDS: Electromyographic evaluation, masseter, temporalis, canine guidance occlusion, bilateral balanced occlusion, thermoplastic complete dentures.

INTRODUCTION

Complete denture wearers suffer from decreased masticatory efficiency which was found to be less than one-sixth that of patients with natural teeth [1, 2]. Psychology, denture comfort, adaptation to dentures and tongue control are some factors influencing patients chewing ability. Apart from that, age, gender, bite forces, chewing rate and oral sensitivity also affected the masticatory function [1].

Soft dentures are generally only used when traditional dentures cause discomfort to the patient that cannot be solved through relining. Soft dentures are not the same as a soft reline for traditional dentures. Soft relines use soft putty- like substance to separate oral mucosa from the hard acrylic dentures. Flexible dentures use a special flexible resin that prevents them from chafing the mucosa, allows the wearer to chew properly [3].

Several concepts that are routinely employed on the construction of complete dentures are not based on strict scientific methods, but are derived from clinical observation and repetition over the years, although it does not mean that they are incorrect [4, 5].

One of these concepts is the bilateral balanced occlusion, which is considered by many authors as fundamental for treatment success, as it would be able to provide greater retention and stability than the canine guidance. Better masticatory function is attributed to the bilateral balanced occlusion, since it brings more grinding surfaces in contact at each

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movement [6]. However, a critical review of the literature reveals that there is not sufficient scientific evidence to support bilateral balanced occlusion as the ideal occlusal concept for complete dentures. Evidence suggests that the occlusal concept has little influence on clinical outcomes and patients' satisfaction [7]. Furthermore, procedures involved in the construction of a set of dentures with bilateral balanced occlusion are much more complex and time consuming than those for canine-guided dentures for both the dentist and the dental technician. [4]

Occlusion may alter muscle activity and related jaw movements in mastication. Muscle activity, which is a reflection of masticatory function of the patient, can be objectively evaluated using surface electromyography (EMG) [8]. EMG is a valuable parameter to assess muscular dysfunction. Surface EMG measures muscle activity non-invasively using surface electrodes placed on the skin overlying the muscle to determine the timing of the muscle contraction and to investigate the behavior of the muscle during functions of the stomatognathic system [9].

To date, there is no evidence to recommend a specific occlusal design for thermoplastic complete dentures. Therefore, this study was conducted to investigate the effects of balanced occlusion and canine guidance occlusion on masseter and temporalis muscle activity in thermoplastic complete dentures.

MATERIAL AND METHODS

Ten male completely edentulous patients, whose ages ranged from 55 to 70 years, were selected from the outpatients of the Removable Prosthodontic Department, Faculty of Dentistry, Al-Azhar University. All of the patients have normal jaw relationship (Angle's class I), well or moderately developed ridges, and were assessed clinically to have normal temporomandibular joints and free from any systemic diseases that may affect temporomandibular joints. Any patient with Angle's class II or class III jaw relationship, flat ridge, myofacial pain dysfunction syndrome or limited mouth opening were excluded.

Complete denture was constructed for each patient using the standard technique followed in the department till the mounting of casts on a semi-adjustable articulator (Hanau Modular Articulator System 192, Whip Mix Corporation, U.S.A) was made. Setting-up of teeth in bilateral balanced occlusion was established with low incisal guidance. The maxillary and mandibular posterior teeth were arranged in antero-posterior and medio-lateral curves to obtain balance.

The patients were divided randomly into two equal groups;

1- **Group A (BBO → CGO):** Those having dentures with bilateral balanced occlusion (BBO) first then changed into canine guidance occlusion (CGO).

2- **Group B (CGO → BBO):** Those having dentures with canine guidance occlusion (CGO) first then changed into bilateral balanced occlusion (BBO).

For group B, the setting of bilateral balanced occlusion was changed into canine guidance occlusion by adjusting the setting of the canine teeth so that the vertical overlap was increased and the horizontal overjet was decreased. By this way, the canine was the only tooth that provides contact during excursive movements.

The dentures were waxed up and tried in the patient's mouth. The waxed up dentures were flasked using a special flask (Vertex thermo-flask designed for injection molding technique), processed into thermoplastic nylon (Vertex ThermoSens injection type denture base material, Vertex-Dental B.V., The Netherlands) by using a special machine (Thermoject-22 Vertex machine, Vertex-Dental B.V., The

Netherlands). Finishing of the thermoplastic denture was done by using special stones with a rapid and shaving motion while polishing was done by using Vertex Thermo Silicon Polisher with Thermo-Gloss paste and emulsion for the best polishing results.

The dentures were delivered to the patients after adjusting the occlusion in the patient's mouth by doing spot grinding using an articulating paper. Instructions for oral hygiene and denture cleaning were given to the patient. One month was left as an adaptation period [10] for the denture with the first occlusal scheme then the electromyographic evaluation was carried out.

