Movimentos mandibulares na fala: interferência das disfunções temporomandibulares segundo índices de dor****

Mandibular movements in speech: interference of temporomandibular disfunction according to pain indexes

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****Pesquisa Realizada na Faculdade de Medicina da Universidade de São Paulo.

Artigo de Pesquisa

Artigo Submetido a Avaliação por Pares

Conflito de Interesse: não

Recebido em 18.11.2006.
Revisado em 15.03.2007.
Aceito para Publicação em 15.03.2007.

Abstract

Background: temporomandibular disorders can cause general alterations of the mandibular movements due to modification in the condition of muscles and articulations. Electrognathography, a computerized exam used to complement the diagnosis of these disorders, allows the objective delineation and record of the mandibular movements, determining their amplitude and speed. Aim: to verify the characteristics of mandibular movements of individuals with temporomandibular dysfunction and in asymptomatic individuals during speech, through computerized electrognathography, analyzing possible interferences of this dysfunction and severity implications regarding pain indexes. Method: 135 adults were divided in four groups based on their pain indexes, using a numeric scale: zero for pain absence, one for mild pain, two for moderate pain and three for severe pain. Mandibular movements were observed during the sequential naming of balanced pictures taking in consideration the occurrence of phonemes in the Brazilian Portuguese language. Records were obtained using computerized electrognathography (BioEGN - BioPak system). Results: the analysis of the results point that differences indicated as significant for mandibular opening amplitude and mandibular closing speed occurred between index zero and all of the other pain indexes. Regarding mandibular opening speed during speech, statistically significant differences were obtained between index zero and index three. It was observed that mandibular movements in speech are discreet, with an anteroposterior component and deviations in laterality. Conclusion: the presence of temporomandibular dysfunctions causes reduction in the values of maximum mandibular opening and a reduction in both mandibular opening speed and mandibular closing speed during speech The different pain indexes: mild, moderate and severe do not seem to determine larger reduction of these values.

Key Words: Temporomandibular Joint Disorders; Arthralgia; Kinesiology Applied; Speech, Language and Hearing Sciences.

Resumo

Tema: as disfunções temporomandibulares podem acarretar alterações gerais nos movimentos mandibulares devido à modificação nas condições musculares e articulares. A eletrognatografia, exame computadorizado utilizado para complementar o diagnóstico dessas disfunções, permite delinear e registrar de maneira objetiva os movimentos mandibulares, determinando sua amplitude e velocidade. Objetivo: verificar as características do movimento mandibular na fala em indivíduos com disfunções temporomandibulares e em assintomáticos, por meio de eletrognatografia computadorizada, analisando possíveis interferências dessas disfunções e as implicações de severidade quanto ao índice de dor. Método: 135 participantes adultos foram divididos em quatro grupos com base nos graus de dor, utilizando-se escala numérica, sendo: zero para ausência de dor, um para dor leve, dois para moderada e três para dor grave. Os movimentos mandibulares foram observados na nomeação seqüencial de figuras balanceadas quanto à ocorrência dos fonemas da língua. Os registros foram obtidos com eletrognatografia computadorizada (BioEGN – sistema BioPak). Resultados: a análise dos resultados mostrou que as diferenças apontadas como significantes para amplitude de abertura e para velocidade de fechamento mandibular, ocorrem entre o grau zero e todos os outros graus de dor. Para velocidade de abertura mandibular na fala, foi obtida diferença estatisticamente significante entre grau zero e grau três. Constatou-se que os movimentos mandibulares na fala são discretos, com componente antero-posterior e desvios em lateralidade. Conclusão: a presença de disfunções temporomandibulares acarreta redução das amplitudes máximas de abertura e redução da velocidade tanto de abertura quanto de fechamento dos movimentos mandibulares durante a fala. Os diferentes graus de dor: leve, moderado e grave, parecem não determinar maior redução desses valores.

Palavras-Chave: Transtornos da Articulação Temporomandibular; Artralgia; Cinesiologia Aplicada; Fonoaudiologia.

Referenciar este material como:
BIANCHINI, E. M. G.; PAIVA, G.; ANDRADE, C. R. F. Mandibular movements in speech: interference of temporomandibular disfunction according to pain indexes (original title: Movimentos mandibulares na fala: interferência das disfunções temporomandibulares segundo índices de dor). *Pró-Fono Revista de Atualização Científica*, Barueri (SP), v. 19, n. 1, p. 7-18, jan.-abr. 2007.

Introduction

The speech articulation is a sensory-motor process which involves the active regulation of strengths among the muscular system and the vocal tract (Andreatta et al.,1996; Hillis et al., 2004) relating itself with structures conformation and amplitude of movements developed in order to allow the several articulation postures proper to each sound (Marchesan, 2000). The mandible participation, more specifically the mandibular movements, enables spaces modification allowing free tongue and soft tissues movements (Smith & Zelaznik, 2004; Bianchini & Andrade, 2006).

The speech neuromotor control, which is highly dynamic, involves the participation of cortical and sub-cortical brain regions directed to the movement preparation and execution (Van Turennout et al., 2003) and it may be altered due to peripheral structural changes, as well as by training and repetitive experiences inducing plasticity (Jurgens, 2002; Van Turennout et al., 2003).

Studies with electromagnetic articulography (EMA) showed that the speech control development is not uniform; accordingly, the synergic relation between movements of the tip and the body of the tongue with the mandible is not the same during this process (Smith & Zelaznik, 2004; Murdoch et al., 2006).

Subjective data indicate discrete highly coordinated and synchronized mandibular movements during speech, slight antero-posterior movements without deviations along its course (Felicio,1999; Rodrigues Garcia et al.,2003). Objective studies concerning mandibular movements during speech for the Brazilian Portuguese language are recent (Bianchini et al.,2003, Bianchini & Andrade, 2006). Analysis of asymptomatic individuals using electromyography revealed approximate values of 11 mm for opening amplitude during speech with protrusive components: 1,22 mm, retrusive components: 5,67 mm, and lateral deviations around 1,5 mm (Bianchini & Andrade, 2006).

