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Influence of Temporomandibular Disorder in the Stomatognatic System: Electromyography, Mandibular Movements and Articular Sounds Analysis

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Abstract

Context: EMG test can be used as an auxiliary method to diagnose TMDs, as it detects and graphically records the electrical potential created when the muscle fibers are activated by the neuromuscular system, and the results provide information about contraction, tone and muscular fatigue, mandibular movements by gnathography and articular noises by sonography.

Aim: To analyze if the electrical activity of the masseter and temporal muscles, present a statistically significant variation when in the presence of TMD, besides the presence of muscular fatigue, mandibular movements and joint noise in individuals with TMD.

Settings and Design: The sample consisted of 37 individuals, 20 were individuals of the observational group and 17 of the control group.

Materials and Methods: Data were obtained in: rest and Maximum Voluntary Contraction (MVC), opening, closing, lateralities and protrusion.

Statistical Analysis: The difference between the rest and MVC measurements was verified and the relationship of the variables with the presence of TMD was organized and submitted to statistical analysis using SPSS (IBM Statistic 20.0).

Results: Statistically significant values were observed at MVC ($p=0.007$), MVC in right masseter ($p=0.002$) and left ($p=0.005$) and right temporal ($p=0.048$), in the difference between rest and MVC in right masseter ($p=0.001$) and left ($p=0.007$) and in the presence of fatigue ($p=0.000$), deviation/deflection ($p=0.000$) and masticatory tendency ($p=0.000$).

Conclusion: Individuals with TMD had higher muscle electrical activity at rest and lower in function, presented more fatigue and unilateral mastication, as well as greater presence of deviation/deflection and joint noise than control group.

Keywords: Diagnosis; Masticatory muscles; Electromyography; Temporomandibular joint disorders

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Introduction

Temporomandibular Disorder (TMD) is a comprehensive term for pain and dysfunction involving the masticatory muscles and Temporomandibular Joints (TMJs). TMD is the most common orofacial pain condition after toothache. Its prominent features include regional pain in the face and preauricular area, limitation of jaw movements and TMJs noises during jaw movements [1].

TMDs involve not only physical changes but also behavioral, emotional, psychosocial aspects [1,2]. In 1992, Dworkin and LeResche [3] proposed a questionnaire to assess the necessary aspects for the diagnosis of these changes aimed at clinical research. In 2014, it was updated and expanded for use in clinical settings, where the main types of dysfunctions were tested for accuracy, the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) [4].

In addition to the application of questionnaires and physical exams, complementary exams -

such as radiographic exams, ultrasound, nuclear magnetic resonance (reference standard), for example, are widely used. Currently, Electromyography (EMG) exams - have shown reliable results when used as an auxiliary method in the differential diagnosis of TMDs [2,5,6].

TMDs cause changes in the electrical activity of the masticatory muscles due to the disorder itself or compensatory mechanisms associated with the symptoms [7]. When associated with the patient's clinical history and physical examination, EMG provides objective, reproducible and valid data on the functional condition of masticatory muscles in individuals with TMD [8]. In addition, it is a non-invasive and low cost [9,10].

Other information that can be obtained, such as mandibular movements and the acquisition of joint sounds, can corroborate the diagnostic precision [2]. One of the issues that need to be clarified is related to the presence of chronic pain in patients with TMD; the origin of these pains may involve not only the skeletal muscle system, but also the central and autonomic nervous system [2].

Therefore, the aim of this study was to analyze, through EMG, if the electrical activity of the masseter and temporal muscles present a statistically significant variation when in the presence of painful TMD, in addition to the presence of muscle fatigue, mandibular movements and TMJ noises in individuals with TMD compared to a control group.

Materials and Methods

Study design

A cross-sectional observational experimental analytical study was carried out on a sample consisting of individuals with TMD (observational group) and without TMD (control group). Ethics and Research Committee of Tuiuti University of Paraná (process number 79654117.0.0000.8040) previously approved the research. All individuals agreed and signed informed consent forms before clinical procedures and examinations were performed.

