The Influence of the Temporomandibular Disorder on Speech Function

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ABSTRACT

This study identifies how TMD patients may present lateral deviations in speech, that is, these changes are expected in patients with joint involvement, as well as in the knowledge of which are the main characteristics that occur in the movement of the jaw during the speech, which are the lateral deviations. This process is important, since it directs a closer look at the professionals working in the TMD area, in the sense that they consider this function during the evaluation of the patient and, if they find any alteration, it may add information for the diagnosis of joint conditions and with the understanding of the painful phenomenon. Moreover, the study is a try to discover the relationship between linguistics and dentistry field .

CHAPTER ONE

INTRODUCTION

The Influence of the Temporomandibular Disorder on Speech Function

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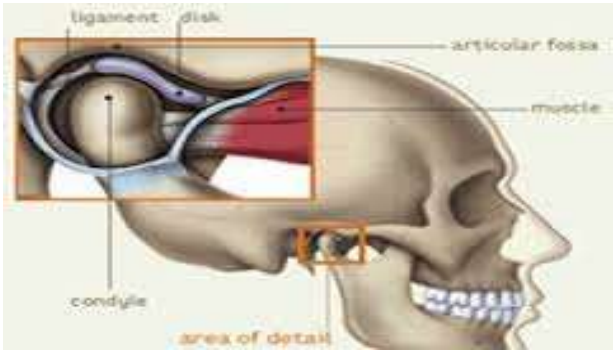
The term " TMJ " stands for **t**emporo**m**andibular **j**oint. When a TMJ is painful or not functioning properly, the condition is known as TMD, or **t**emporo**m**andibular joint **d**ysfunction (or **d**isorder). In this post I will introduce concepts of TMJ anatomy, function, disorders, and diagnostic tools. The TMJs are positioned right in front of you ear canals. You can find them by placing your fingertips in front of your ears and opening wide.



The top of your lower jaw is part of what forms the TMJ. The following picture shows the major parts of the joint. The upper bone portion is part of the temporal bone, and the lower portion, the condyle, is part of the lower jaw. Between the two bones is a disc which functions as a cushion that slides between the bones as you lower and raise your jaw. The condyle and disc are controlled by muscles from the front. The disc is also controlled by a ligament in the back. There is a capsule surrounding the entire joint which holds the lubricating joint fluid. In addition, there are nerves and blood vessels serving the joint.

The lateral deviations are the main alteration of the mandibular movement during the speech performance in painful TMD. Such deviations are more expected in joint TMD (disc displacement and degenerative diseases). The perception of pain and joint noise are the main complaints related to the orofacial speech function in individuals with painful TMD.

The present work tries to answer the questions,What are the possible characteristics of mandibular movements and What are the main symptoms reported ?

It aims analyzing the mandibular movements of patients with painful TMD during the speech function in order to understand possible alterations and which subgroups of patients may present them.In addition , identifying which signs and symptoms related to painful TMD are perceived in the performance of this function.

The present study is based on the hypotheses, The TMD-D/A group presented a higher percentage of use of lateral movement during speech than the other groups. Pain, joint noise, and difficulty in speaking were the most commonly reported signs/symptoms of speech performance. Besides, the perception of joint noises and the presence of lateral deviations were significantly higher in the TMD-D/A group ($p<0.05$).

The Procedures

The procedures to be adopted in this study are as follows:

1.Thirty-two subjects aged between 18-60 years old (35.1 ± 8.9), 23 with TMD (*DC/TMD*; eight men and 15 women) and nine controls were evaluated regarding: self-perception of TMD signs and symptoms during speech (ProTMDMulti); range of mandibular movements during the reading of a word list (electrognatography, Jaw Motion Analyzes).

2.The percentage of movement usage during the speech performance as a function of maximum individual amplitude was calculated, and groups of patients with painful TMD (TMD-D) and painful/joint (TMD-D/A) were subdivided.

CHAPTER TWO

Theoretical Background of TMD

Temporomandibular disorders (TMD) are characterized by localized pain in the face and pre-auricular region, and/or by limitations or interferences in the mandibular movements, in addition to joint noises. The search for treatment becomes more urgent when there is the presence of pain and psychosocial impact. Painful TMDs are of musculoskeletal origin and present high prevalence, being considered as the major cause of non-odontogenic pain in the orofacial region[1,2].