It is verified that the mandibular movements amplitude is related to the integrity of the temporomandibular joint (TMJ), and to the action of skeletal muscles (Bianchini, 2001, Bianchini & Andrade, 2006). However, unfavorable conditions are frequent once the articulation needs to support and accommodate occlusion, muscular and cervical adaptations (Okeson, 1997; Goldstein, 1999). If the functional adaptations demand exceed the structural and functional tolerance of the TMJ, a temporomandibular joint dysfunction (TMJD) may be triggered (Okeson, 1997; Nassif & Talic, 2001), resulting in mandibular movements alteration and consequent stomatognathic functions disorders (Bianchini,2004). The presence of pain leads to a reduction in the amplitude of mandibular movements in speech articulation (Palácios-Moreno et al.,1997, Bianchini, 2000b, Felício & Bortolin, 2001, Bianchini et al., submitted)

The pain description, its diagnosis and associations seem to be of difficult accuracy due to its subjectivity. The pain threshold is individual, differentiated and it modifies the transmitted information a lot (Assencio-Ferreira, 2000). The facial pain intensity depends on the central nervous system modulation, on the attention, on the attitude and on the individual's character, thus resulting in a great variety according to the studied person specially concerning patients with diffuse and recurrent pain, who constitute a group of difficult diagnosis and treatment (Assencio-Ferreira 2000). The pain characteristics, specially concerning intensity, and the presence of associate psychological disorders lead to greater psychological suffering among patients with chronic headaches and myofascial pain (Vazquez-Delgado et al., 2004).

There are several scales, with different validity and reliability levels, aiming to quantify the pain intensity. At first, the most used ones seem to be those with numeric categories and those with non-numeric representations such as adjectives, colors and expressions (Assencio-Ferreira, 2000). The numeric scales are easy to apply and to understand. Despite the existence of variation in the scales proposition, studies refer the use of scales from zero to three, zero meaning absence of pain and three, severe pain (Rodrigues, 2000; Bianchini, 2000a; Manfredi et al., 2001).

In order to obtain objective data concerning mandibular movements used in speech in an attempt to enable quantitative parameters of diagnostic, the purpose of this study was to verify the characteristics of mandibular movements during speech concerning speed, amplitude and lateral deviations in individuals with temporomandibular dysfunction and in asymptomatic ones, using computerized electromyography and analyzing possible interferences of those dysfunctions and the severity implications as to the pain index.

Method

This research was previously approved by the Research Ethics Committee of the Institution (CAPPesq nº116/03) and the informed consent terms of all participants were signed, according to resolution 196/96 (BRASIL, Resolution MS/CNS/ CNEP nº 196/96, 10/10/96).

One hundred and thirty five male and female adults participated on this study. Subject's age ranged from 18 to 57 years old. All of them resided at the metropolitan area of Sao Paulo city. The selection criteria included no missing teeth in a proportion higher than one tooth per quadrant; no crossed occlusion; no dentofacial deformities; no removable dental prosthesis; no prior speech-language therapy including vocal refining; and no communication, neurological or cognitive deficits. Such criteria were necessary, since those particular situations may interfere on mandibular movements involved in speech production.

Initially, participants were distributed in two groups: GI and GII. The research group (GI) comprised 90 consecutive patients spontaneously referred to Center of Diagnosis and Treatment of Temporomandibular Disorder for a computerized diagnosis, once they presented signs and symptoms of TMJD. All of them agreed to perform the speech task and fulfilled the selection criteria. The diagnosis of TMJD was established according to criterion described at literature (Luz et al., 1997; Golstein, 1999; Luz, 2000), such as: presence of painful symptoms in masticatory muscles; pain in the pre-auricular region and in the TMJ; articulation noises; limitations of functional or directed mandibular movements; articulation blocking episodes. The inclusion criterion for this group was to present at least 3 of the described TMJD signals including pain as a determinant for the dysfunction.

The control group (GII) consisted of 45 participants who fulfilled the selection criteria, in a proportional relation to the research group concerning age and gender. The inclusion criterion for this group included absence of TMJD, that is no pain or any other previously described indicative symptoms or signals of TMJD. Participants without signs and symptoms of TMJD who met the selection criteria and who agreed to participate of this research performed the same tasks as GI, in the same period of 12 months.

The data mentioned above were obtained by a questionnaire application and by a physical examination and were registered in a Speech-Pathology protocol concerning signal and symptoms of TMJD (Annex A).

In order to raise data on the pain index, a physical examination was accomplished to verify the presence of pain during extra-oral palpation of masticatory muscles: temporal, masseter and supra-hyoid muscles. The patient was asked to verbally score the pain degree at the palpation moment. This numeric analogical scale was established as a pain gradation criterion which was previously explained to the participant with the following equivalence: 0 (zero) for absence of pain; 1 (um) for mild pain; 2 (two) for moderate pain; 3 (three) for severe pain (Rodrigues, 2000; Bianchini, 2000a, Manfredi et al. 2001). The participants who reported pain degree zero correspond to GII components, control group. Participants with pain degrees of 1, 2, and 3 correspond to the components of GI.

For analyzing the interference of the pain index on the characterization of mandibular movements during speech, the participants were subdivided in four groups as follows: G0, corresponding to the group of participants with a pain degree of zero, that is absence of pain; G1, corresponding to the group of participants with a pain degree of 1, that is mild pain; G2, corresponding to the group of participants with a pain degree of 2, that is moderate pain; and G3, corresponding to the group of participants with a pain degree of 3, that is severe pain.

Table 1 describes the patients' distribution according to the pain degree.

In order to register mandibular movements an electrognathography equipment was used (BioEGN - BioPak system, Bio-Research Associates, Inc., Milwaukee, WI, USA).This equipment allows to monitor and record the spatial position and the course of mandibular movements through a magnet signal capturing. Signals are captured by sensors of an antennae supported on the patient's head, without touching the mandibular region in order to avoid interferences or restrictions of the mandibular movements. This system is connected to a compatible computer with an electrognathography interpretation software installed, registering the magnet's position variation and analyzing the clinical data of mandibular movements.

