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Original articles

Pattern of maximum voluntary contraction in patients with temporomandibular disorder before and after speech therapy with and without use of elastic bandages

Maria Eduarda Gomes Nunes[1]

Fabiane Miron Stefani[2]

[1] Universidade Federal de Santa Catarina - UFSC, Florianópolis, Santa Catarina, Brasil.

[2] Universidade Federal de Santa Catarina - UFSC, Departamento Fonoaudiologia, Florianópolis, Santa Catarina, Brasil.

ABSTRACT

Purpose: to verify if there is an electromyographic difference during maximal (maximum) voluntary contraction of the masseter and temporalis muscles in patients with temporomandibular disorders, before and after speech therapy intervention with and without the use of therapeutic elastic bandages.

Methods: an analysis of secondary data from a clinical intervention study, carried out with 17 adult volunteers, diagnosed with temporomandibular muscle dysfunction with or without disc displacement with reduction. The Bandage Group received manual therapy associated with elastic bandages and the No Bandage Group received only manual therapy. Surface electromyography was performed to record the Maximum Voluntary Contraction before and after four weeks of speech therapy intervention. For exploratory analysis, the Mann Whitney and Wilcoxon paired tests were used, with $P<0.05$.

Results: in the Bandage Group, there was a statistically significant decrease in electrical activity during Maximum Voluntary Contraction in the masseter and temporalis muscles on the left side at the post-therapeutic moment. Comparing the pre- and post-intervention between Bandage Group and No Bandage Group, a statistical difference was found in the electrical activity values of the Maximum Voluntary Contraction in the left temporal muscle.

Conclusion: manual myofunctional speech therapy, associated or not with the use of therapeutic elastic bandages, impacts the muscle activity of the masseter and temporal muscles during Maximum Voluntary Contraction, whether the values demonstrate relaxation and/or equivalence of the electromyographic values of the masticatory muscles.

Keywords: Speech, Language and Hearing Sciences; Temporomandibular Joint Disorders; Muscle Stretching Exercises; Athletic Tape; Electromyography

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Corresponding author:
Fabiane Miron Stefani
Departamento de Fonoaudiologia da Universidade Federal de Santa Catarina, Coordenadoria Especial em Fonoaudiologia - Sala 2 - Prédio anexo ao CCS
Rua Delfino Conti, S/N - Trindade
CEP: 88040-370 - Florianópolis, Santa Catarina, Brasil
E-mail: fastefani@gmail.com

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INTRODUCTION

Temporomandibular dysfunction (TMD) occurs when there is disharmony in the components of the temporomandibular joint (TMJ) and the muscles of the stomatognathic system. TMD is defined as a set of disorders involving the muscles of mastication, TMJ and associated structures.[1]

According to Bastos et al.,[2] several elements contribute to triggering and/or accentuating TMD, given that its etiology is complex and multifactorial and may be related to biomechanical and neuromuscular conditions, and psychosocial and biological factors.

TMD can be subdivided into joint disorders - whose signs and symptoms are related to TMJ, and its subtypes include disc displacement (with or without reduction), arthralgia, osteoarthritis and osteoarthrosis - and muscular disorders - whose signs and symptoms are related to the stomatognathic muscles, and may include pain, limited mouth opening, and otological factors. Mixed TMDs are detected in most cases, that is, with associated muscular and joint factors, especially muscular TMD with disc displacement with reduction. This dysfunction has different causes, and among them, it is possible to mention structural factors, harmful habits, and traumatic injuries.[3,4] Patients who present muscular TMD usually report pain in the region of the muscles of mastication during functional examination and/or muscle palpation, as the interference will be direct on the mandibular muscles and cervical region.[5,6]

The main symptoms presented by patients with TMD are unilateral or bilateral pain in the TMJ region, in addition to headaches and earaches, joint noises, mandibular deviations, and limited mouth opening, and symptoms are often confirmed during palpation examination and jaw movement, assessments necessary to conclude the diagnosis.[7]

As studies suggest,[8,9] the treatment of TMD is multidisciplinary, and the work of the speech therapist who works in orofacial motricity can be complementary to other treatments, such as dental treatment. The direct contact between these two areas, as well as other areas involved, allows achieving the main treatment objective, which is the patient well-being, through pain relief, reduction of muscular and joint overload, and the achievement of neuromuscular and occlusal balance.

