AN EMG STUDY ON FUNCTIONAL ASPECTS OF MUSCLES MANDIBLE DYNAMICS

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ABSTRACT

Aim of the study The aim of this study was to evaluate the muscular forces from the masseter muscles through a series of EMG records. Muscle activity was evaluated in various occlusal relationships/positions to determine possible correlations in the diagnosis and treatment of stomach system disorders. Material and methods The study was conducted on a group of 15 patients presenting clinical signs or symptoms of the dysfunctional syndrome of the dental system and with the acquisition of EMG surface signals was used a special system with 2 EMG acquisition modules in parallel. Results The results obtained from the recordings of various symmetric indices and muscle activity were assessed - equally approximate values were obtained when the apparent asymmetries were recorded in the maximum interference, and lateral movement was performed by the more active masseter muscle. Conclusions The value of the EMG examination as a paraclinical investigation is reflected in the diagnosis and treatment of dysfunctions and even in knowing how it works but needs the interpretation and development of a much wider database.

Key words: EMG records, masseter, dysfunction

INTRODUCTION

The dental system functions as an integrated system, characterized by the production, reception and transmission of forces, but with its own biodynamic laws where muscle contraction plays an essential role. That is why, it is necessary to know the behaviour of each muscle, as well as the force developed by the muscles that develop a significant muscular force as masster muscles. (1,2,3,4,5).

Muscle strength can be determined directly by using resistive tonometry only for certain muscle groups, but the most commonly used method of calculating the force of the muscle is based on electromyographic analysis. Superficial muscles, especially masseters, are typically tackled by surface electrodes. Electromyography thus obtained can be interpreted with sufficient accuracy due to the importance of electronic and computer technology in this field (6). Various studies have attempted to establish a correlation and quantification of the muscle-electrical force relationship, and it has been observed that the amplitude of the electromyographic signal increases simultaneously with the increase in muscle contraction force, so that in the EMG investigations performed, the relationship appears linear. The value of the proportionality constant between the magnitude of the electrical signal and the value of the muscle force developed is assumed to be 40N/cm² (7) or 37N/mm² (8) for the masticatory muscles.

The study investigated and attempted to
quantify, the bioelectric activity of masseter muscles under different occlusal individual circumstances, and compare the results obtained with those of other similar studies.

MATERIAL AND METHODS

The study group consisted of 15 patients - 7 women and 8 men - who had clinical signs or symptoms of dental syndrome dysfunctional syndrome.

In order to obtain surface EMG signals, BIOPAC 150MP acquisition system with 2 EMG acquisition modules was used in parallel. The recording was performed simultaneously on two channels for 15 seconds, resulting in a time series of 30,000 samples for a sampling frequency of 2 KHz. The dynamic range of the acquired signal is [-2mV, 2mV] at the analog input and [-5V, 5V] at the digital system output. The electrodes used were 5 mm diameter circular surface electrodes made of Ag|AgCl, an alloy that provides its own reduced noise of approximately 0.3 mV. They were mounted in characteristic areas in the right and left right muscles, perpendicular to the investigated muscle fibers. The distance between the electrodes was kept constant in all determinations - 10 mm.

For each patient, EMG signals were recorded in the following situations: in posture relationship; in maximum intercourse; in maximum voluntary contraction in maximum interaction; in maximum voluntary contraction in prolonged effort and protrusion position; in the maximum voluntary contraction in the sideways and in the right and left side respectively.

RESULTS AND DISCUSSIONS

The mean and power of recorded electrical signals were calculated and, based on these values, the asymmetry and muscle activity index was subsequently calculated for the masseter muscle under occlusive conditions defined previously.

The asymmetry index is defined by the relationship between the amount of electrical activity between symmetrical muscle bundles (eg. the right masseter/left masseter) and the activity index is defined by the relationship between the electrical activities between the two muscle bundles.

We noticed that in the postural position (fig. 1), the electrical activity was negligible, leading to approximate unitary asymmetry indices.

In the position of maximum intercourse and of the maximum voluntary contraction,
the obvious asymmetries were recorded, reported by sub/over-unit value indices. We also noticed the phenomenon of muscle fatigue characterized by the reduction of the amplitude of the electro-myographic signal (fig. 2).