Data calibration

The data collection was composed of an examiner who was trained and calibrated for the EMG and DC/TMD analysis.

Prior to the beginning of data collection, theoretical concepts were reviewed and calibration procedures were performed, which involved training and verification of agreement. To check the intra-examiner and inter-examiner agreement for the EMG and DC/TMD instruments, Cohen's Kappa concordance indexes were used. An experienced and qualified professional in the specific area evaluated was considered the gold standard.

The examiner's training for of EMG and DC/TMD analysis was carried out at Tuiuti University of Paraná involving the consolidation of theoretical bases and the evaluation of 5 individuals in the same age group. The inter-examiner Kappa obtained was 0.92 for EMG and 0.87 for DC/TMD.

The intra-examiner calibration was performed in another group of 5 individuals of the same age group and with an interval between the first and the second application of 7 days. The intra-examiner agreement obtained a Kappa value of 0.96 for EMG and 0.94 for DC/TMD.

Sample selection

At random, 83 individuals of both sexes were submitted to DC/TMD for the diagnosis of TMD. The inclusion criteria for both groups were considered: Not having a diagnosis of neuromuscular and/or degenerative diseases; not having suffered trauma in the temporomandibular region; not having autoimmune disease that compromised the joints and not having undergone previous treatment for TMD.

The DC/TMD contains two axes: Axis I consist of a physical diagnosis through a standardized clinical examination and can be used to classify the individual according to the clinical conditions of TMD into three groups: Group I - Muscle disorders; Group II - Joint dysfunction; and Group III - Degenerative disorders. To be allocated to the observational group, individuals should belong to at least one of the groups on Axis I; otherwise, they were allocated to the control group. Moreover, Axis II assesses the patient's emotional and psychosocial aspects.

The individuals who met the inclusion criteria and the DC/TMD were placed in the observational group (n=38), and those who did not fit in, participated in the control group (n=45). Of the 38 individuals in the observational group, 20 agreed to participate in the research and of the 45 individuals in the control group, 17 agreed to participate. After acceptance, the other evaluation procedures were applied.

Data acquisition

Electromyography: To perform this exam, the individual must remain seated with his feet flat on the ground, habitual posture, looking at the horizon, immobile and without voluntary movements. The electrodes were applied to the skin according to the protocol proposed by SENIAM in the anterior temporal and masseter muscles, bilaterally [11].

The subjects were instructed by the researcher as to the position and operation of the exam. This was performed in three takes of fifteen seconds at rest and three takes in Maximum Voluntary Contraction (MVC), according to the FOP-UNICAMP protocol [12]. The median of the results obtained in RMS (Root Mean Square) was used.

The 8-channel K7 Myotronics Noromed Inc® equipment was used. The electromyographic signals were conditioned through programmable instrumentation amplifiers *via* software and analogue filters, Butterworth type filter, low-pass with frequency of 10 Hz (high-pass) and 1500 Hz (low-pass) and gain of 100 times. The signals were digitized with a sampling frequency of 2000 Hz, with 12 bits of resolution and simultaneous sampling of the signals. For visualization and processing of the electromyography signal, the software k7 myotronics was used in a notebook microcomputer brand Acer® Aspire 5630 with an Intel Core 2 Duo® microprocessor, with 3000 MB of RAM memory, 300 GB of hard disk. To acquire the signal, disposable Duo-trode electrodes from Myotronics Inc®, surface electrodes, composed of Ag/AgCl (silver, silver chloride), with solid conductive gel (hydrogel) and conductive adhesive were used.