Speech therapy, in particular, is based on myofunctional therapy, which aims to adapt the orofacial muscles and stomatognathic functions. A speech therapy intervention that is being studied and widely discussed is the therapeutic elastic bandage, a therapeutic resource that adds greater efficiency to therapies, as long as it is applied with appropriate technique and associated with other therapeutic methods, especially orofacial myofunctional therapy. Its application is on the integumentary system, providing constant and lasting stimuli from the environment to the body through the afferent and efferent pathways of the primary sensory cortex, culminating in a better motor response.[8]

One of the strategies most used by health professionals to investigate muscle activity is surface electromyography (sEMG), which allows non-invasive assessment by capturing electrical signals from muscles during the resting state or during muscle contraction activity.[10] One of the most used measurements in sEMG is Maximum Voluntary Contraction (MVC), which can be described as the most intense muscular contraction that a muscle is capable of generating voluntarily, against maximum resistance, as, for example, in maximum intercuspation. Such muscle activation occurs through the action of motor neurons in the central nervous system, which cause muscle fibers to contract.

Evaluating electromyographic activity can contribute to more accurate, early and effective diagnosis and monitoring of muscular, biomechanical, and sensory changes associated with TMD, and its data can complement diagnosis, treatment and even prognoses in speech therapy practice.[11]

Considering the scarcity of research that provides scientific evidence of the effectiveness of using therapeutic elastic bandages and even speech therapy for cases of TMD, this study aimed at verifying whether there is an electromyographic difference in the masseter and temporal muscles during MVC in patients with temporomandibular disorders, before and after speech therapy intervention with and without the use of therapeutic elastic bandages.

METHODS

Study design, ethical aspects and sampling

This work is a blind experimental study, approved under opinion 2.676.182, CAAE 80653017.8.0000.0121, by the Research Ethics Committee of Universidade Federal de Santa Catarina (UFSC), Santa Catarina, Brazil. The collection was carried out at the UFSC Speech Therapy School Clinic during 2019, with inclusion of secondary data related to the results of the initial research project, entitled "Therapeutic elastic bandage effects on the treatment of temporomandibular dysfunction." The sample for this study comprised 17 women who agreed to participate in the research and signed the Informed Consent Form (ICF).

Eligibility criteria

The patients included in the initial research had a diagnosis of muscular TMD with or without disc displacement with reduction, made by a dental surgeon through a clinical examination using the Diagnostic Criteria for Temporomandibular Joint Disorders (DC/TMD) classification system, who also analyzed and included volunteers with clinically normal occlusion, that is, without significant changes in occlusion or bite. Women aged between 18 and 40 years, with a body mass index (BMI) between 25 and 29 were included.

Exclusion criteria were the following: individuals with diagnosed neurological diseases; patients who were diagnosed with joint TMD; patients with three or more missing teeth or two missing posterior antagonist teeth (keys to occlusion); individuals who used muscle relaxants in the 72 hours preceding the initial clinical study and/or have undergone speech therapy for TMD in the last 6 months.

Thus, the research included 17 women, who were divided into two groups: Bandage Group (BG), with 10 women who used therapeutic elastic bandages associated with manual myofunctional therapy; and No Bandage Group (NBG), with seven women who did not use therapeutic elastic bandages, only speech therapy intervention through manual therapy. All of them were assessed before and after speech therapy intervention. The division into groups was not randomized, and the participant chose to use or not a bandage.

Procedures

There was a speech therapy assessment of the participants that included analysis of their complaints and clinical histories using a temporomandibular dysfunction assessment questionnaire,[12] in addition to the application of the Orofacial Myofunctional Evaluation with Scores Expanded (OMES-E) protocol, for participant inclusion/exclusion. Regarding sEMG, participants received instructions, at the time of scheduling the examination, about remaining fasting for two hours before the examination and not wearing any metal object in the head and neck region, such as, for example, jewelry, piercing etc, in addition to coming with clean skin, free from cosmetics and creams.