For verifying the mandibular movements performed during speech, an easily- recognizable picture list, comprising all the Brazilian Portuguese language phonemes in several positions, was used

(Marchesan, 1998; Bianchini & Andrade, 2006), to be named sequentially with no interruptions. (Figure 1).

The test was performed with the patient sitting in a chair on a rubber isolation floor. The magnet was centralized from the inferior labial frenum and accommodated above it, at the anterior and inferior region of the lower central incisors without interfering in the occlusion. The magnet was fixed with an adhesive plate type Stomahesive of approximately 0,5 mm high and 0,7 mm width.

The antennae support was placed on the glabella region with the upper temple parallel to the interpupil line. The lateral temples were positioned above the ears, parallel to the ground and adjusted by the strap located in the back of the head. After the equipment adjustment and calibration, the participant was invited to initiate the specific speech test. The participant was instructed to make a slightly teeth contact, in order to eliminate some possible interference. The test was then started by capturing mandibular movements observed in three planes: sagittal, frontal and horizontal, generated by the magnet and captured by the BioEGN antennae.

The XY window of the software was selected in the computer screen. This window registers mandibular movements in graphs and in millimeters, in different planes. The sagittal plane registers show the opening and closing mandibular movements (vertical scale), associated to protrusive and retrusive movements (horizontal scale). Registers at the frontal plane show opening and closing mandibular movements (vertical scale) associated to lateral movements (horizontal scale). Registers at the horizontal plan show lateral movements (vertical scale) associated to antero-posterior movements (horizontal scale). All registers were printed in standardized paper, with measures and analysis in mm (Figure 2).

Data regarding the mandibular movements performance during words utterance were quantified according to: maximum mandibular opening and closing speed; maximum amplitude in the sagittal and frontal planes (in mm); maximum protrusion amplitude (in mm); maximum retrusion amplitude (in mm); maximum opening amplitude in the frontal plane (mm); maximum amplitude of lateral deviations (in mm); and type of lateral translation, if it was uni or bilateral.

The statistical analysis used two-tailed tests based on presumed normal distribution. The descriptive analysis comprises the calculation of summary-measures, as follows:

. parametric variables (quantitative): simple arithmetic average, standard-deviation, confidence interval, minimum and maximum values;
. non-parametric (qualitative): absolute frequency table and relative frequency (percentage).

The analytical part comprises the application of the following tests:

Paramétric variábles (quantitative)

For the concomitant comparison of the simple arithmetic averages of the target variables, the Variance Analysis (ANOVA) was used with further application of the Tukey's Test or the Dunnett's Test (when necessary), according to the result concerning the variances homogeneity between the considered groups, for the comparison pair to pair among the four groups of pain degrees.

Non paramétric (qualitative)

For the concomitant comparison of the simple arithmetic averages of the target variables, the Kruskal-Wallis Test was used, with further application of the Mann-Whitney Test, when necessary, for the comparison pair to pair among the four groups of pain degrees.

The significance level adopted was 5% (0,050), for all statistical tests. The computational program SPSS (Statistical Package for Social Sciences) version 10.0 was used to obtain the statistical values.

Results

Tables 2 and 3 show results regarding the maximum speed of the mandibular movement during speech according to the pain gradation. Table 2 concerns the opening speed and table 3, the closing speed.

Figure 3 was constituted based on tables 2 and 3, and it summarizes the results regarding the speed of the mandibular movement during speech based on pain degrees. It can be observed that either the opening or the closing speed values during speech are greater in the group without pain (G0) and they decrease in the groups with pain (G1, G2, G3). It is observed a similarity between G1, G2 and G3, however a discrete speed decrease is observed for either opening or closing with the increase of the pain degree. Concerning the speed during opening, a significant statistical difference is verified between G0 and G3. As to the closing speed , it is observed that the significant differences always occur between the pain degree zero and all the other pain degrees. This result indicates that there are differences between the control group and the research group, independently of the pain degree.

Tables 4, 5 and 6 describe the results regarding maximum amplitude of mandibular movements during speech, according to the pain degrees, observed in the sagittal plane: opening, protrusion and retrusion, respectively.

Figure 4 was based on tables 4, 5 and 6 and summarizes results observed in the sagittal plane: opening, protrusion and retrusion. It can be observed that the amplitude values of mandibular opening are higher in the group without pain (G0) and similar in G1, G2 and G3. It is observed that significant differences always occur between pain degree zero (GO) and all the other pain degrees (G1, G2, G3). This result indicates that there are differences between the control group and the research group, independently of the pain degree. Concerning the values of mandibular protrusion and retrusion, similar results were obtained in all groups. The statistical analysis confirms these findings.

Tables 7, 8 and 9 show results concerning maximum amplitude of mandibular movements during speech according to the pain degrees, observed in the frontal plane: opening, lateral deviation to the right and lateral deviation to the left, respectively.

Figure 5 was constituted based on tables 7,8 and 9, and it summarizes the results observed in the frontal plane: opening, right and left deviations. It can be observed that the mandibular opening amplitude values are higher in the group without pain (G0) and similar in G1, G2 and G3. Significant differences occur always between pain degree zero (G0) and all the other pain degrees (G1, G2, G3). This result indicates that there are differences between the control and the research groups, independently of the pain degree. Differences between the pain degrees 1, 2 and 3 are not significant for this variable. The lateral deviation values obtained were similar in all groups.. The statistical analysis confirms these findings.

Table 10 describes the results regarding presence and type of lateral deviation during mandibular movements in speech, if uni or bilateral, according to the pain degree.

It is observed that the relative sequential distributions present non-significant statistical differences between the four groups of pain degrees for the type of mandibular movement devaition. There are evidences of a similar distribution of deviation types among the four groups of pain degrees.

