

Desempenho mastigatório em adultos relacionado com a desordem temporomandibular e com a oclusão *****

Masticatory performance in adults related to temporomandibular disorder and dental occlusion

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Abstract

Background: temporomandibular disorder and mastication. Aim: to compare subjects who present temporomandibular disorders to a control group considering mastication and to analyze the related variables. Methods: 20 subjects with temporomandibular disorder (TMD group) and 10 controls - selection based on clinical examination and anamnesis - responded to a questionnaire on the self-perception of pain severity and presence of noise in the temporomandibular joints, muscle pain, otologic symptoms, headaches, and jaw opening difficulties. The subjects were also submitted to a clinical examination regarding the number of teeth and functional occlusion - measurements of jaw opening and jaw lateral excursions, occlusal interferences, occlusal contacts of the working and non-working-side, and mastication evaluation. Mastication was evaluated in terms of time needed to eat a stuffed cookie, number of chewing strokes and type (unilateral or bilateral). The maximum force needed at first to break the cookie, verified with a TA-XT2 Texture Analyzer (Stable Micro Systems), was of 4341.8 g. The groups were compared using variance analysis and the correlations between variables were calculated using the Pearson product-moment test. Results: most of the control subjects presented bilateral pattern of mastication, whereas the TMD group tended to present the unilateral pattern. Masticatory type scores and laterality measurements were significantly higher in the control group. The TMD group presented higher means in terms of: age, time of chewing, number of chewing strokes and TMD severity. Chewing time and type were positively correlated with TMD severity and negatively correlated with number of occlusal interferences. Conclusion: in the TMD group, chewing differed from the normal physiological standard. The number of occlusal interferences and the severity of TMD were variables correlated to chewing.

Key Words: Temporomandibular Joint; Mastication; Dental Occlusion; Food Analysis.

Resumo

Tema: desordem temporomandibular e mastigação. Objetivo: comparar sujeitos com desordem temporomandibular a um grupo controle quanto à mastigação e analisar as variáveis relacionadas. Métodos: 20 sujeitos com desordem temporomandibular (grupo com DTM) e 10 do grupo controle, ambos selecionados de acordo com o exame clínico e anamnese, responderam sobre a sua auto-percepção de severidade de dor e sons nas articulações temporomandibulares, dor nos músculos, sintomas otológicos, cefaléia e dificuldade para abrir a boca. Foram também submetidos ao exame clínico, considerando o número de elementos dentários presentes e a análise funcional da oclusão - medidas de abertura bucal, excursão lateral da mandíbula, interferências oclusais e contatos oclusais do lado de trabalho e balanceio. A mastigação foi avaliada quanto ao tempo para ingerir, ao número de golpes mastigatórios e ao tipo mastigatório (unilateral ou bilateral), usando um biscoito recheado, cuja força máxima para quebrá-lo no primeiro momento foi de 4341,8g, como verificado com o auxílio do Texture Analyser TA-XT2 (Stable Micro Systems). Os grupos foram comparados por análise de variância e as correlações entre as variáveis foram calculadas pelo teste produto-momento de Pearson. Resultados: a maioria dos sujeitos do grupo controle apresentou tipo mastigatório bilateral, enquanto que no grupo com DTM houve tendência ao tipo mastigatório unilateral. No grupo controle foram estatisticamente maiores os escores do tipo mastigatório e as medidas de lateralidade. No grupo com DTM foram maiores as médias de idade, o tempo de mastigação, o número de golpes mastigatórios e a severidade da DTM. O tempo e o tipo mastigatório foram correlacionados, respectivamente de modo positivo e negativo, à severidade da DTM e ao número de interferências oclusais. Conclusão: no grupo com DTM a mastigação diferiu do padrão fisiológico normal. O número de interferências oclusais e a severidade da DTM foram as variáveis correlacionadas à mastigação.

Palavras-Chave: Articulação Temporomandibular; Mastigação; Oclusão Dentária; Análise de Alimentos.