The most recent publication recognized by the international scientific community on the diagnostic classification of TMDs was redone in 2014, which presents the protocol called *Diagnostic Criteria for Temporomandibular Disorders* (DC/TMD), which aimed at increasing the sensitivity and specificity of the instrument that preceded it (*Research Diagnostic Criteria for Temporomandibular Disorders*, RDC/TMD), as well as make it practical for use by both researchers and clinicians[3,4].

Among the updates contained in the DC/TMD, there was a high consideration of the painful complaint and the reports of pain triggered by the chewing, yawning, kissing and speaking functions, collected in the anamnesis, which are taken as parameters in the investigation of musculoskeletal pain when looking for their reproduction during clinical examination, specifically during palpation and measurement of the mandibular excursion movements (investigation of the family pain)[3].

Speech is considered a complex function that permeates a large part of social interactions[5]. Although not always mentioned in the complaints of patients with TMD, when questioning, the speech function can also be identified as a factor of modification of the pain perception and functional difficulty, since it involves mandibular movements and structures directly related to

pain and function. Due to this relationship, there is also its investigation in the DC/TMD protocol, as previously described[3]. In addition, the impacts on speech, according to the analysis of the narratives of patients with TMD, were related to pain, avoidance of speech, professional losses and the need for phonoarticulatory adaptations during the oral communication, leading to social, emotional and labor implications[6]. This interaction of the emotional and cognitive aspects with the motor behavior and the painful perception end up influencing the functional capacity and quality of life of patients with painful TMD[7,8], being relevant its investigation to the understanding of the diagnostic and delineation of specific conducts[4,9].

Phonoarticulation is a linguistic ability that depends on the structural integrity and integrated neuromotor coordination of the stomatognathic and respiratory systems for the production and formation of sounds and chaining in speech and, thus, to be able to manifest the language through oral communication. The act of speaking depends on vocal production and precision in performing the articular sequences, which involve the participation of the laryngeal structures, orofacial muscles, the tongue, the mandible, temporomandibular joints (TMJ), the teeth and the central nervous and peripheral system[10,11].

In individuals with painful TMD, these motor adjustments may be altered in order to avoid muscle action that causes pain or other symptoms such as noises and mandibular locking (fear of movement or kinesiophobia)[12,13], thus limiting the articulatory movements in speech. The oral mouth movements in speech may also be limited by physical factors, such as the displacement of the articular disc, preventing the necessary movement of the jaw head and spasticity of the jaw lift muscles. Regardless of the reason, the lower the degree of mandibular opening to phonoarticulation, the greater the resistance to air passage and the consequent also greater induced effort[5,14].

Studies investigating the speech in TMD subjects, some found alterations related to the amplitude of the mandibular movements, speed of the opening and closing of the mandible, voice and excessive participation of the perioral muscles, pointing to possible impairments in the speech intelligibility and discomfort during the verbal communicative act[15-17]. However, these differences between symptomatic and asymptomatic groups have not always been observed[18]. Complaints about difficulties in speech in patients with TMD may be related to muscle fatigue and pain, limitations, deviations and blockages of the mandibular movements, the effort to be understood, the presence of hoarseness, avoidance of oral communication and, to interocclusal devices introduced into the oral cavity, commonly used in the treatment of painful TMD[15,19]. Similar characteristics were also found in patients with vocal alterations, presenting an association with the severity of the TMD[14].

Faced with this, the question arises: Who are TMD patients with complaints and changes in the mandibular movements during speech? An analysis that considers subgroups of diagnoses according to DC/TMD could contribute to the elucidation of this question, directing the clinical view during the examination to the design of the functional needs related to the speech of these patients. In view of the above, the purpose of this study was to analyze the mandibular movements of patients with painful TMD during the speech function, in order to understand possible alterations and which subgroups of patients may present them, in addition to identifying which signs and symptoms related to painful TMD are perceived in the performance of this function.

CHPTER THREE

METHODS

Design of the study

Cross-sectional descriptive observational study.