It was done using Schwarzer topas EMG trolley system. During all recordings, the patients were seated with their head unsupported and were asked to maintain a naturally erect position. Electro-conductive paste was applied on the electrodes before they contacted the skin. The myoelectric activity of both masseter and temporalis muscles was recorded by means of bipolar electrodes positioned so that; the active electrode on the belly of the muscle parallel to the fiber orientation and the other reference electrode was placed on a bony part (chin or forehead) (Fig. 1 a and b). The third ground electrode was fixed on the wrist of the patient's hand.

The patients were instructed to chew on symmetrical pieces of about one cm cubes of banana and the EMG was recorded. Then the patients were instructed to chew on grains of peanut of similar size and diameter and the EMG was recorded. Finally, the patients were instructed to chew on one cm cubes of raw carrots and the EMG was recorded. This was done for both masseter and temporalis muscles.

Three readings for each test food were recorded and the mean was taken. EMG of the maximum contraction of the muscle was recorded. The computerized data showed the activity of the muscle per second (Act.) and amplitude per turn (A/T) of the EMG signals. After that, the occlusal scheme was exchanged according to the patient's group as follows;

1- **Group A (BBO → CGO):** The occlusal scheme was changed into canine guidance occlusion by adding tooth-colored self-cured acrylic resin to the palatal surfaces of the maxillary canines.

2- **Group B (CGO → BBO):** The occlusal scheme was changed into bilateral balanced occlusion by grinding the incisal and the labial surfaces of the lower canine and the palatal surface of the upper canine.

Dentures with the second occlusal scheme were delivered to the patients and checked up for occlusion. One month was left as an adaptation period for the denture with the second occlusal scheme.

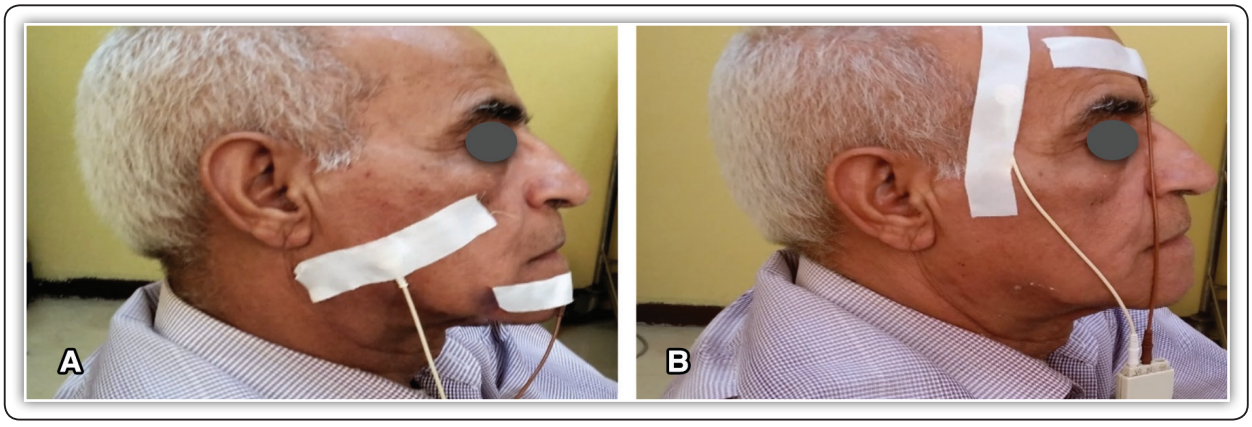

Fig. 1: EMG; a) Surface electrodes on the masseter muscle, b) Surface electrodes on the temporalis muscle,

Electromyographic evaluation was then carried out again. The data were collected, tabulated and analyzed by using Paired- t-test.

RESULTS

Table (1) shows the mean of the EMG activity (in milliseconds) of the masseter muscle, the mean of the EMG amplitude (in millivolts) per turn of the masseter muscle, the mean of the EMG activity (in milliseconds) of the temporalis muscle, and the mean of the EMG amplitude (in millivolts) per turn of the temporalis muscle during chewing different foods (banana, peanut and carrot) and the effect of changing the occlusal scheme on them.

The results of this study revealed that, there was no significant difference between the canine guidance and the bilateral balanced occlusal schemes in the EMG activity (in milliseconds) of the masseter muscle when chewing banana, peanut and carrot ($P > 0.05$). Also, there was no significant difference between the canine guidance and the bilateral balanced occlusal schemes in the EMG amplitude (in millivolts) per turn of the masseter muscle when chewing banana, peanut and carrot ($P > 0.05$).

There was no significant difference between the canine guidance and the bilateral balanced occlusal schemes in the EMG activity (in milliseconds) of the temporalis muscle when chewing banana, peanut and carrot ($P > 0.05$). Also, there was no significant difference between the canine guidance and the bilateral balanced occlusal schemes in the EMG amplitude (in millivolts) per turn of the temporalis muscle when chewing banana, peanut and carrot ($P > 0.05$).