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Introduction

In view of the importance of masticatory function for the digestive process and of its reciprocal relationship with the components of the stomatognathic system, several studies have focused on masticatory function in order to describe it (Hiemae et al., 1996) and to propose methods for its evaluation (Mioche et al., 2003; Whitaker, 2005).

The force, movements, time and type of mastication are aspects that can be influenced by variables such as morphology, health status of the orofacial structures, functional muscular and articular capacity, as well as the characteristics of the foods ingested (Mazzetto et al., 2002; Mioche et al., 2003; Engelen et al., 2005; Cattoni, 2005).

Since individuals with temporomandibular disorders (TMD) frequently present limitations of masticatory function (Felício et al., 2002; Sato et al., 2002), they have been compared to control groups. Although most studies have pointed out the prevalence of unilateral mastication among subjects with TMD (Miyawaki et al., 2004; Felício et al., 2005), significant differences between them and control groups have not always been detected (Souza et al., 2005), especially when individuals presenting occlusal changes, but not TMD, were selected (Felício et al., 2002).

According to previous studies conducted on subjects with adequate occlusion and no dysfunction, the process occurs with symmetrical activity between the left and right masseter and anterior temporal muscles (Ferrario et al., 2000). However, in subjects with occlusal balancing side interferences (Nishigawa et al., 1997) and with unilateral crossbite (Pizzol, 2004), an altered and symmetrical pattern of muscle contraction has been observed by electromyography and by palpation during mastication. Also, during clenching in habitual maximum intercuspation, subjects with a diagnosis of TMD presented greater asymmetry than did healthy subjects (Alajbeg et al., 2003).

Occlusal problems are related to signs and symptoms of TMD, possibly affecting masticatory function and favoring functional asymmetry of the stomatognathic system (Hatch et al., 2001; Miyawaki et al., 2004). However, the wide variability in masticatory movements among subjects suggests that the effects of peripheral impulses on the masticatory movements differ among subject and that occlusal variables may or may not influence the motor response of jaw movements during mastication depending on the pattern of masticatory movement developed by each individual (Ogawa et al., 2001).

An important aspect is that masticatory

function can be affected by a complex interaction of direct and indirect effects, whereas in many studies these aspects are considered separately (Hatch et al., 2001; Salgado, 2002).

The general objective of the present investigation was to compare a group of patients with TMD to a control group regarding masticatory function and to analyze the possible related variables. Specific objectives were as follows:

- . to compare the groups in terms of the following variables: age, chewing time, number of strokes and masticatory type, severity of TMD, measures of jaw excursion movements, number of occlusal interferences on the balancing and working sides, and number of teeth.
- . to analyze the correlation between the variables described.

Method

All subjects gave written informed consent to participate in the study, which was approved by the Research Ethics Committee of the Dental School of Ribeirão Preto, USP, process nº. 99.1.225.58.4.

The study was conducted on 20 subjects with TMD who were seeking treatment for the problem and on 10 control subjects with no TMD complaints (CG).

Inclusion criteria

TMD group when submitted to clinical odontologic examination, the subjects should present signs and symptoms of TMD such as presence of pain in the masticatory muscles and/or in the temporomandibular joint (TMJ) during jaw function and upon palpation, limitation of jaw excursion movements, TMJ sounds, and abnormal static or dynamic occlusion.

Group without TMD: the subjects should be free of signs and symptoms of TMD based on the same diagnostic model, regardless of occlusal condition.

Exclusion Criteria: subjects wearing full upper or full lower dentures, or both, subjects with neurological disorders, and subjects with tumors or traumas in the head and neck region were excluded from the study. Subjects with acute pain that would prevent chewing were also excluded from the TMD group.

Procedures

A JVC-GR-AX-720 videocamera, 8 mm

videocassette tapes, a digital chronometer (Technos), printed protocols, and chocolate-filled cookies were used in order to obtain data about mastication.