Sample

The sample consisted of 32 subjects, aged between 18 and 60 years old (35.1 ± 8.9), and all of them signed the free and informed consent term before the study. The project was approved by the research ethics committee of the School of Dentistry of Ribeirão Preto of the University of São Paulo (FORP/USP) and registered in the Brazil Platform of the Health Department (CAAE: 53561316.0.0000.5419). Of these, 23 had TMD (8 men and 15 women - TMDG) and 9 belonged to the control group (CG), composed of healthy people without TMD who agreed to participate in the study, matched by gender and age to TMDG subjects. The study variables were the mandibular movements evaluated by electrognatography and self-perception of the TMD signs and symptoms during speech, assessed through the use of a specific protocol[20]. (ProTMDMulti)

Inclusion criteria

Subjects aged between 18 and 60 years old, diagnosed with painful TMD according to the *Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)*[3]. Also according to this protocol, the CG subjects, matched for age and gender with the TMDG, should not present TMD. Both groups should present Angle class I or II occlusion, with stable functional dental occlusion.

Exclusion criteria

Subjects with dental absences, use of removable prostheses, use of fixed prostheses with more than 2 elements, presence of occlusal discrepancies (cross bite, open bite, accentuated horizontal and vertical trespasses), Intra-joint TMD type aplasia, hypo or hyperplasia, dysplasias, neoplasias, ankylosis; patients undergoing orthodontic, speech-language or dental treatment or who have received any treatment for TMD in the last 6 months.

Clinical evaluations

After the diagnosis was made, subjects with TMD were grouped according to the conditions "painful TMD" and "painful TMD associated with a joint component", according to the classification established by this instrument, with a view to identify possible differences or changes in the mandibular movements during speaking according to such conditions. The self-perception of the TMD signs and symptoms during speech was assessed by the item of the ProTMDMulti questionnaire specific to this functional aspect[20]. The subjects assigned scores ranging from zero (absence) to 10 (worst possible severity) to each sign/symptom according to the severity perceived during speech.

The mandibular movements were evaluated by means of electrognatography, which recorded the mouth opening and maximum right and left lateralities, considered as a 100% movement amplitude. The measurements of maximum amplitude of the mandibular movements were taken as a reference to calculate the percentage of amplitude of the mandibular movements recorded during the speech function, according to the maximum measures of their movements. The movements during speech were tested by speech samples from the repetition of a phonetically balanced word list during electrognathography recording[21].

The recording and analysis of the jaw movements were performed using system-specific software, WinJaw (version 10.6 for Windows).Data on the mandibular movements, both during speech performance and maximum amplitude, presented parametric distribution, therefore the mean and standard deviation values are presented; the groups with TMD (painful and painful/joint) and control were compared by means of Analysis of Variance (One-Way). On the other hand, the ProTMDMulti signs and symptoms scores were non-parametric and the median and interquartile values were presented; the groups with painful versus painful/joint TMD were compared for each sub item of the instrument using the Kruskal-Wallis test. The level of significance adopted for all the analyzes was 5%.

RESULTS

In general, the mean maximum amplitude of the mandibular movements did not differ between patients with TMD and the controls. The maximum mouth opening was the parameter with the greatest differences: the mean for controls was 47.4 (± 4), while for patients with painful

TMD it was 40.2 (± 11) and the painful and joint TMD was 42 (± 7.6). However, in the laterality movements, the groups had very similar amplitude values (Table 1).

Table 1 Mean and standard deviation of the absolute values of the opening movements, right and left laterality (in millimeters) for the groups: control, painful TMD, painful/joint TMD. Mean of the percentage of use of the maximum amplitude of the mandibular movement during speech.

Mandibular movements	***Control***	***Painful TMD***	***TMD painful/joint***
Maximum			
Maximum opening	47.4 (4)	40.2 (11)	42 (7.6)
Laterality D	10 (1)	10 (3.4)	9.2 (3.4)
Laterality E	11 (2)	9.6 (1.7)	11.2 (4)
In Speech			
Maximum opening	10 (2.6)	9.6	9.24
Laterality D	1.3 (0.5)	1.2	2.3
Laterality E	1 (0.3)	1	2.5
In Speech (% of total movement)			
Maximum opening	21.4%	24%	22.5%
Laterality D	12.5%	12.4%	25.9%
Laterality E	10%	11.2%	23%

Source: elaborated by the author; TMD = Temporomandibular Dysfunction; D = Right; E = Left.

During the speech performance, patients with TMD with articular components presented greater lateral deviations than the other groups. These results can be verified in Table 1 , which shows the percentage of speech use in relation to the maximum movement amplitude. That is, the group with painful/joint TMD performed more lateral movements of the jaw and used a greater percentage in relation to the maximum lateral movements during the repetition of the list of words. The painful DTM group did not present this speech pattern and demonstrated mandibular movements during this function, similar to the control group, despite the presence of pain.