To conduct the examination, it was necessary that all electronic equipment was turned off, and the room had to be silent and with only natural light. The participants remained seated, with their feet flat on the floor and their head unsupported, with their chin parallel to the floor. The skin in the region where the electrodes would be adhered was cleaned with 70% alcohol using gauze to better signal capture by reducing impedance. The electrodes were positioned on the masseter and temporal regions, and the ground electrode fixed on the skin in the sternum region and then connected to the device to start collecting data. A four-channel MioTool 400 electromyograph (Miotec®, Rio Grande do Sul, Brazil) was used. To perform the MVC tests, the electromyograph was configured with an A/D converter with 14 bits of resolution in the acquisition of EMG signals, a common rejection rate for >100 dB signals, a 20 Hz high-pass filter and a 500 Hz low-pass filter. Acquisition capacity was 2,000 samples/seconds per channel and the electrical isolation was 5,000 volts. Values were presented in Root Mean Square (RMS) values automatically, according to the brand website (Miosuite 1.0). The equipment used was connected to a notebook disconnected from the electrical network and the electromyographic tracings were archived on the hard disk and on a USB device. The electromyographic examinations and subsequent analysis were conducted by a single blinded examiner, who did not know which group the participant belonged to, whether BG or NBG.

Electromyographic recordings were performed during rest and maximum teeth clenching to register MVC, in two measurements, and after normalization, the mean was used for analysis. The first measurement was a 20-sec recording during rest, in which the participants were instructed to relax their face and keep their top and bottom teeth apart. Resting values

were not used for analysis but to exclude the presence of background noise that could interfere with the test and also for muscle relaxation between MVC tests. To evaluate MVC, cotton rollers were positioned on the posterior teeth, on the key-to-occlusion region (first and second molars), and as much clenching as possible between the bottom and top teeth was requested for 10 seconds, with the examiner giving verbal incentives in order for the participant to maintain the contraction throughout the collection period.

BG members had bandages applied bilaterally on the masseter muscle region skin, with a fixed point at the angle of the mandible and with tension directed at the zygomatic arch, so that the tension occurred in the direction of muscle relaxation (opposite to the contraction of the masseter). The bandages were put on by a single therapist, certified for the technique used. Participants were instructed to remain with the bandages for a period of three uninterrupted days. They were fixed weekly after each manual therapy session. Manual speech therapy was performed once a week, for four weeks, for both groups, at the Speech Therapy school clinic of the home institution, conducted by a single therapist, calibrated and trained by the project coordinator. Manual therapy was given bilaterally to the masseter and temporal muscles, consisting of muscle stretching carried out in vertical movements contrary to the force vector of the muscle contraction, in three series of 10 repetitions, and massage performed with circular movements (three series of 20 repetitions) along the muscles, using the index and middle fingers. The therapy sessions were given by a single therapist, different from the researcher who carried out the electromyographic assessments.

Participants were instructed to perform the therapeutic program three times a day for four weeks, and were instructed to film the exercises at home and send them to the researcher in charge to ensure that they were performed daily. If the videos were not sent, the participant would be removed from the sample.

At the end of the sessions, that is, in the fifth meeting, a new sEMG examination was conducted, using the same protocol as at the beginning of the research.

Data analysis

To analyze the sEMG data before and after the speech therapy intervention with and without the use of elastic bandages, such data were added to Microsoft Excel 2010 spreadsheets and the information about the mean MVC values was normalized by the maximum peak of contractions. One chose this type of normalization because the sEMG data normalization, generally performed by the MVC, could not occur, given that MVCs themselves were under analysis. Thus, normalization was performed by the peak of the MVCs, and, therefore, mean MVC values were presented as a percentage of maximum peak values. Mann–Whitney U and Wilcoxon signed-rank tests were used for exploratory analysis. Only p-values lower than 0.05 were considered significant.