DISCUSSION

This study aimed to evaluate two occlusal schemes; canine guidance and bilateral balanced, in completely edentulous patients receiving complete dentures made from thermoplastic material (nylon) by electromyographic evaluation of the masseter and temporalis muscles while the patients were chewing different types of food (banana, peanut and carrot). Patients with systemic disease or neuromuscular disorders were excluded to avoid any effect on the muscle tone. Patients with temporo-mandibular joint dysfunction were also excluded to avoid any disturbance in muscle behavior [11].

TABLE (1): Means and standard deviations of EMG activity and EMG amplitude per turn of the masseter and temporalis muscles of canine guidance and the bilateral balanced occlusal schemes:

Test food	OS	EMG activity (in milliseconds) of the masseter muscle		EMG amplitude (in millivolts) per turn of the masseter muscle		EMG activity (in milliseconds) of the temporalis muscle		EMG amplitude (in millivolts) per turn of the temporalis muscle	
		Mean ± SD	P value	Mean ± SD	P value	Mean ± SD	P value	Mean ± SD	P value
Banana	CG	34.600 ± 28.791	0.564	0.288 ± 0.074	0.492	3.400 ± 4.812	0.274	0.183 ± 0.032	0.686
	BB	28.300 ± 18.074		0.275 ± 0.062		4.700 ± 6.325		0.187 ± 0.032	
Peanut	CG	66.400 ± 60.200	0.470	0.352 ± 0.063	0.689	16.700 ± 23.702	0.561	0.233 ± 0.027	0.105
	BB	55.100 ± 28.815		0.340 ± 0.057		14.600 ± 15.450		0.247 ± 0.026	
Carrot	CG	57.200 ± 51.062	0.882	0.349 ± 0.069	0.295	26.300 ± 35.040	0.172	0.262 ± 0.052	0.920
	BB	58.600 ± 37.325		0.331 ± 0.028		18.600 ± 21.272		0.261 ± 0.044	

SD ±: Standard Deviation, OS: Occlusal Scheme, CG: Cnine Guidance, BB: Bilateral Balanced.

The crossover design of this study is common on human research in Medicine and Dentistry and has been used in other trials that investigated occlusion in complete dentures. Its major advantage is the elimination of inter-subject response variation to the same treatment, since all treatments are applied to all subjects, increasing the statistical efficiency of the study given the need for a smaller number of subjects. Furthermore, since each patient works as his/her own control, the crossover design allows the reduction of the effect of non-controlled external variables, such as sex, previous denture experience, mucosal health status and resiliency, and alveolar ridge height and width [12, 13].

The flexible resin Vertex is chemically nylon based plastic polyamide. It has long term performance. Polymer unzipping is negligible and hence it is highly stable. It also had high creep resistance and fatigue endurance. It had good wear characteristics and solvent resistance. It had no porosity, no biological material build up, odor or stains. It provided good dimensional and color stability [14].

The two occlusal schemes were not compared only on the same subject to avoid personal difference between patients but also on the same mandibular and maxillary denture bases to avoid denture factors that influence the muscle activity such as vertical and horizontal maxillo-mandibular relationships and denture fitness.

The electrical output of a muscle, measured by electromyography, is proportional to the energy consumed to produce contractions. The masseter and temporalis muscles were evaluated because they are the largest and strongest of the masticatory muscles, the most superficial and are accessible to surface EMG examination. The surface EMG recordings provided a safe, easy, and non-invasive method that allowed objective quantification of the energy of the muscle [15, 16].

The symmetrical pieces of about one cm cubes of raw carrot and banana or the grains of peanut of similar size and diameter were used to eliminate the influence of different food size on muscular efficiency [17].

The results of the present study showed no significant difference between the canine guidance and the bilateral balanced occlusal schemes in the EMG activity (in milliseconds) of the masseter or the temporalis muscles during chewing all test foods. In addition, the present study showed no significant difference between the two occlusal schemes in the EMG amplitude (in millivolts) per turn of the masseter or the temporalis muscles during chewing all test foods.

All these results indicate that changing the occlusal scheme from canine guidance to bilateral balanced or the reverse has no significant effect on the electromyographic evaluation of the complete dentures made from thermoplastic resin.

The results of this study are in accord with that of a study compared the masticatory efficiency through evaluation of electromyographic activity between bilateral balanced occlusion, canine guidance occlusion, lingualized occlusion and monoplane occlusion schemes and found no statistically significant difference in masticatory efficiency among the bilateral balanced occlusion, lingualized occlusion and canine guidance occlusion [18].

The results are also in accord with a study compared the activity of the masseter and temporalis muscles by surface electromyography in complete dentures with canine guidance and bilateral balanced occlusal schemes and found that no difference in muscle activity between the two occlusal schemes [19].

The results of this study are not in accord with that of a study reported that canine guidance occlusion reduced masseter muscle activity in complete denture wearers. The authors stated that neuromuscular function in edentulous subjects is similar to that found in dentate people and that canine guided dentures prevent para-functional habits. This may be due to utilization of a computerized

quantification method which differs from the method used in the present study [20].

CONCLUSION

Both bilateral balanced occlusion and canine guidance occlusion can be used successfully in thermoplastic complete dentures without affecting the masseter or temporalis muscle activity.

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