For a precise determination of the characteristics of the food employed, the texture of the cookies was measured by evaluating the hardness parameter. The analyses were carried out using a Texture Analyser TA-XT2 (Stable Micro Systems) instrument with a knife edge-shaped probe (HDP/BS Knife Edge). Ten samples of chocolate-filled chocolate cookies of the Bono brand were analyzed; each sample was removed from the package at the time of the test and the following analytical conditions were used: compression force analysis mode; pretest velocity of 2.0 mm/s, test velocity of 2.0 mm/s, and post-test velocity of 10.0 mm/s; 20 g of force, and a distance of 20 mm. The texture of the cookies was measured by evaluating the maximum force at the first time of cookie breaking. At that point the cookie is fractured into two pieces, the subsequent force is substantially reduced, and the continued penetration of the knife edge breaks the cookie into small pieces. The maximum force detected was 4341.8 g, with a coefficient of variation of 11%.

The subjects responded to a questionnaire regarding the signs and symptoms of TMD (pain in the TMJ, facial pain, sounds in the TMJ, headache, cervical pain, biting discomfort, tooth sensitivity, hearing symptoms and difficulty in opening the mouth, in swallowing and talking), which permitted only positive or negative replies. Next, scores from zero (no pain) to seven (very intense pain) were attributed to the intensity of pain in the craniomandibular region. The degree of TMD severity was established for each subject by the sum of the number of symptoms multiplied by the pain score attributed by each subject. The questionnaire can be applied to asymptomatic subjects since it contains a zero degree of TMD.

The following aspects were recorded for the evaluation of occlusion: number of teeth present, number of occlusal interferences on the balancing side and on the working side, i.e., contact of the posterior teeth during lateral jaw excursion, and jaw excursive measures, i.e., maximum mouth opening and right and left laterality starting from maximum habitual intercuspatation (MHI).

For the evaluation of mastication, the subjects sat on a common chair, with their feet resting on the floor. A chocolate-filled cookie was offered and the subjects were instructed to chew in their habitual manner while images were recorded on videocassette. The chewing test was performed individually and the videos were later analyzed by

two independent examiners. To determine the time needed to consume the cookie, the chronometer was always started after the cookie was placed in the oral cavity and was stopped after the final swallowing of each portion. Masticatory type was determined by recording whether trituration was alternate bilateral, simultaneous bilateral, chronic unilateral (95% of the time on the same side of the oral cavity) or preferentially unilateral (66% of the time on the same side) (Felício, 2002), and whether chewing was performed with the anterior teeth (anterior). Next, according to the percentages obtained, the following scores were attributed: alternate bilateral trituration (3), simultaneous bilateral trituration (2), unilateral chewing preference (1), chronic unilateral or anterior chewing (0).

The number of chewing strokes was counted at each jaw elevation with intercuspatation, i.e., when tooth-food-tooth contact occurred.

Data analysis

Analysis of variance was used for comparison between groups, with groups being considered as the dependent variable and the other factors as independent variables. The product-moment Pearson correlation test was applied to investigate the correlations between variables.

Results

The groups analyzed according to gender consisted of 4 men and 17 women for the group with TMD and of 4 men and 6 women for the control group (CG).

Analysis of variance revealed significant differences between GTMD and CG regarding age, chewing time, chewing type, TMD severity, and the measures of right and left jaw laterality movements. The mean scores of chewing type and of right and left laterality measures were significantly higher in CG compared to GTMD. Mean age, chewing time, number of chewing strokes and TMD severity were higher in GTMD. TABLE 1 presents the mean values and the results of analysis of variance.

Correlation between variables

Chewing type was negatively correlated with number of chewing strokes, with TMD severity and with the number of occlusal interferences on the balancing side. Chewing time was positively correlated with the same variables and with the

number of occlusal interferences on the working side.

The age of the subjects was positively correlated with TMD severity and negatively correlated with the measure of right laterality. TMD severity was also correlated with the measure of left laterality.

The measure of right laterality was positively correlated with the measure of left laterality and negatively correlated with the number of occlusal interferences on the balancing side. The number of teeth was positively correlated with the measure of left laterality. The correlation indices (Pearson's r), the levels of significance and the correlations with other variables are presented in TABLE 2.

TABLE 1. Comparison of the mean values for GTMD and CG and results of analysis of variance.