RESULTS

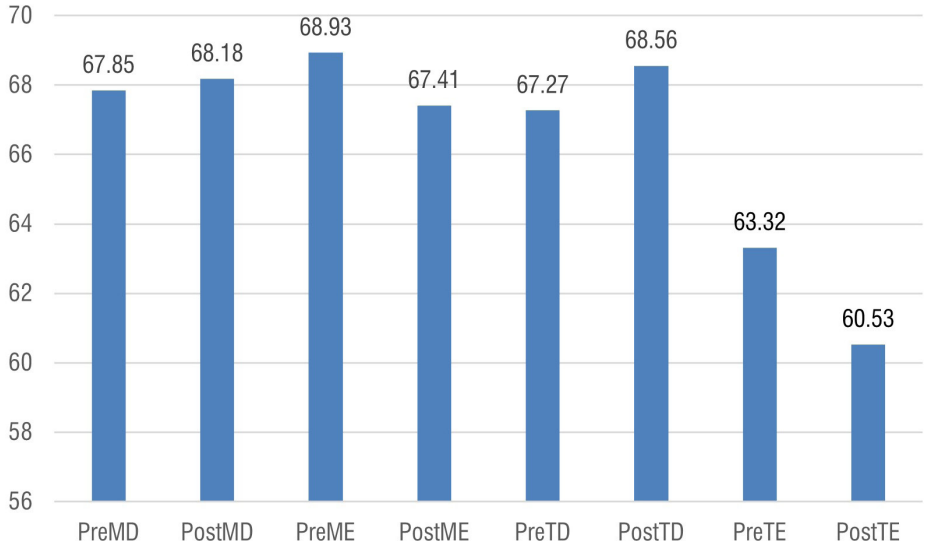
According to Table 1, NBG, in its pre- and post-therapy comparison, did not present statistically significant MVC values. For GB, it was possible to observe a statistically significant decrease in electrical activity during muscle contraction, related to teeth clenching, in the left masseter and temporal muscles after the participants underwent therapy.

Table 1. Comparison of muscle activity values during Maximum Voluntary Contraction before and after manual speech therapy (without the use of bandages) (n=7) on the left side, and comparison of muscle activity values during Maximum Voluntary Contraction before and after speech therapy associated with the use of bandages (n=10) on the right side

BANDAGE GROUP				NO BANDAGE GROUP			
Musc.	Pre-intervention Mean %	Post-intervention Mean %	p-value	Musc.	Pre-intervention Mean %	Post-intervention Mean %	p-value
RM	67.81	68.93	0.106	RM	67.88	67.65	0.437
LM	69.11	75.19	0.065	LM	68.81	61.96	**0.003***
RT	64.66	69.39	0.098	RT	69.10	67.97	0.088
LT	58.50	63.70	0.077	LT	66.70	50.60	**0.027***

Captions: RM (right masseter); LM (left masseter); RT (right temporalis); LT (left temporalis); Musc. (muscle)
*Significance p<0.05.

When comparing pre- and post-intervention, in relation to the total sample (BG and NBG), Figure 1 demonstrates the differences, in percentage of microvolts (normalized data) in each muscle studied.



*Comparison of the muscular activity of the two muscles studied. Abbreviations: PreRM (Pre-intervention - right masseter), PostRM (Post-intervention - right masseter); PreLM (Pre-intervention - left masseter), PostRM (Post-intervention - left masseter); PreRT (Pre-intervention - right temporalis), PreLT (Pre-intervention - left temporalis); PostRT (Post-intervention - right temporalis), PostLT (Post-intervention - left temporalis).

Figure 1. Comparison of the mean of normalized electromyographic values during the Maximum Voluntary Contraction before and after the intervention for both groups studied, per muscles, in percentage (n=17)

DISCUSSION

The sample group of this research was composed exclusively of females, taking into account the higher prevalence of TMD in this population, given that due to anatomical, behavioral, hormonal and psychosocial causes, females are about three times more likely to present TMD[13] when compared to males. The focus of this research was the MVC of people with TMD, as some studies[14] demonstrate that these patients have a greater amplitude of muscle activation because of their lower functional efficiency compared to subjects considered asymptomatic when performing the same motor activities.

This study included both groups receiving myofunctional speech therapy through stretching and muscle relaxation. Its effect demonstrated an approximation of MVC electromyographic values between the muscle groups, and after therapy the right and left sides tended to present values closer to each other than at the pre-therapy intervention. According to some studies,[15,16] this relaxation or equivalence of electromyographic values occurs because manual therapy promotes the adequacy of orofacial muscles and stomatognathic functions through reduction of orofacial myofunctional compensations, and relief of orofacial pain.

