

ELECTROMYOGRAPHIC EVALUATION OF MASSETER AND ANTERIOR TEMPORALIS MUSCLES IN RESTING POSITION AND DURING MAXIMUM TOOTH CLENCHING OF EDENTULOUS PATIENTS BEFORE AND AFTER NEW COMPLETE DENTURES

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ABSTRACT

The aim of this study was to assess the electrical activity of the masseter and anterior temporal muscles in patients with severe bone resorption, with complete dentures worn for over ten years, and five months after having new dentures put in place. The RDC questionnaire was applied to twelve asymptomatic patients, before and five months after new dentures were put in place. The electrical activity recordings were made in the mandibular position at rest, and during maximum tooth clenching. The electrical activity of the masseter and anterior

temporal muscles in the position at rest presented no statistically significant difference after five months of wearing the new complete dentures. Electrical activity during tooth clenching exhibited a statistically significant reduction only in the right temporal muscle. A period longer than five months of wearing the new complete dentures is required for adaptation and the acquisition of functional capacity.

Key words: *surface electromyography, jaw muscles, complete denture.*

AVALIAÇÃO ELETROMIOGRÁFICA DOS MÚSCULOS MASSÉTER E TEMPORAL ANTERIOR DURANTE A POSIÇÃO DE REPOUSO E NO MÁXIMO APERTAMENTO DENTAL ANTES E APÓS USO DE NOVAS DENTADURAS COMPLETAS

RESUMO

O objetivo deste estudo foi avaliar a atividade elétrica dos músculos masseteres e temporais anteriores em pacientes com severa reabsorção óssea, com prótese total há mais de dez anos de uso e após cinco meses da instalação de novas próteses. Após a aplicação do questionário RDC, em doze pacientes assintomáticos, antes e após cinco meses da instalação de novas próteses. O registro da atividade elétrica dos músculos foram realizadas na posição de repouso mandibular e no apertamento máximo dental. A atividade elétrica dos

músculos masseteres e temporais anteriores na posição de repouso não apresentou diferença estatisticamente significativa após cinco a reabilitação. Para o apertamento dental houve redução com diferença estatisticamente significativa apenas no temporal direito. Há necessidade de um período de adaptação e capacidade funcional maior que cinco meses de uso das novas próteses totais .

Palavras chave: *Eletromiografia, músculos da mandíbula e dentadura completa*

INTRODUCTION

Michelotti *et al.* (1), stated that although the relationships between the upper cervical spine and mandibular position are described in the literature, they could not be proven for further caudally located spine sections. Conversely, some studies deny the existence of correlations between specific orthopedic findings and certain sagittal jaw positions (2, 3). Mastication is a highly coordinated neuromuscular function involving fast effective movements of the

jaw and continuous modulation of force (4). The alveolar bone tends to resorb, the formation of new bone is lost, and the overlying mucosa presents a decreased number of receptors, resulting in the reduction of the afferent inputs (5, 6). In edentulous subjects sensory feedback is altered. In these patients, the masticatory cycle amplitude and efficiency, and the masticatory force are smaller in comparison with dentate subjects. Moreover, both the opening and closing velocity of masticatory

cycles are reduced, while the occlusal pause is longer (7, 8). The change of denture determines a modification of the peripheral information, with a need of adaptation of the motor control strategy. The investigation of the adaptation process to a new denture is relevant to understand the control of muscles during maximal voluntary clenching and may provide essential information for the diagnosis of dysfunctions of the masticatory system (9, 10). The analysis of electromyographic (EMG) activity and kinetics of the movement provides an insight into the motor control system (11). Although after rehabilitation with a new denture EMG parameters usually approach those observed in dentate subjects, this is not observed in specific cases (7, 8). In this context, many factors play a role, such as age, gender, number of years of being edentulous, oral conditions, denture mobility and subjective experience wearing dentures (12). The poor fit and the lack of stability of the full denture clearly affects the function (13). To provide further insight into the adaptation to a new complete denture in edentulous subjects, we planned a longitudinal study for the simultaneous evaluation of jaw muscles activity (by EMG in patients with complete denture). The subjects were thus analyzed in postural position of the mandible and during maximal voluntary clenching in two experimental sessions: (i) with the old denture (worn for at least 10 years), (ii) with the new denture, five months after placement.