Mandibular movements: For this examination, a Computerized Mandibular Scanner (CMS) of the K7 device (Myotronics-Noromed Inc.®) was used in order to assess mandibular movements and speed. Magnetic sensors were used for the evaluation, which were placed on the individual's head and a magnet was affixed with wax to the lower incisors, without bite interference. The magnetic sensor for this purpose must be parallel to the ground. Opening, closing, lateral and protruding movements were recorded. The recording speed included the measurement of the maximum and average values of both the opening and closing movements. The individuals were asked to open and close their mouths as quickly as possible, joining the incisors together. K7 Evaluation Software Version 8.0 collected the results. Records were accepted when an individual was able to successfully repeat the kinesiographic pattern. In the exam, there is a vertical and anteroposterior gain of 10 mm per division and a lateral gain of 5 mm per division.

TMJ noises – sonography: For this exam, the chosen room should have as little sound as possible so that there is no interference in the acquisition. A sensor was placed over each joint and two acquisitions were made, one being a slow sonography and the other a quick sonography, where the individual should open and close his mouth at the speed predetermined by the software.

In the exam, there is a gain speed of 100 mm/s per division and a sound gain of 100 µV per division. After the examiner's calibration, the sounds were interpreted based on the quality of sound amplitude; high frequency and low amplitude sounds suggest crackling; low frequency and high amplitude sounds suggest clicks.

Data analysis

Data were organized and subjected to statistical analysis using SPSS (IBM Statistic 20.0). Descriptive analyses were performed (frequency of variables and measures of central tendency and dispersion). The association between measurements obtained through EMG and each independent variable was assessed using the Mann-Whitney test. The level of significance adopted was 5%. As the outcome is represented by a measure at rest and MVC, a subtraction was performed between these measures, in order to obtain comparison data between the groups. Bivariate analysis was also performed between the variables presence of TMD, muscle fatigue and unilateral chewing using the chi-square test.

Results

The Observational Group (OG) had 20 individuals (mean age 40.6 years) and the Control Group (CG) had 17 individuals (mean age 30.2 years). Of the final sample, 29.7% were male and 70.3% female. The average pain time in the observational group was 60.75 months and the average pain, based on the visual analogue scale, was 6.6 (moderate).

Regarding the range of motion, statistically significant differences were seen in maximum opening and deviation/deflection in the presence of TMD. Protrusion and the right and left sides had lower averages when comparing one group to the other, despite not having statistical significance, as seen in Table 1.

In Table 2, at rest, higher values of muscle electrical activity were observed in the individuals of the OG than in the individuals of the CG, but without statistical significance. In Table 3, at MVC, the CG presented higher values of EMG in all muscle groups with statistical significance in the right (p=0.002) and left (p=0.005) masseter and right anterior temporal (p=0.048). When comparing the control and observational groups, in the difference between the measures of rest and MVC. In Table 4, a greater difference was observed in the individuals of CG, however, only this difference was statistically significant in the right masseter and left masseter.

Table 5 shows the distribution of the presence of muscle fatigue, masticatory tendency, deviation/deflection and joint noises related to the presence of TMD. With regard to muscle fatigue, of the 37 participants, 23 presented fatigue (5 in the CG and 18 in the OG) and 14 did not (12 in the CG and 2 in the OG). Regarding the masticatory tendency, of the 17 individuals in the CG, all had a tendency to bilateral chewing and of the 20 individuals in the OG, 7 had a bilateral tendency and 13 unilateral. Results on the presence of deviation/deflection on the control and observational groups in Table 5 show that no individual in the CG presented deviation/deflection whereas 19 in the OG presented deviation/deflection and only one did not. Upon sonography examination, the results of the collected sounds show that at right TMJ, 13 individuals in the CG showed no signs of noise and 4 with some noise and of the individuals in the OG, 10 presented without noise and 10 with noise. At left TMJ, 7 individuals from the CG showed no signs of noise and 10 with some noise and from the individuals from the OG, 7 presented without noise and 13 with noise.

Statistically significant values are observed in relation to fatigue (p=0.000), masticatory tendency (p=0.000) and presence of deviation/deflection (p=0.000). Although the individuals in the OG had a higher prevalence of joint noises, the individuals in the CG also presented some noise; therefore, there was no statistical significance between the groups.