In BG, lower mean MVC values were observed post-intervention in the left temporal and masseter muscles, and there was a decrease in values in the right temporal and masseter muscles, but without statistical significance. Manual therapy techniques that aim to control pain and act directly on tissue specificities, such as elasticity, promote the body ability to rearrange itself, causing reactions that lead to muscle relaxation and improved range of motion.[17] In addition to relaxation and stretching strategies, a therapeutic elastic bandage was used as a complementary method. As described in the study by Silva et al.,[18] the bandage produces tactile stimuli on the skin (integument), which increase perception in the area and, consequently, the conduction of sensory information caused by its use, up to the somatosensory area of the cerebral cortex and the cerebellum. Such stimuli occur through the muscles (afferent route), which triggers a motor response from the muscles under the bandage, in this case, a decrease in electrical activity.

Participants of this research should remain with the bandage for three days, which were reapplied weekly, for four weeks, in face-to-face consultations. Therapeutic elastic bandages do not contain medications and, according to the study by Martins et al.,[19] aim to improve muscle function, blood circulation, lymphatic drainage, and promote pain relief. BG showed a significant decrease in MVC values in the left masseter and temporal muscles after the combined interventions, suggesting better functioning/relaxation of those muscles.

According to the result presented previously, NBG did not demonstrate significant statistical values in the MVC analyzes, but it was observed, upon reevaluation, an increase in the electromyographic activity of the masseter and temporal muscles on both sides after myofunctional therapy with stretching and massage. The increase in electrical potential during MVC of the muscles mentioned above suggests a tendency towards closer electromyographic activity values between the masseter and temporal muscles, demonstrating greater balance of the system during MVC, which suggests an improvement in the general TMD condition.

The masseter muscle is one of the main muscles responsible for jaw movements and the major responsible for applying force during biting. Therefore, its physiological state is fundamental for the individual's well-being and adequate functioning of the jaw and face in all its functions. Muscular balance can be characterized by the adequacy regarding the strength of muscle groups, which occurs when comparing the muscles of the same limb, such as in the comparative analysis between right masseter and left masseter.[20]

The equivalence of electromyographic values, observed in NBG, reaffirms that speech therapy, according to a study by Melchior et al.,[21] has been proposed as part of the treatment of individuals with TMD, with the aim of promoting orofacial myofunctional balance and, thus, minimize contributing factors related to the functional conditions of the stomatognathic system.

The results demonstrate a statistically significant decrease in the left masseter and temporal muscles of BG. This fact can be explained by the relaxation of the muscles associated with therapy using the bandage, which leads to a reduction in the number of motor units activated for the same task.

Hyperactivity of facial muscles accounts for a large part of the etiology of TMDs. In the individuals in this study, there was an approximation of electromyographic values and/or relaxation of the muscles of mastication verified by a decrease in electrical potential values, which indicates an improvement in this etiological factor of the TMD.

According to the data discussed above, both groups presented relaxation characteristics and/or equivalence in the electromyographic values of the muscles studied. NBG members, who performed only manual speech therapy, demonstrated an increase in MVC values and reached an approximation in the mean MVC values, with no statistical difference; in turn, BG members, who used elastic bandages to complement manual therapy, showed significant statistical and observational differences in possible relaxation of the facial muscles, observed by the decrease in electrical activity after treatment. The findings of this research demonstrate that both groups benefited from the proposed therapies.

As a study limitation, it is observed that the fact that the groups were not divided randomly may have been a bias, since a participant who chose not to use the bandage could mean a participant who perhaps did not have the same engagement with treatment and research as those who chose to use the bandage.

CONCLUSION

This study concludes that the MVC electromyographic values presented significant results in BG regarding the left masseter and temporal muscles, with a decrease in electrical activity in this group found after the speech therapy intervention associated with the use of bandages. In this same group, it was possible to observe, in addition to values suggestive of muscle relaxation, a muscular balance between face sides.

NBG, on the other hand, did not present a statistically significant change in muscle activity during MVC. However, it was possible to observe, after speech therapy, an approximation of electromyographic values between the muscles studied bilaterally.

In this way, myofunctional speech therapy given with stretching and relaxation, associated or not with the use of therapeutic elastic bandages, impacts the muscular activity of the masseter and temporal muscles, promoting a decrease or equivalence in the electromyographic values of the muscles of mastication.

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Authors' contribution:

MEGN: formal analysis, investigation, original draft writing.

FMS: conceptualization, fundraising, methodology, project administration, writing, review and editing.