Variables	GTMD	CG	F Value	P Value
Age (years)	37.15	24.1	7.909*	0.009
Chewing time (seconds)	116.511	78.964	11.40*	0.002
Chewing type	1.55	2.6	5.822*	0.022
Number of strokes	66.25	54.3	3.037	0.092
TMD severity	48.8	1.3	48.236*	0.000
Mouth opening (mm)	48.15	50.2	0.522	0.476
Right laterality (mm)	4.5	7.4	11.102*	0.002
Left laterality (mm)	4.5	7.9	17.139*	0.000
Interference with balancing side	1.3	0.6	1.675	0.206
Interference with working side	1.9	1.1	1.905	0.178
Number of teeth	30.55	31.6	3.718	0.064

Legend: *= significant differences between groups, p = probability of sample equality.

TABLE 2. Moment-product Pearson correlation (r values) and levels of significance (N=30)

	Chewing			TMD		Laterality		Interference		
	Age	Time	Type	No. of Strokes	Severity	Opening	Right	Left	Balancing	Working
Chewing time	0.30									
Chewing type	-0.17	-0.35								
Number of strokes	0.25	0.68***	-0.36*							
TMD Severity	0.41*	0.46**	-0.38*	0.17						
Opening	-0.29	-0.15	0.26	-0.15	-0.25					
Right Laterality	-0.42*	-0.28	0.33	-0.21	-0.33	0.34				
Left laterality	-0.22	-0.31	0.26	-0.07	-0.59***	-0.00	0.53**			
Interference with balancing side	0.11	0.45*	-0.38*	0.23	0.27	-0.02	-0.45*	-0.40		
Interference with working side	0.32	0.47**	-0.13	0.26	0.23	0.18	-0.29	-0.25	0.54**	
Number of teeth	-0.26	-0.13	0.13	0.04	-0.31	-0.01	0.26	0.49**	-0.01	0.01

Legend: Significant at the 5% level = *; 1% = **; 0.01% = ***

Discussion

When food is taken into the mouth it goes through a series of events until it is completely consumed, such as transport to the post-canine area, trituration, and transport to the pillar of the fauces. Mastication is concluded only after the liberation phase, during which there is a period of collection of the food fragments that remained in the buccal vestibule and final deglutition (Hiimeae et al., 1996). For this reason, in the present study the swallowing of food was also considered in the analysis of chewing time.

Food texture was also determined since many of the divergences between studies investigating the mastication of individuals with and without TMD may be due to the type of food used, because the chewing process is influenced by the characteristics of the food (Douglas, 2002; van der Bilt, 2002; Mioche et al., 2003; Engelen et al., 2005; Berretin-Felix et al., 2005).

In the present study, most of the CG subjects presented a bilateral chewing type, while GMTD subjects tended to have unilateral chewing, in agreement with literature reports (Miyawaki et al., 2004; Felício et al., 2005). Previous studies have demonstrated agreement between clinical and electromyographic methods for the determination of chewing side (Christensen, Raude, 1985; Pignataro Neto et al., 2004), as well as between the use of a chronometer and of electromyography to record the duration of the chewing act (Arrais et al., 2004).

The mean age of CG subjects was significantly lower than that of GTMD subjects but this variable was not correlated with chewing time or type. According to the literature, subjects with TMD who are older than 50 years have significantly lower scores of chewing ability than subjects younger than 40 years (Kurita et al., 2001). However, age per se may not be a determinant factor for the occurrence of changes in masticatory function as long as dental and muscular health is preserved. Changes in chewing pattern were observed when the effects of age were associated with dental conditions in terms of number of functional units (Kohyama et al., 2003), which is a parameter related to the level of masticatory muscle activity and is considered to be the best predictor of masticatory performance (Hatch et al., 2001; Ferrario et al., 2002).

Thus, with passing years, there is a need to differentiate between disease and aging process in order to establish the conduct to be followed (Nisa e Castro et al., 2004), since negative factors that would not significantly affect the functioning

of the system when considered separately, may eventually affect this functioning due to a cumulative effect (Hatch et al., 2001; Salgado, 2002). This may perhaps support the positive correlation between age and TMD severity observed here.