Table 1: Distribution of the maximum opening in mm, deviation/deflection in mm and protrusion in mm in relation to the presence of TMD, n=37.

Maximum Opening in mm						
	Mean	Median	SD	Min	Max	p*
CG	47.57	49.1	7.18	32.8	58.2	0.007
OG	39.21	38.85	9.83	16.3	56.3	
Deviation/Deflection in mm						
CG	0	0	0	0	0	0
OG	3.99	2.95	4.23	0	19.8	
Protrusion in mm						
CG	12.17	6.8	23.5	2.7	103	0.557
OG	7.22	7.35	2.7	3	11.5	
Left laterality in mm						
CG	17.3	7.7	37.67	3.4	163	0.104
OG	9.72	9.05	2.46	5.7	15.9	
Right laterality in mm						
CG	9.19	9	3.06	4.9	18	0.537
OG	9.53	9.55	3.12	4.4	18	

Table 2: Distribution of rest measures in masseter and temporal muscles in relation to the presence of TMD, n=37.

Right temporal at rest in µV						
	Mean	Median	SD	Min	Max	p*
CG	4.9	4.4	3.83	0.3	14.5	0.497
OG	5	3.25	6.3	0.2	25.1	
Left temporal at rest in µV						
CG	4.87	4.3	3.65	0.7	14	0.297
OG	3.94	3	3.7	0.2	15.5	
Right masseter at rest in µV						
CG	2.6	2.5	1.76	0.2	6.1	0.357
OG	4.14	1.4	9.5	0.2	43.7	
Left masseter at rest in µV						
CG	2.1	2.2	1.36	0.2	4.5	0.424
OG	2.43	1.5	3.29	0.2	14.3	

Table 3: Distribution of MVC measurements in the masseter and temporal muscles in relation to the presence of TMD, n=37.

Right temporal at MVC in µV						
	Mean	Median	SD	Min	Max	p*
CG	156.07	60.1	416.82	8.6	1769	0.048
OG	33.73	23	26.82	4.3	88.4	
Left temporal at MVC in µV						
CG	60.05	69.6	38.35	9.1	119.7	0.065
OG	35.94	30.5	24.29	5.3	95	
Right masseter at MVC in µV						
CG	64.43	73.6	46.12	5.4	180.2	0.002
OG	23.08	24.1	16.28	0.7	51.5	
Left masseter at MVC in µV						
CG	56.5	60.8	35.02	6.5	110.3	0.005
OG	28.85	27.25	35.58	1.8	169.5	

Table 4: Differences between Rest and MVC measurements in the masseter and temporal muscles in relation to the presence of TMD, n=37.

Right temporal in µV						
	Mean	Median	SD	Min	Max	p*
CG	47.96	54.2	33.09	0	110.4	0.133
OG	28.67	18.65	25.5	-2.3	78.4	
Left temporal in µV						
CG	55.18	64.7	37.51	3.3	118.2	0.056
OG	32	25.95	22.69	1	90.06	
Right masseter in µV						
CG	61.83	71.7	45.17	4.2	174.1	0.001
OG	18.94	17.6	14.89	0.1	48.1	
Left masseter in µV						
CG	54.4	60	34.36	6.3	107.3	0.007
OG	26.42	23.8	32.99	-1.5	155.2	

Discussion

According to the results of this study, individuals with TMD had a lower range of jaw movements, although the result was only statistically significant at MVC. These findings are compatible with most studies in the literature [2,13-15]. Still related to mandibular movements, the presence of deviation/deflection had a high statistical significance in this research. For many authors, this change is also highly prevalent in individuals with TMD when compared to a group without TMD [2,14,15]. In this study, no individual in the control group had a deviation/deflection, whereas almost all individuals in the group with TMD presented some difficulty in performing the mandibular movements and presented some deviation/deflection.