TABLE 1. Distribution of participants according to the pain degrees

G0 : Degree 0	**G1** : Degree 1	**G2** : Degree 2	**G3** : Degree 3	Total
45 (33,3%)	37 (27,4%)	19 (14,1%)	34 (25,2%)	135 (100%)

FIGURE 1. Picture list for naming

FIGURE 2. Individual register of mandibular movements during words utterance

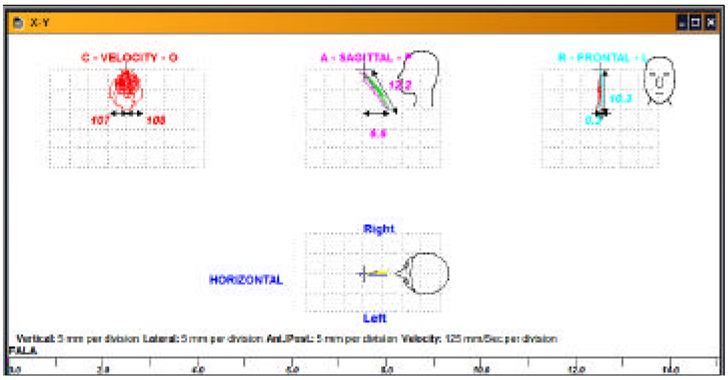

TABLE 2. Speed of mandibular opening (mm/sec), according to the pain degrees

Groups	Average	Standard-Deviation	Confidence Interval	Significance (p)	Comparison pair to pair Tukey's Test (p)
G0	88,62	31,37	79,20 - 98,05	0,021*	G0 x G1 (p = 0,116) G0 x G2 (p = 0,162) G0 x G3 (p = 0,024)* G1 x G2 (p = 0,994) G1 x G3 (p = 0,924) G2 x G3 (p = 0,994)
G1	74,92	26,06	66,23 - 83,61		
G2	72,89	15,43	65,46 - 80,33		
G3	70,79	29,42	60,53 - 81,06		

TABLE 3. Speed of mandibular closing (mm/sec), according to the pain degrees

Groups	Average	Standard-Deviation	Confidence Interval	Significance (p)	Comparison pair to pair Dunnett's Test (p)
G0	89,56	33,67	79,44 - 99,67	0,001*	G0 x G1 (p = 0,017)* G0 x G2 (p = 0,011)* G0 x G3 (p = 0,005)* G1 x G2 (p = 0,999) G1 x G3 (p = 0,983) G2 x G3 (p > 0,999)
G1	70,22	22,83	62,60 - 77,83		
G2	68,00	18,55	59,06 - 76,94		
G3	66,24	26,35	57,04 - 75,43		

FIGURE 3. Graphic representation of variables opening and closing speed according to the pain degrees

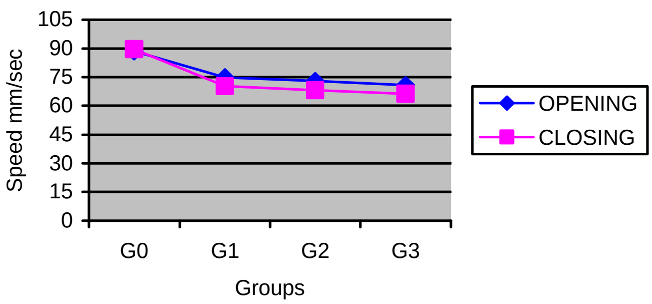

TABLE 4 . Opening amplitude in the sagittal plane (in mm), according to the pain degrees

Groups	Average	Standard-Deviation	Confidence Interval	Significance (p)	Comparison pair to pair Tukey's Test (p)
G0	12,74	3,18	11,78 - 13,69	< 0,001*	G0 x G1 (p < 0,001)*
G1	9,60	2,81	8,66 - 10,53		G0 x G2 (p = 0,008)*
G2	10,26	2,39	9,11 - 11,41		G0 x G3 (p < 0,001)*
G3	9,34	2,67	8,41 - 10,28		G1 x G2 (p = 0,845)
					G1 x G3 (p = 0,982)
					G2 x G3 (p = 0,678)

TABLE 5. Mandibular protrusion amplitude (in mm), according the pain degrees

Groups	Average	Standard-Deviation	Confidence Interval	Significance (p)
G0	1,98	0,82	1,66 - 2,31	0,678
G1	2,09	0,96	1,58 - 2,60	
G2	2,36	1,28	1,50 - 3,23	
G3	2,20	0,81	1,83 - 2,56	

TABLE 6. Mandibular retrusion amplitude (in mm), according the pain degrees

Groups	Average	Standard-Deviation	Confidence Interval	Significance (p)
G0	5,66	2,08	5,04 - 6,29	0,061
G1	4,85	1,73	4,27 - 5,43	
G2	5,00	1,63	4,21 - 5,78	
G3	4,55	1,88	3,90 - 5,21	

FIGURE 4. Graphic representation of mandibular movements amplitude variables in the sagittal plane, according to the pain degrees

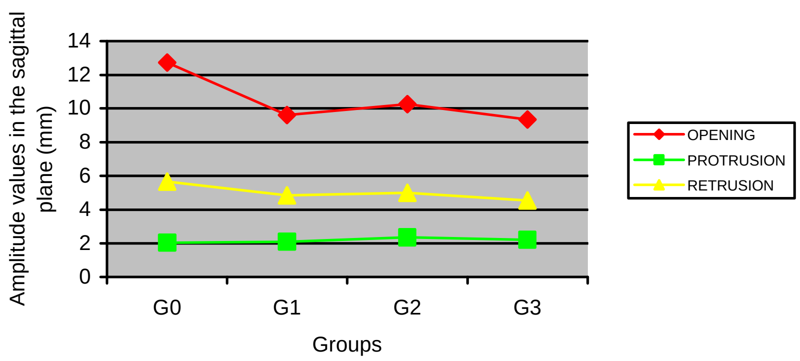

TABLE 7. Opening amplitude in the frontal plane (in mm), according to the pain degrees