On average, during speech, the groups used between 21% and 24% of the maximum opening amplitude and around 12.5% of the maximum range of laterality, except for the group of TMD patients with joint components, who used between 23% and 26% in laterality (Table 1).

The main signs and symptoms related to TMD that are perceived during speech are: muscle and joint pain, joint noise and speech difficulty, regardless of the TMD diagnostic subtype. Among all the items evaluated by ProTMDMulti, only the joint noise was statistically different between the painful and painful/joint TMD groups, since the group with articular components reported much more noise during speech than the other group. Regarding the total score of ProTMDMulti – speech item, no difference was observed between the groups with a diagnosis of TMD (Table 2).

Table 2 Median and interquartile deviation of the *Protocol for Multiprofessional Centers for the Determination of Signs and Symptoms of Temporomandibular Disorders* (ProTMDMulti) at the moment of "speaking" for each sign and perceived symptom, Kruskal-Wallis ($p<0.05$).

ProTMDMulti	***Painful TMD***	***Painful/joint TMD***	***p***
Muscle pain	5 (3.5)	4 (4)	0.86
Painful TMD	5 (5)	4 (4.5)	0.19
Neck ache	0 (6)	1 (5.5)	0.82
Earache	0 (0.75)	0 (1.5)	0.87
Buzz	0 (0)	0 (0.5)	0.81
Ear fullness	0 (3.5)	0 (3)	0.65
Sensitive teeth	3.5 (6)	0 (0)	0.2
Articular noise	2.5 (6)	7 (4)	0.02*
Difficulty swallowing	0 (0.5)	0 (2)	0.74
Speech difficulty	4.5 (3.5)	3 (2.5)	0.69
Total score	28 (20.5)	20 (17.5)	0.87

Source: elaborated by the author; *Statistical significance ($p<0.05$); TMD = temporomandibular dysfunction.

Compared with the control group, the mandibular movements during speech were broader in relation to lateral movements, that is, patients with painful TMD had a higher percentage of laterality use than the controls, as can be seen in Figure 1 A.