At rest, higher values of muscle electrical activity were observed in individuals with TMD than in those without TMD, but without statistical significance. Other studies, also found higher values of muscle electrical activity at rest in the group of individuals with TMD in their sample, when compared to a control group [16-18]. On the other hand, another study found results that suggest that the electromyographic activity of the masticatory muscles does not differ between the groups studied during the situation of mandibular rest, however, the number of individuals selected to compose the sample

Table 5: Distribution of the presence of muscle fatigue, masticatory tendency, deviation/deflection and joint noises related to the presence of TMD, n=37.

		CG	OG	p*
Fatigue	No	12	2	0
	Yes	5	18	
Masticatory Tendency	Unilateral	0	13	0
	Bilateral	17	7	
Deviation/Deflection (mm)	No	17	1	0
	Yes	0	19	
Left TMJ noises	No	7	7	
	Yes	10	13	0.699
Right TMJ noises	No	13	10	
	Yes	4	10	0.098

of this study was only 8, divided in groups with and without TMD [18].

Individuals with TMD, in the present study, had lower muscle electrical activity as a function when compared to the control group. Other studies have also reached similar results, in which, when submitted to some type of effort, individuals with TMD had less muscle performance [16-19]. For other authors, individuals with TMD exhibited hyperactivity of the chewing muscles in function, however the sample was composed only by adolescents, which may justify the disagreement between the results, since the electromyography is an exam influenced by some variables, such as age [20-22]. In another study, the results were the reverse of that found in this. At rest, individuals with TMD obtained less muscle electrical activity and in function, greater electrical activity. On the other hand, apparently no data were collected on edentulous areas or dental sensitivity for other reasons in the sample analyzed by these researchers [23].

In this study, as already seen above, individuals with TMD showed greater muscle electrical activity at rest, but in function, the muscles had less electrical activity when compared to a control group. To discuss this topic, an author proposed that these results suggest that the modulation of muscle activity was not the direct consequence of a peripheral nociceptive mechanism and seems to indicate that a central mechanism was at work [24]. The contrast between increased EMG activity at rest and reduced amplitude of the masseteric reflex may reflect motoneurons modulations that differed in tonic *vs.* phasic conditions in individuals with chronic pain [24]. In the same line of thought, a study, where the authors induced pain in the masseter muscles to analyze EMG behavior, they were able to observe that experimentally induced pain reduced the activation of the masseter muscle on the side of the work, reducing the physiological recruitment of masseters between the two sides during chewing. This also suggests that there is a central mechanism component acting in orofacial pain and not just peripheral pain [19]. Such data may indicate that individuals with temporomandibular disorders have an altered neuromuscular system, when assessed through surface electromyography [16].

Studies that evaluated the masticatory tendency, were able to observe that the individuals with TMD present greater impairment of the masticatory function, as well as the preference side of mastication [7,13,25]. The authors point out that the masticatory tendency is a physiological defense mechanism to avoid more aches.

In this study, there was great statistical significance regarding the presence of fatigue in the individuals in the sample. Individuals with TMD showed more fatigue than individuals in the control group, corroborating with other authors [23,26,27]. The use of surface electromyography to assess muscle fatigue is an excellent diagnostic tool to identify individuals with temporomandibular disorder [27].

In addition to data on pain, fatigue and jaw movements, joint sounds were also observed in this study. In general, individuals with TMD are more likely to have joint noise. Other studies also say that joint noises are common signs and symptoms among subjects with TMD [28-31]. However, in this study, the presence of joint noises was observed in individuals who were not classified with TMD, in view of that, there is the question on the accuracy of the DC/TMD clinical examination in identifying the presence of joint noise. In a systematic literature review, the authors could conclude that the DC/TMD criteria for assessing joint sounds are at risk of false-positive or negative results and, therefore, do not have great diagnostic value, which can justify the results present in this research. This is due to the fact that the presence of joint noise suggests dysfunctions involving the condyle/disc complex [2], which, for an accurate diagnosis, imaging exams are necessary [4].