Group	Average	Standard-Deviation	Confidence Interval de	Significance (p)	Comparison pair to pair Tukey's Test (p)
G0	11,18	2,79	10,34 - 12,02	< 0,001*	G0 x G1 (p < 0,001)*
G1	8,19	2,56	7,33 - 9,04		G0 x G2 (p = 0,001)*
G2	8,55	2,26	7,46 - 9,64		G0 x G3 (p < 0,001)*
G3	7,97	2,25	7,18 - 8,75		G1 x G2 (p = 0,958)
					G1 x G3 (p = 0,983)
					G2 x G3 (p = 0,854)

TABLE 8. Amplitude of mandibular lateral deviation to the right (in mm), according to the pain degrees

Group	Average	Standard-Deviation	Confidence Interval	Significance (p)
G0	1,83	0,74	1,58 - 2,08	0,490
G1	2,17	1,33	1,66 - 2,67	
G2	2,07	0,77	1,65 - 2,50	
G3	2,18	1,13	1,69 - 2,67	

TABLE 9. Amplitude of mandibular lateral deviation to the left (in mm), according to the pain degrees

Group	Average	Standard-Deviation	Confidence Interval	Significance (p)
G0	2,05	0,88	1,74 - 2,36	0,327
G1	2,48	1,06	1,95 - 3,01	
G2	1,97	1,26	1,25 - 2,70	
G3	1,95	0,78	1,58 - 2,33	

FIGURE 5. Graphic representation of variables opening amplitude and lateral deviation in the frontal plane, based on pain degrees

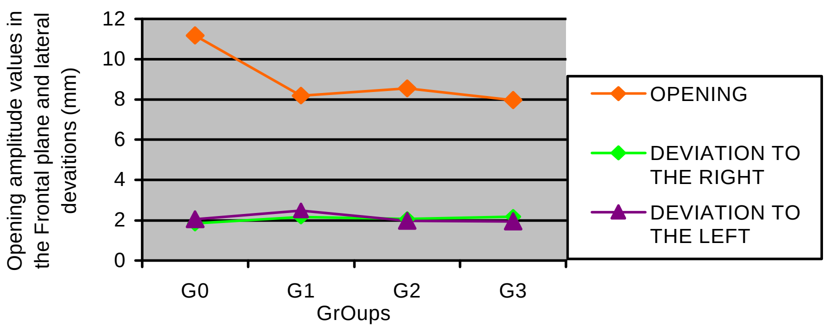

TABLE 10. Lateral mandibular deviations, according to the pain degrees

Groups	Without deviation	Unilateral deviation	Bilateral deviation	Total
G0	0 (0,00%)	20 (44,44%)	25 (55,56%)	45 (100,00%)
G1	2 (5,41%)	23 (62,16%)	12 (32,43%)	37 (100,00%)
G2	0 (0,00%)	9 (47,37%)	10 (52,63%)	19 (100,00%)
G3	2 (5,88%)	22 (64,71%)	10 (29,41%)	34 (100,00%)
Significance (p)	0,295	0,213	0,050	—

Discussion

This study involved a group of participants presenting signs and symptoms of temporomandibular dysfunctions constituted by consecutive patients referred by spontaneous demand for a computerized diagnosis. The literature review concerning characteristics of the population with TMD points out to a predominance of female patients ranging in age from 25 to 35 years old (Clark & Takeuchi, 1995; Palácios-Moreno et al. 1997; Luz et al., 1997, Bianchini, 2000a, 2000b). Therefore, aiming to avoid interferences regarding the variables gender and age, the voluntary participants of the control group matched the characteristics of the research group in a proportional relation concerning these variables, according to methodological criteria.

The identification protocol concerning signs and symptoms of TMD used in this research allowed the differentiation of the participants according to the degree of pain, enabling the proposition of verifying possible differences between values of mandibular movements in speech according to the pain degree. In this study, a numeric pain scale, easy to apply and to understand, varying from zero to three was used, where zero means absence of pain and three, severe pain (Rodrigues, 2000; Bianchini, 2000a; Manfredi et al., 2001). It was observed a similar distribution of patients with pain degrees 1 and 3, and a smaller number of participants with pain degree 2.

The generic term tenmporomandibular dysfunction includes two essential groups of dysfunctions: the muscular ones and the intra-articular, or just articular ones (Okeson,1997; Goldstein,1999; Luz,2000; Garcia et al.,2000; Mazzonetto & Spagnoli, 2001; Nassif & Talic,2001). In this research, participants were not subdivided concerning these groups, despite the recognition of the importance of such classification. The reasons for this choice mainly concern the necessity of obtaining image exams that precisely define the involvement, or not, of articular disorders obeying the methodological rigor necessary for this kind of differentiation. The exams would also have be requested for the asymptomatic group, submitting these patients to the difficulty and consequences of such complementary exams. Furthermore, literature points out some difficulties of data interpretation of these exams depending on the technique and criteria adopted (Palácios-Moreno et al.,1997; Almeida et al.,1997) and, mainly, the existence of some morphological alterations in articular surfaces and modified condylar position also in asymptomatic individuals (Tasaki et al., 1996). Thus, the temporomandibular dysfunctions characterization for this research took into account clinical data, in special the presence of muscular and/or articular chronic pain, and at least three discrete signs described in the literature (Luz, 2000, Palácios-Moreno et al., 2001).

The pain, understood as the main complaint, was fundamentally an important advertence of the organism modulating motor responses in order to change behaviors and functions in an attempt to minimize the unpleasant sensation (Assencio-Ferreira, 2000; Rodrigues, 2000). The presence of pain, which was the main inclusion criterion for the GI, associated to mandibular movements and to stomatognathic functions, specially related to the articulation function (Palácios-Moreno et al.,1997; Bianchini,2000c,2004), seems to determine a neuromuscular protecting mechanism, justifying the reduction of mandibular opening amplitude during speech in this group; nevertheless, the consulted literature did not provide data relating the speech characterization to any pain index.

Criteria concerning pain symptoms are highly subjective and of difficult precision due to the several variables that may interfere, such as: type of problem, individual threshold of perception and discomfort, attention, attitude and emotional aspects associated to the problem and its repercussion (Okeson, 1997; Assencio-Ferreira, 2000; Bianchini, 2000a; Vazquez-Delgado et al., 2004, Siqueira et al., 2004). In the literature there are reports concerning the symptoms and signs worsening observed in patients, such as functional limitations due to intense pain associated to temporomandibular dysfunctions progression (Garcia et al., 2000). Thus, clinical signs, including those indicative of internal derangement, become more meaningful where there is associated pain (Luz, 2000; Conti et al., 2000).