The activity level of the masseter muscles during maximal occlusion was directly correlated with the recording of normal occlusal contacts in the protrusion and laterality position, which means that a higher level of muscle activity in the maximum position will lead to more significant activities in the prominent position - aspect highlighted by Bakke's study (9), but in our study we did not find this result constantly.

In the lateral position, we generally recorded comparable activities between the right and left superficial muscles or slightly enlarged activities of the contralateral masseter muscle at the lateral movement.

Approximately equal values were obtained when significant asymmetries were recorded in the maximum interference, and lateral movement was performed by the more active masseter muscle.

The registrations that were performed supposed the single use of surface electromyographies in the case of the anterior temporalis and the superficial masseter muscles; the reports of electrical activities between the two muscles (calculated by means of muscular asymmetry and activity) in effort occlusion in maximum intercuspidation and eccentric lateral and protrusion test positions were similar to the data cited by Ferrario (10) in the literature. Further details regarding the muscular activity and asymmetry are shown below (fig. 3 and fig. 4).

![Figure 3. Electrical activities in protrusion test position](image1)

![Figure 4. Electrical activities in effort occlusion](image2)

Reported to some studies in literature, this study demonstrated greater activity of the masseter muscle in effortless occlusion (11). The maximum intervention position is the only contact position with the best occlusal stability that typically allows the highest level of electrical activity in normal functional activity. In general, the left-right balance can be assessed visually under the form of forces located on one side and the other of the central median line. The elements that are closer to the middle will have a larger impact than those closer (12).

Thus, there is a close link between the extension of occlusal contacts in the natural teeth and the level of electromyographic activity of the maximum voluntary contraction of the masseter muscles.
Together with the increase of the occlusal support in the protruding and lateral positions, the activity level of the masseters was almost equal to the level obtained in the maximum intercuspation, which is an extremely important observation in the occlusal concepts of prosthesis application for the total lack of teeth (13,14). The assessment of the clinical-biological indices of the prosthetic field allows the monitorisation of the changes related to the biological components of the stomatognathic system. 

PRODENT Indices (Neo-Tech) can sustain the therapeutically decision by the support supplied for the assessment of the pro prosthetic procedures effectiveness and monitorisation of the oro-maxillo-facial system changes (15).

CONCLUSIONS

The value of the EMG examination as a paraclinical investigation is reflected in the diagnosis and treatment of dysfunctions and even in knowing how it works but needs the interpretation and development of a much wider database. The results of the EMG records and the electrical activity relationships between these muscle groups calculated by the asymmetry and the muscle activity index, in the aforementioned occlusal situations can be summarized as follows:

1. in the posture position, the muscular asymmetry indices had an approximate unitary value;
2. in the effort, the obvious asymmetries were observed for all cases and the phenomenon of "muscle fatigue" was revealed, characterized electromiographically by the reduction of the amplitude of the signal;
3. in the lateral tests we highlighted comparable electrical activities between the right and left superficial muscles, or the light electrical activities for the masseter muscles in the contralateral part with the movement performed.
4. in the test laterotrusion movement, we ascertained much lower electrical activities than in the test position; the most intense electrical activity was registered in the effort occlusion in maximum intercuspation, proving the role of the occlusal support on the muscular activity;
5. in the protrusion position of the test, there was a greater reduction in the amplitude of the EMG signal for the superficial masseter muscle than for the anterior temporal muscle compared to the value obtained in the maximum effort intervention.

REFERENCES

7 deLuca C.J., The Use of Surface Electromyography in Biomechanics, Wartenweiler Memorial Lecture - The International Society for Biomechanics, 1993, 70-75
10 Ferrario V. F., Tartaglia G. M., Galleta A., Grassi G. P. & Sforza C., The influence of occlusion on jaw and
15 Forna Doriana, Feier R., Topoliceanu C., Forna Norina, Popescu E., Study regarding the possibilities to use application Prodent in the prosthetic stage, Romanian Journal of Oral Rehabilitation Vol. 9, No. 3, July-September 2017, 97-100