Conclusion

- Muscle electrical activity was greater at rest and less in function (considering maximum voluntary contraction), comparing the observational group to the control group.
- Individuals with TMD showed less range of movements, with statistical significance at maximum opening, greater presence of deviation/deflection and muscle fatigue.
- Regarding joint noise, in subjects with TMD, a higher prevalence was observed, but individuals in the control group also had the presence of noises not detected by the DC/TMD.
- Further research is suggested to standardize the EMG values and verify the accuracy of the DC/TMD clinical examination to assess joint noise.

References

1. List T, Jensen RH. Temporomandibular disorders: Old ideas and new concepts. Cephalalgia. 2017;37(7):692-704.
2. Okeson JP. Tratamento das Desordens Temporomandibulares e Oclusão. 6th Ed. Rio de Janeiro: Elsevier; 2008.
3. Dworkin SF, Leresche L. Research diagnostic criteria for temporomandibular disorders: Review, criteria, examinations and specifications, critique. J Craniomandib Disord. 1992;6(4):301-55.
4. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache. 2014;28(1):6-27.
5. Machado NAG, Strini PJSA, Branco CA, Borges RN, Mazzetto MO, FernandesNeto AJ, et al. Eletromiografia aplicadaàs desordens temporomandibulares. Revista Odontológica do Brasil Central. 2010;19(51):280-4.
6. Politti F, Casellato C, Kalytczak MM, Garcia MBS, Biasotto-Gonzalez DA. Characteristics of EMG frequency bands in temporomandibullar disorders patients. J Electromyogr Kinesiol. 2016;31:119-25.
7. Santana-Mora U, Cudeiro J, Mora-Bermúdez MJ, Rilo-Pousa B, Ferreira-Pinho JC, Otero-Cepeda JL, et al. Changes in EMG activity during clenching in chronic pain patients with unilateral temporomandibular disorders. J Electromyogr Kinesiol. 2009;19(6):e543-9.
8. Hugger S, Schindler HJ, Kordass B, Hugger A. Clinical relevance of surface EMG of the masticatory muscles. (Part 1): Resting activity, maximal and submaximal voluntary contraction, symmetry of EMG activity. Int J Comput Dent. 2012;15(4):297-314.
9. Sforza C, Rosati R, De Menezes M, Musto F, Toma, M. EMG analysis of trapezius and masticatory muscles: Experimental protocol and data reproducibility. J Oral Rehabil. 2011;38(9):648-54.
10. Lodetti G, Mapelli A, Musto F, Rosati R, Sforza C. EMG spectral characteristics of masticatory muscles and upper trapezius during maximum voluntary teeth clenching. J Electromyogr Kinesiol. 2012;22(1):103-9.
11. Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM). 2018.
12. Pedroni CR, Borini CB, Bérzin F. Electromyographic examination in temporomandibular disorders - Evaluation Protocol. Braz J Oral Sci. 2004;3(10):526-9.
13. De Felício CM, Mapelli A, Sidequersky FV, Tartaglia GM, Sforza C. Mandibular kinematics and masticatory muscles EMG in patients with short lasting TMD of mild-moderate severity. J Electromyogr Kinesiol. 2013;23(3):627-33.
14. Watanabe SK. Diagnóstico da Disfunção Temporomandibular. RCS. 2013;4(1):2-6.
15. Gawriołek K, Azer SS, Gawriołek M, Piotrowski PR. Mandibular function after Myorelaxation Therapy in temporomandibular disorders. Adv Med Sci. 2015;60(1):6-12.
16. Amarante EL, Lima JAS, Bandeira RN, Moura APA, Pessoa LSF, Pernambuco LA, et al. Eletromiografia de superfície do músculo masseter emuniversitários com alto grau de ansiedade e disfunção temporomandibular. Rev CEFAC. 2018;20(1):44-52.
17. Berni KC, Dibai-Filho AV, Pires PF, Rodrigues-Bigaton D. Accuracy of the surface electromyography RMS processing for the diagnosis of myogenous temporomandibular disorder. J Electromyogr Kinesiol. 2015;25(4):596-602.
18. Berni KCS, Silva MT, Sestare THI, Schwarzenbeck A, Bigaton DR. Avaliação eletromiográfica dos músculos mastigatórios de mulheres com e semdisfunção temporomandibular. In: 6º Mostra Acadêmica da UNIMEP - 6º Congresso de Pós-graduação. Piracicaba: Anais da 6º Mostra Acadêmica da UNIMEP; 2008.
19. Pasinato F, Santos-Couto-Paz CC, Zeredo JL, Macedo SB, Corrêa ECR. Experimentally induced masseter-pain changes masseter but not sternocleidomastoid muscle-related activity during mastication. J Electromyogr Kinesiol. 2016;31:88-95.
20. Lauriti L, Silva PF, Politti F, Biasotto-Gonzalez DA, Fernandes KP, Mesquita-Ferrari RA, et al. Pattern of electromyographic activity in mastication muscles of adolescents with temporomandibular disorder. J Phys Ther Sci. 2013;25(10):1303-7.
21. Lauriti L, Motta LJ, de Godoy CHL, Biasotto-Gonzalez DA, Politti F, Mesquita-Ferrari RA, et al. Influence of temporomandibular disorder on temporal and masseter muscles and occlusal contacts in adolescents: An electromyographic study. BMC Musculoskelet Disord. 2014;15:123.
22. Oliveira LF, Palinkas M, Vasconcelos PB, Regalo IH, Cecilio FA, Oliveira EF, et al. Influence of age on the electromyographic fatigue threshold of the masseter and temporal muscles of healthy individuals. Arch Oral Biol. 2017;84:1-5.
23. Owashi Vallejo KP, Sapin-de Brosses E, Bonnet AS. Electromyography of the masticatory muscles during biting. Comput Methods Biomech Biomed Engin. 2017;20(sup1):155-6.
24. Bodéré C, Téa SH, Giroux-Metges MA, Woda A. Activity of masticatory