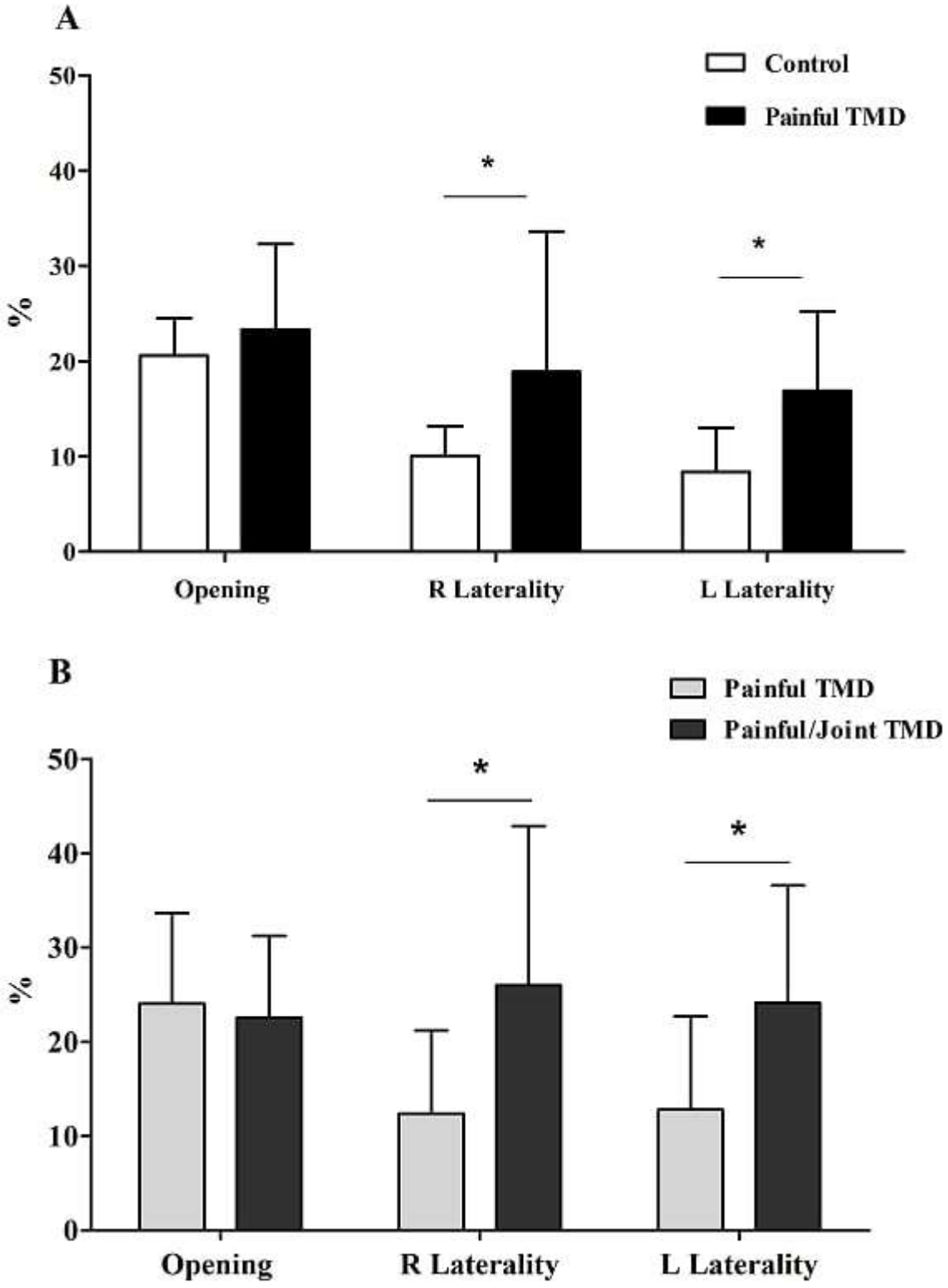


Figure 1 A – Comparison between Control Group versus Painful TMD Group; B – Comparison between Painful TMD Group versus Painful/Articular TMD Group of the percentage mean of movement as a function of the maximum amplitude in speech performance from the

electrognatography examination (Jaw Motion Analyses; Zebris Medizintechnik®), *Statistical significance (ANOVA One-Way, $p<0.05$).

And in the comparison between the TMD subgroups, patients with associated joint condition diagnoses presented more lateral deviations than those with painful TMD without articular components (Figure 1 B), reinforcing the results from Table 1 .

DISCUSSION

The results of this study demonstrated that, during the speech performance, individuals with painful TMD perceive signs and symptoms, especially muscle/joint pain and TMJ noises, although the scores attributed by them are low. In this sense, it is relevant to consider that the speech function does not demand large mandibular movements and muscular effort such as chewing, for example, which may justify the low scores of self-perceived severity of signs and symptoms during speech. In a previous study with a similar sample, reduced scores of ProTMDMulti were found on the symptom "speech difficulty", considering all the protocol situations (on waking, chewing, talking and at rest), which also proves not to be the most affected by TMD [22]. Discomfort in speech may be more evident after long periods of high-intensity performance, which is more often with people who use the speech professionally, such as teachers [23].

Among the main speech-related complaints, patients with TMD usually report fatigue after long periods, limited mandibular movements, joint noises, mandibular locking, hoarseness, difficulty in being understood, speech difficulty, avoidance of speech situations and adaptations to speak[6,15,17]. Considering this context, the speech function can be altered in different parameters, and the mandibular movement promotes modifications in the buccal space and thus allows the interaction between the different structures used as tongue, palate, lips, cheeks, teeth according to the different orofacial postures necessary for the production of each sound[15,16,24]. However, the performance of this orofacial function does not seem to be necessarily impaired as to the amplitude of the mandibular movements, that is, there was no significant limitation of the amplitude of the mandibular movements in comparison to the control group in this study, as well as in a previous study[18]. What was observed were more lateral deviations in patients with painful TMD with an associated joint component.

There was a slight reduction in the vertical amplitude of the mandibular movement during speech in subjects with TMD when compared to controls; however, previous studies found a more significant reduction of the vertical amplitude in individuals with TMD[15,17]. This difference can be justified by the method of analysis of the amplitude of the movements, the electrognatography equipment used and the specific characteristics of the samples; although it is relevant to consider that the results are not in disagreement.