MATERIALS AND METHODS

Twelve edentulous patients (eight women and four men aged between 64 and 84 years) with complete, old maxillary and mandibular dentures, worn for over 10 years were selected for the present study based on anamnesis and clinical exams. All patients presented diminished occlusal vertical dimension (OVD), with deficient dental occlusion, and severe bone resorption, particularly of the mandibular arch. They were all asymptomatic and presented no signs or symptoms of TMD, confirmed by the Dworkin and Leresche Research Diagnostic Criteria (RDC) questionnaire. The selected patients were informed about the treatment to be instituted and signed a term of consent in accordance with the recommendations of the Human Research Ethics Committee in Brazil. The guidelines of the Declaration of Helsinki and the European Guidelines for Good Clinical and Laboratory Procedures were strictly observed.

Electrode positioning was done by palpation of the muscles. The electrode was placed in the centre of the masseter muscle, at an equidistant point from the upper and lower insertions, maintaining the teeth in occlusal contact. In the case of the anterior temporalis muscle during mandibular movement, the anterior border was located and the electrode was placed perpendicular to the sagittal plane 1.5–2.0 cm over the zygomatic arch immediately behind the frontal process of the zygomatic bone (14). During the EMG recordings, the patients were kept in a comfortable sitting position with no head-rest aligned according to Frankfort horizontal plane, parallel to the floor.

These electrodes were connected by cables to an amplifier, and the amplifier was connected in turn to a computer loaded with the Bioresearch “Bio EMG” (USA) software. The electrical signal was captured and the electrical activity of the muscles was analyzed. The recordings were made in the mandibular position at rest, and during maximum tooth clenching.

For the recording of the mandibular position at rest, the patient remained seated in the orthostatic position, looking at the horizon, and keeping his/her teeth slightly separated, in a state of mandibular inertia.

After recording the electrical activity of the muscles in the mandibular position at rest, the patient was asked to clench his/her teeth, and keep them clenched for two seconds. Next the patient was asked to relax the muscles, slightly separating the teeth for another two seconds. All the times were controlled by the operator. The electrical activity was recorded at four time-points: 2, 4, 6 and 8 seconds. To record maximum tooth clenching, the patient maintained tooth contact for two seconds, and electrical activity was recorded at 3 time points: 2, 6 and 10 seconds.

The recordings were made before, and five months after the new dentures were put in place.

Statistical analysis of the electromyographic recordings was performed by Student's *t* test.

RESULTS

After five months, one patient reported having difficulty with adapting to the new mandibular denture. The electromyographic exams revealed no statistically significant differences in mean electrical activity recorded five months after placement of

TABLE 1. Mean electrical activity (μv) in the anterior temporal and masseter muscles, recorded in the resting position of the mandible, before and after five months of wearing the new dentures.								
PATIENT	POSTURAL POSITION: AT REST							
	RIGHT ANTERIOR TEMPORAL		LEFT ANTERIOR TEMPORAL		RIGHT MASSETER		LEFT MASSETER	
	Before	After 5 months	Before	After 5 months	Before	After 5 months	Before	After 5 months
MEAN	3.325	3.158	3.225	3.433	4.275	3.85	4.108	3.833
Difference between before and after	0.167		-0.208		0.425		0.275	
There was no statistically significant difference in electrical activity between readings prior to and five months after placement of the new dentures								

TABLE 2. Mean electrical activity (μv) of the anterior temporal and masseter muscles, recorded during tooth clenching, before and after five months of wearing the new dentures.								
PATIENT	TOOTH CLENCHING							
	RIGHT ANTERIOR TEMPORAL		LEFT ANTERIOR TEMPORAL		RIGHT MASSETER		LEFT MASSETER	
	Before	After 5 months	Before	After 5 months	Before	After 5 months	Before	After 5 months
MEAN	56.592*	33.05*	44.642	37.933	47.65	41.408	43.908	38.45
Difference between before and after	23.542		6.709		6.242		5.458	
* Statistically significant difference at 5%								

new dentures, in the resting position, for the anterior temporal muscles on both sides for the 12 patients (Table 1).

The maximum tooth clenching recordings revealed a reduction in the mean electrical activity value of the anterior temporal muscles, on both sides, before and after the new dentures were put in place (Table 2). This difference, however, was statistically significant only on the right side, five months after the dentures were put in place. The masseter muscles in maximum tooth clenching, exhibited no statistically significant difference between pre and post-treatment readings for both sides. However, the numerical value of the mean was lower after the treatment.