muscles in subjects with different orofacial pain conditions. Pain. 2005;116(1-2):33-41.

25. Ferreira CL, Machado BC, Borges CG, Rodrigues Da Silva MA, Sforza C, et al. Impaired orofacial motor functions on chronic temporomandibular disorders. J Electromyogr Kinesiol. 2014;24(4):565-71.

26. Pitta NC, Nitsch GS, Machado MB, Oliveira AS. Activation time analysis and electromyographic fatigue in patients with temporomandibular disorders during clenching. J Electromyogr Kinesiol. 2015;25(4):653-7.

27. Woźniak K, Lipski M, Lichota D, Szyszka-Sommerfeld L. Muscle fatigue in the temporal and masseter muscles in patients with temporomandibular dysfunction. Biomed Res Int. 2015;2015:269734.

28. Gonçalves DA, Dal Fabbro AL, Campos JA, Bigal ME, Speciali JG. Symptoms of temporomandibular disorders in the population: An epidemiological study. J Orofac Pain. 2010;24(3):270-8.

29. Ferreira CLP, Silva MAMR, de Felício CM. Sinais e sintomas de desordem temporomandibular emmulheres e homens. CODAS. 2016;28(1):17-21.

30. Hilgenberg PB, Saldanha AD, Cunha CO, Rubo JH, Conti PC. Temporomandibular disorders, otologic symptoms and depression levels in tinnitus patients. J Oral Rehabil. 2012;39(4):239-44.

31. Naeije M, Kalaykova S, Visscher CM, Lobbezoo F. Evaluation of the research diagnostic criteria for temporomandibular disorders for the recognition of an anterior disc displacement with reduction. J Orofac Pain. 2009;23(4):303-11.