As to the verification of possible differences between the obtained values regarding mandibular movements in speech according to the pain degree, it was observed in this study that groups with pain G1, G2 and G3, behaved similarly concerning the speed and amplitude of mandibular movements, without significant statistical differences.

Concerning the speed of mandibular movements during speech according to the different pain degrees, data showed mean values of speed for either mandibular opening or closing higher in the group without pain (G0), with a notorious decrease in groups with pain G1, G2 and G3 with non-significant statistical differences. Nevertheless, a discrete decrease of either opening and closing speed was observed with the increase of pain degree, possibly meaning a modulation of motor responses preserving the function (Assencio-Ferreira, 2000).

Data obtained in this research also point to different characterization concerning mandibular opening and closing speed during speech according to the pain degree. For closing speed, there were significant statistical differences between pain degree zero and each one of the other pain degrees, demonstrating that for mandibular closing any pain index: mild, moderate or severe seem to interfere on speed. Contrarily, as to the opening speed, there was a significant statistical difference only between pain degree zero and pain degree three, that is, between absence of pain and severe pain. This finding agrees with Garcia et al. (2000), who point out limitations of movements associated to intense pain, and with Jankelson (1990) that shows cases of important reduction of speed associated with myositis and advanced degenerative alterations and articular pain.

The speed of mandibular movements during speech is a characteristic of difficult subjective observation once it involves a series of simultaneous movements of other structures (Ostry et al.,1997; Cookman & Verdolini,1999; McClean,2000), and of great possibility of variations inherent to some factors that also may determine and regulate the mandibular movement such as: teeth contact, anatomy and physiology of articulations, action of muscles and ligaments, as well as the neuromuscular integration of all these factors from proprioceptors located mainly in the oral mucosa, in the masticatory muscles, and in the priodont (Murdoch, 1997). Once the speed of mandibular movements is associated with so many variables, the temporomandibular dysfunctions interference could not be significant for determining the speed of those movements in speech.

A significant statistical difference was verified concerning the opening amplitude results between G0 and the other groups: G1, G2 e G3. Given this data, the worsening of signs and symptoms according to the pain intensity doesn't seem to determine a greater reduction of mandibular movements maximum amplitude during speech. In this study, it was observed that the presence of pain, which is characteristic of these dysfunctions, determines a sign of opening amplitude reduction, and no evidences were found as to the worsening of this sign with the increase of pain. Thus, the reference of functional limitations due to intense pain associated to the progression of temporomandibular dysfunctions is not confirmed (Garcia et al., 2000). Concerning protrusive and retrusive movements, no differences were observed between the four pain degrees analyzed, suggesting that the pain seems not to interfere in these movements during speech.

Literature about signs and symptoms of temporomandibular dysfunctions indicates asymmetry of mandibular movements in general, and deviations in mandibular course associated to presence of pain, hyperactivity of lateral pterygoid muscle, inflammatory process, incorrect relation condyle/disc, and TMJ morphological alterations (Garcia et al., 2000). As to the characterization of mandibular movements during speech, scarce previous researches point out the verification of important mandibular movement deviations. Causes associated to these deviations in speech concern: masticatory muscle asymmetry associated with TMD, presence of unilateral muscular problem, and occlusion factors such as premature teeth contact that would provoke deviation in the mandibular closing course to avoid them (Rodrigues et al.,1998; Bianchini,2000c). Therefore, it was expected that groups with pain showed higher incoordination of mandibular movements in speech and, consequently, more frequent deviations and with greater amplitudes (Bianchini,2000b, 2000c). For the group without pain, it was expected that deviations were less frequent or very discrete. However, results of this study using a precise instrument did not confirm these data, once they showed that lateral deviations of mandibular movements in speech are frequent in all groups. These data also differ those presented by Peraire et al. (1990) who found, in na asymptomatic population, 19,7% of the sample without deviations of such movements in speech. Observing the characterization of these deviations regarding the different pain degrees in relation to the amplitude and to the type of deviation, data showed that all groups behaved similarly, once results did not present significant differences between the four groups according to the pain degree: G0, G1, G2 and G3. In the literature no references with such implications were found.

On the other hand, despite the non-significant statistical differences, it is observed in the clinical practice that the higher the pain degree, greater functional limitations may be observed . Therefore, despite the importance of the statistical data, it's essential to be aware of the pain degree and its localization for either, the clinical exam achievement or the type of treatment to be employed once such signs may characterize different types of impairments and compensatory protecting responses, enabling the system functioning (Bianchini, 2000a, 2000b;).

Once, no significant statistical differences were found between the pain degrees proposed in this study, it seems important to verify variations regarding the classification of temporomandibular dysfunctions proposed by several authors mentioned here (Garcia et al.,2000; Mazzonetto & Spagnoli,2001; Nassif & Talic,2001) in further studies concerning the characterization of mandibular movements during speech in individuals with such dysfunctions, despite the difficulties of researches derived from this classification (Tasaki et al.,1996; Palácios-Moreno et al.,1997; Almeida et al.,1997)

The use of computerized electrognathography in this research as an investigation tool of these characteristics was an efficient measuring method, providing objective data concerning these movements.

Conclusion

From the results obtained in this study it's possible to suggest that:

- the different pain degrees: mild, moderate and severe, don't seem to determine greater reduction of the maximum opening amplitude and closing speed of mandibular movements during speech. The presence of pain, which is a characteristic of temporomandibular dysfunctions, is what seems to determine the reduction of opening amplitude and closing speed of mandibular movements during speech, independently of the pain degree. The presence of severe pain degree results in a greater reduction of the opening speed of mandibular movement during speech.
- the different pain degrees don't seem to determine differences in the maximum amplitude of protrusive and retrusive mandibular movements and in lateral deviations during speech, once data analysis show that the groups behave similarly as regards to these variables.