DISCUSSION

The mean electrical activity values of the muscles analyzed in the position at rest, and in maximum tooth clenching with the old complete dentures were higher in comparison with those of patients

with the new complete dentures. Electrical activity in the position at rest, after 5 months of wearing the new dentures, was higher only in the left anterior temporal muscle (Table 1).

The mandibular postural position can undergo alteration with reduction in OVD. According to Agerberg (15), patients with complete dentures worn for longer than 10 years, with precarious adaptations and retentions, acquire the habit of clenching their teeth to keep the dentures stable, and may produce muscular hyperactivity, both in the temporal and masseter muscles. This overload may increase the electrical activity of these muscles. According to the author, after these patients are rehabilitated and OVD is reestablished, by replacing the old dentures with new ones, they no longer clench their teeth to keep the dentures stable and the muscles return to the postural position at rest, with decreased electrical activity (16) (Table 1).

Studies have shown that the elevator muscles of the mandible have low electrical activity when the

mandible is in the position at rest (17, 14), and particularly, in an asymptomatic condition (18). Electrical activity of the temporal muscle was lower than that of the masseter muscle after five months of having the new complete dentures put in place (Table 1). Similar data were found by Tallgren *et al.* (19) and Gervais *et al.* (18).

A statistically significant reduction was observed in the mean electrical activity values of the right anterior temporal muscle during tooth clenching, and on both sides, after five months of wearing the new dentures. Under the same conditions, a reduction in the mean electrical activity values was observed in the masseter muscle. However, this reduction did not reach statistical significance (Table 2).

The comparative mean electrical activity values of the masseter muscles and the anterior temporal muscles during the tooth clenching test, after five months of having the new dentures put in place (Table 2), were similar to those found by Kawazoe (20). This finding is in keeping with the fact that the masseter muscle is more active in raising the mandible, especially during masticatory function (21, 22), and according to Lippold (23), the mean electrical activities recorded at the surface of the muscles increases with the force of muscular contraction.

The main function of the temporal muscle is to maintain the mandible against the force of gravity, and it is therefore considered a postural muscle (17, 24-27).

The reduction in the electrical activity of the anterior temporal muscle in maximum tooth clenching after prosthetic treatment (Table 2), may be an adaptation that occurs after OVD and the occlusal surfaces have been reestablished, causing the anterior temporal muscle to return to its main role of postural muscle of the mandible (24, 25), associated with enhanced occlusal stability (17, 28, 29).

Reduction in electrical activity in the masseter muscle during the maximum tooth clenching tests (Table 2) with new dentures is in disagreement with the results of Liconi *et al.* (30) and Lindauer *et al.* (31), who found that after 30 days of putting the new dentures in place, the electrical activities were significantly greater. According to the authors, this increase in electrical activity occurred as a result of reestablishing OVD. In the present study, this disagreement could be explained by a new occlusal condition (17, 32). The new denture with correctly

positioned cusps, facilitates intercuspitation and demands a lower amount of force to grind the food (33-37). These results are similar to those found by Tallgren *et al.* (19), Gunne *et al.* (34), Ralph (38) and Haraldson *et al.* (39). These results also correspond to the period of 12 to 18 months after the new dentures were put in place.

As a result, a lower bite force is developed by the muscles. Several authors state that the main cause of reduction in masseter muscle electrical activity during maximum tooth clenching, also found in the patients of the present study, may be related to the patient's lack of muscular capacity and ability to adapt to the new complete dentures (24, 34, 36, 40-42).

Patients who have been edentulous for over 10 years and have adapted to their unsatisfactory prosthesis may need extra time to re-establish their musculature after changing the prosthesis and it may be necessary to consider new parameters for these patients. It is essential to explain to complete denture users, the importance of periodical visits to their odontologist in order to evaluate their dentures and oral conditions. These factors are intimately linked to aesthetics and functionality (43).

Clinically, the use of the new complete denture will allow balanced occlusal contacts to be established, functionally benefiting the masticatory system by allowing a return to normal parameters (44).

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From these results, we may conclude that a new complete denture allows for neuromuscular reprogramming, which contributes to muscular balance of the masticatory system.

CONCLUSIONS

The electrical activity of the masseter and anterior temporal muscles in the position at rest presented no statistically significant difference after five months of wearing the new complete dentures.

The electrical activity of the masseter and anterior temporal muscles during tooth clenching was reduced. The difference was statistically significant only in the right temporal muscle, after five months of wearing the new complete dentures.

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