Missing teeth and the use of dentures have been previously associated with asymmetry of the masseter and temporal muscles during contraction as observed by palpation, a fact that, in turn, could be justified by the predominance of the unilateral chewing type (Monteiro et al., 2005). In the present study the number of teeth was not significantly correlated with time of ingestion, chewing type, TMD severity or subject age, probably because the number of missing teeth was small and subjects wearing full upper or lower dentures, or both, were excluded from the study.

The duration of the chewing act does not always differ significantly between individuals with and without TMD (Berretin-Felix et al., 2005) but, according to the present data, chewing time was longer for GTMD subjects, in agreement with a previous study (Felício et al., 2002), whereas the scores for chewing type were lower. The results for both variables - time and type - may be interpreted to reflect the functional performance of the stomatognathic system.

There was a negative correlation between chewing type and number of occlusal interferences, and a positive correlation between chewing time and TMD severity. Contact of the posterior teeth in jaw lateral excursion, i.e., occlusal interferences, may increase the functional load applied to the TMJs by changing the muscle coordination between the right and left sides (Nishigawa et al., 1997; Ferrario et al., 2000; Ferrario et al., 2003), and the stability of jaw movement during mastication is intimately related to chewing efficiency (Unno et al., 2005).

Thus, the larger number of occlusal interferences and the severity of TMD seem to impair the functional chewing performance, leading to a different type of normal physiology (bilateral alternate) and increasing the time needed to process and ingest food. This may be interpreted as an effort to prevent discomfort and as hesitation in choosing an area where the cookie could be better triturated, i.e., the area of highest masticatory efficiency (Felício et al., 2002).

The positive correlation between number of chewing strokes and time and the negative correlation with chewing type agree with the previous explanations. However, the avoidance of

nociceptive stimuli and the modifications of the proprioceptive scheme may affect the adaptability and coordination of jaw movements.

On this basis, it is interesting to consider that the occlusal interferences may also be the consequence of a modification of the occlusal position secondary to the presence of joint and/or muscle pain (Fuji, 2002).

Significant differences in the amplitude of jaw movements were observed between CG and GTMD, in agreement with previous studies (Celic et al., 2004; Hansdottir and Bakke, 2004). The laterality measures were negatively correlated with the number of occlusal interferences and with TMD severity. These movements were not significantly correlated with chewing type (Felício et al., 2005) or chewing time results.

It has been previously demonstrated that human masticatory movements related to occlusal guidance differ according to the movement patterns acquired individually (more horizontal or more vertical), causing varied motor responses according to the functional potential of each individual (Ogawa et al., 2001).

Injuries to the stomatognathic system may affect the adaptive capacity and negatively affect the pattern (Type) of trituration, thus affecting chewing performance (Hatch et al., 2001; Kurita, et al, 2001; Mazzetto et al, 2002; Sato et al, 2003; Pizzol, 2004; Cattoni, 2005). Marked functional deficiency has been previously associated with

the differences detected in subjects with chronic joint pain, involving a lower pain threshold in response to pressure, a smaller mouth opening, a longer duration of masticatory cycles, a lower closing velocity and a lower biting strength compared to healthy subjects. This deficiency was attributed to a possible adaptive reflex and to prolonged hypoactivity of the masticatory muscles (Hansdottir and Bakke, 2004).

The compensations performed in order to execute the masticatory function under adverse conditions, even in a reflex manner, are not always effective and, on a long-term basis, may contribute to the progression of TMD.

Conclusion

The present study permitted us to conclude that there were differences between the groups compared. The mean scores for masticatory type and for right and left laterality measurements were higher for the control group, whereas mean age, chewing time, number of chewing strokes and TMD severity were higher for the TMD group.

The number of occlusal interferences and the severity of TMD were the variables correlated with mastication, with the following tendency: the higher the number of occlusal interferences and TMD severity, the longer the chewing time and the lower the score of masticatory type, i.e., more distant from the normal physiological pattern.

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