Apendix

Speech-Language Protocol for Identification of Signs and Symptoms of Temporomandibular Dysfunctions

1. Identification:
Name: Gender: Birth date: Age:
Indication Prontuário nº:

2. Description of signs and symptoms
Regarding presence of pain in masticatory muscles, in pre-auricular region and in TMJ ( ) yes ( ) no
Presence of pain during palpation in masticatory muscles, in pre-auricular region and in TMJ ( ) yes ( ) no
Pain degree: ( ) absent (0) ( ) mild (1) ( ) moderate (2) ( ) severe (3)
Presence of articular noise: Clicking ( ) yes ( ) no Crepitation ( ) yes ( ) no
Limitation of mandibular movements: Directed ( ) yes ( ) no In function ( ) yes ( ) no
Occurrence of articular blocking ( ) yes ( ) no
3. Characterization:
Removable dental prosthesis: ( )yes ( )no Dental failure: ( )yes ( )no
Dentofacial deformities: ( )yes ( )no Crossbite: ( )yes ( )no
4. Observation:

References

ALMEIDA, S. M.; BOSCOLO, F. N.; PEREIRA, T. C. R. Estudo comparativo entre duas técnicas radiográficas transcranianas utilizando o cefalostato ACCURAD-200, nas posições padrão e corrigida, e confecção de gabaritos para delimitação dos espaços articulares. *R. Odontol. Univ. SP*, São Paulo, v. 11, p. 51-60, jan. 1997. supl.

ANDREATTA, R. D.; BARLOW, S. M.; BISWAS, A.; FINAN, D. S. Mechanosensory modulation of perioral neuronal groups during active force dynamics. *J. Speech Hear. Res*., Bloomington, v. 39, n. 5, p. 1006-1017, oct. 1996.

ASSENCIO-FERREIRA, V. J. Fisiopatologia da dor. In: BIANCHINI, E. M. G. (Org.). *Articulação temporomandibular*: implicações, limitações e possibilidades fonoaudiológicas. Carapicuiba (SP): Pró-fono, 2000. p. 81-104.

BIANCHINI, E. M. G. Avaliação fonoaudiológica da motricidade oral: anamnese, exame clínico, o quê e por que avaliar. In: BIANCHINI, E. M. G. (Org.). *Articulação temporomandibular:* implicações, limitações e possibilidades fonoaudiológicas. Carapicuiba (SP): Pró-fono, 2000a. p. 191-254.

BIANCHINI, E. M. G. Relações das disfunções da articulação temporomandibular com a articulação da fala. *R. Dent. Press Ortodon. Ortopedi. Facial*, Maringá (PR), v. 5, n. 1, p. 51-59, jan.-fev. 2000b.

BIANCHINI, E. M. G. Avaliação fonoaudiológica da motricidade oral: distúrbios miofuncionais orofaciais ou situações adaptativas. *R. Dent. Press Ortodon. Ortopedi. Facial*, Maringá (PR), v. 6, n. 3, p. 73-82, mai.-jun. 2001.

BIANCHINI, E. M. G.; ROSSI, S. S. B.; PAIVA, G.; NASR, M. K.; PAIVA, A. F. Verificação da interferência das disfunções da ATM na amplitude e velocidade do movimento mandibular durante a fala por meio de eletrognatografia. *R. Dent. Press Ortodon. Ortopedi. Facial*, Maringá (PR), v. 8, n. 3, p. 109-115, mai.-jun. 2003.

BIANCHINI, E. M. G.; ANDRADE, C. F. A model of mandibular movements during speech: normative pilot study for the Brazilian Portuguese Language. *Cranio,* Chattanooga (TN), v. 24, n. 3, p. 197-206, jul. 2006.

BIANCHINI, E. M. G.; PAIVA, G.; ANDRADE, C. F. Patterns of mandibular movements in subjects with Temporomandibular Disorders and in asymptomatic ones. *Cranio,* Chattanooga (TN), no prelo.

CLARK, G. T.; TAKEUCHI, H. Temporomandibular dysfunction, chronic orofacial pain and motor disorders in the 21st century. *J. Calif. Dent. Assoc*., Los Angeles, v. 23, n. 4, p. 41-50, apr. 1995.

CONTI, P. C. R.; MIRANDA, J. E. S.; ORNELAS, F. Ruídos articulares e sinais de disfunção temporomandibular: um estudo comparativo por meio de palpação manual e vibratografia computadorizada da ATM. *Pesq. Odontol. Bras.*, São Paulo, v. 14, n. 4, p. 367-371, out. 2000.

COOKMAN, S.; VERDOLINI, K. Interrelation of mandibular laryngeal functions. *J. Voice,* Philadelphia, v. 13, n. 1, p. 11-24, mar. 1999.

FELÍCIO, C. M. Produção da fala. In: FELÍCIO, C. M. (Org.). *Fonoaudiologia aplicada a casos odontológicos*: motricidade oral e audiologia. São Paulo: Pancast, 1999a. p. 49-89.

FELÍCIO, C. M.; BORTOLIN, J. B. Fala e dor em condições orais variadas: aplicação da psicofísica. *Pró-Fono R. Atual Cient.*, Carapicuiba (SP), v. 13, n. 1, p. 78-82, mar. 2001.

GARCIA, A. R.; MADEIRA, A. C.; PAIVA, G.; OLIVIERI K. A. N. Joint vibration analysis in pacients with articular inflammation. *Cranio,* Chattanooga (TN), v. 18, n. 4, p. 272-278, oct. 2000.

GOLDSTEIN, B. H. Temporomandibular disorders: a review of current understanding. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod.*, Jackson (MS), v. 88, n. 4, p. 379-385, oct. 1999.

HILLIS, A. E.; WORK, M.; BARKER, P. B.; JACOBS, M. A.; BREESE, E. L.; MAURER, K. Re-examining the brain regions crucial for orchestrating speech articulation. *Brain*, New York, 127, pt. 7, p. 1479-1487. jul. 2004 Epub 2004 apr. 16.