Patients with joint TMD showed more lateral deviations in speech, probably related to intra-articular morphological changes (disc displacements, degenerative processes, differences in the synovial fluid quantity and composition, erosions, flatness, among others) and associated muscle compensations. These deviations do not seem to be directly related to the pain, since the group with painful TMD without joint involvement presented parameters of mandibular mobility similar to those of the control. The intensity of pain perceived during the speech function did not limit the mandibular movements to perform it, perhaps because it presents low severity scores in the sample studied. Despite the presence of pain during this function, limitation of the

mandibular movements is not always present and seems to be more associated with fear of symptoms[12,13], generating protective strategies to contain orofacial mobility to avoid them. This behavior is associated with the effort of the laryngopharyngeal structures in the attempt to increase the projection of the voice in the space and the speech intelligibility, but it can result in phono articulation and vocal alterations. That is, despite the presence of pain, this function can be performed with or without alteration of the amplitude of the mandibular movements [15,18] and it appears to be associated with the degree of severity of TMD[14] and to the greater or lower use of speech in everyday life[23].

Corroborating these reflections, it is important to consider that one of the main clinical features of TMD-related pain is the exacerbation by function, typical of musculoskeletal pain. From this perspective, the DC/TMD symptom questionnaire addresses the subjective perception of signs and symptoms, the investigation of pain alteration (worsening or improvement) by orofacial functions and parafunctions, among them the speech[3]. This assertion points to a relationship aimed at altering pain through the speech function, not a change in the speech by the presence of pain. In a study that investigated TMD in subjects with complaints of vocal alterations, no correlation was found between these two conditions, probably because the TMD symptomatology found in 61.9% of the subjects was subclinical, that is, they did not complain or look for treatment[25]. And this function presents its importance in the TMD situations as it forms the role of the diagnostic criterion in altering the pain perception. Changes and complaints of speech in subjects who manifest them can be seen as a consequence of TMD and actions for their rehabilitation should be associated with pain relief and other strategies for the TMD management, as well as encouraging their implementation as part of this management through guidelines and exercises.

Joint noise was the only sign/symptom that differentiated the groups of patients with painful TMD and painful/joint TMD. The perception of crackling and noises during speech was significantly greater in joint cases, regardless of pain. However, the perception of joint noises in TMJ does not represent a problem or a dysfunction to be treated, since healthy individuals may present noises during speech performance and do not seek treatment. Thus, mandibular deviations during speech are not related to the severity of painful TMD, since there is no direct relation between noise and pain intensity[26], but perhaps with the presence of morphological alterations of TMJ, such as those that cause articular noise. Emphasizing this idea, previous studies that investigated functional alterations in patients with TMD demonstrated that orofacial functions and parafunctions that require effort and excessive load, such as chewing and dental tightening, are the most frequently reported by patients with painful TMD[27-29].

The results of this study help identify which TMD patients may present lateral deviations in speech, that is, these changes are expected in patients with joint involvement, as well as in the knowledge of which are the main characteristics that occur in the movement of the jaw during the speech, which are the lateral deviations. This orientation is important, since it directs a closer look at the professionals working in the TMD area, in the sense that they consider this function during the evaluation of the patient and, if they find any alteration, it may add information for the diagnosis of joint conditions and with the understanding of the painful phenomenon.

Although the articular involvement leads to a more patho-physiologically comprehensible perception of the articular noise, it does not exacerbate other signs and symptoms during the speech performance, as there were no differences in the scores of the other ProTMDMulti items

among the painful TMD and painful/joint groups. This is justified by the fact that the articular noise intensity does not correlate with the severity of TMD or with more complex and more difficult management[26].

CONCLUSION

In conclusion, the main change in the mandibular movement during speech in individuals with painful TMD is the lateral deviations. Such deviations are more expected in TMD cases with joint involvement (disc displacements and degenerative diseases). Although no significant changes in the mandibular mobility are found in the speech performance, individuals with painful TMD may report some degree of discomfort, mainly related to the presence of muscle and joint pain, and to the perception of joint noises. The presence of lateral deviations in speech and joint noises, which are more related to joint TMD do not accentuate the subjective perception of other signs and symptoms, especially pain. Therefore, the identification of lateral deviations in speech in individuals with painful TMD may be a first indication of an associated joint condition, which does not necessarily represent the need for intervention in both the articular aspect and the speech function, as well as it has no direct relation with the degree of perceived pain.

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