JANKELSON, R. R. Mandibular tracking for diagnosis and treatment in clinical practice. In: JANKELSON, R. R. *Neuromuscular dental diagnosis and treatment*. St. Louis (Missouri): Ishiyaku Euro America Inc., 1990. p. 175-247.

JURGENS, U. Neural pathways underlying vocal control. *Neurosci. Biobehav. Rev.*, v. 26, n. 2, p. 235-258, mar. 2002.

LUZ, J. G. C.; MARAGNO, I. C.; MARTIN, M. C. Characteristics of chief complains of patients with temporomandibular disorders in a Brazilian population. *J. Oral Rehabil.*, v. 24, n. 3, p. 240-243, mar. 1997.

LUZ, J. G. C. Alterações temporomandibulares e sintomatologia. In: BIANCHINI, E. M. G. (Org.). *Articulação temporomandibular:* implicações, limitações e possibilidades fonoaudiológicas. Carapicuiba (SP): Pró-fono, 2000. p. 105-132.

MANFREDI, A. P. S.; SILVA, A. A.; VENDITE, L. L. Avaliação da sensibilidade do questionário de triagem para dor orofacial e desordens temporomandibulares recomendado pela Academia Americana de Dor Orofacial. *R. Bras. Otorrinolaringol.*, São Paulo, v. 67, n. 6, p. 763-768, nov. 2001.

MARCHESAN, I. Q. *Práticas fonoaudiológicas:* uma visão compreensiva. 1998. 211 f. Tese (Doutorado em Educação) - Faculdade de Educação da UNICAMP, Universidade Estadual de Campinas, Campinas.

MARCHESAN, I. Q. The speech pathology treatment with alterations of the stomatognathic system. *Int. J. Orofac. Myol*., Denver (CO), v. 26, n. 2, p. 5-12, nov. 2000.

MAZZONETTO, R.; SPAGNOLI, D. B. Artroscopia para o tratamento dos desarranjos internos da articulação temporomandibular. *R. APCD*, São Paulo, v. 55, n. 5, p. 337-342, set.-out. 2001.

MCCLEAN, M. D. Patterns of orofacial movement velocity across variations in speech rate. *J. Speech Lang. Hear. Res.*, Rockville, v. 43, n. 1, p. 205-216, jan. 2000.

MURDOCH, B. E. *Desenvolvimento da fala e distúrbios da linguagem:* uma abordagem neuroanatômica e neurofisiológica. Rio de Janeiro: Revinter, 1997. p. 67-89.

MURDOCH, B. E.; CHENG, Y.; GOOZÉE, J. V. Physiologic development of tongue-jaw coordination. *Spraak-en Taalpathol.*, Nijmegen, v. 14, suppl. , p. 20, jul. 2006.

NASSIF, N. J.; TALIC, Y. F. Classic symptoms in temporomandibular disorder patients: a comparative study. *Cranio*, Chattanooga (TN), v. 19, n. 1, p. 33-41, jan. 2001.

OKESON, J. P. Current terminology and diagnostic classification schemes. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod*., Jackson (MS), v. 83, n. 1, p. 61-64, jan. 1997.

OSTRY, D. J.; VATIKIOTIS-BATESON, E.; GRIBBLE, P. L. An examination of the degrees of freedom of human jaw motion in speech and mastication. *J. Speech Lang. Hear. Res.*, Rockville, v. 40, n. 6, p. 1341-1351, nov. 1997.

PALÁCIOS-MORENO, A. M.; CHILVARQUER, I.; LUZ, J. G. C. Achados radiográficos, sinais e sintomas nas disfunções da articulação temporomandibular. *R. Odontol. Univ. SP*, São Paulo, v. 11, n. 4, p. 273-278, out.-dez. 1997.

PERAIRE, M.; SALSENCH, J.; TORRENT, J.; NOGUERAS, J.; SAMSO, J. Study of mandibular movements during speech. *Cranio*, Chattanooga (TN), v. 8, n. 4, p. 324-331, oct. 1990.

RODRIGUES, A. C. Y.; BERRETIN, G.; JORGE, J. C.; GENARO, K. F. Caracterização das alterações miofuncionais orais e auditivas em indivíduos com disfunção craniomandibular. *Pró-fono R. Atual. Cient.*, Carapicuiba (SP), v. 10, n. 1, p. 51-55, mar. 1998.

RODRIGUES-GARCIA, R. C.; OLIVEIRA, V. M.; DEL-BEL-CURY, A. A. Effect of new dentures on interocclusal distance during speech. *Int. J. Prosthodont.*, v. 16, n. 5, p. 533-572, oct. 2003.

RODRIGUES, L. Avaliação odontológica. In: BIANCHINI, E. M. G. (Org.). *Articulação temporomandibular:* implicações, limitações e possibilidades fonoaudiológicas. Carapicuiba (SP): Pró-fono, 2000. p. 133-166.

SMITH, A.; ZELAZNIK, H. N. Development of functional synergies for speech motor coordination in childhood and adolescente.*Develop. Psychobiol.*, v. 45, n. 1, p. 22-33, jan. 2004.

TASAKI, M. M.; WESTESSON, P. L.; ISBERG, A. M.; REN, Y. F.; TALLENTS, R. H. Classification and prevalence of temporomandibular joint disk displacement in patients and symptom-free volunteers. *Am. J. Orthod. Dentofac. Orthop.*, Seatle, v. 109, n. 3, p. 249-262, mar. 1996.

VAN-TURENNOUT, M.; BIELAMOWICZ, L.; MARTIN, A. Modulation of neural activity during object naming: effects of time and practice. *Cereb. Cortex*, New Haven (CT), v. 13, n. 4, p. 381-391, apr. 2003.

VAZQUEZ-DELGADO, E.; SCHMIDT, J. E.; CARLSON, C. R.; DELEEUW, R.; OKESON, J. P. Psychological and sleep quality differences between chronic daily headache and temporomandibular disorders patients. *Cephalalgia*, Oxford, v. 24, n. 6, p. 446-454, jun. 2004.