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Influence of body position on maximum bite force

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SUMMARY

Objective: To evaluate the maximum bite force (MBF) in subjects with and without Temporomandibular Dysfunction (TMD), in three different positions (sitting, lying and standing). Methods: The sample consisted of 60 individuals, aged between 19 and 35 years, who were divided into two groups: with TMD (n = 30) and without TMD (n = 30). First, the RDC/TMD questionnaire was applied and, after diagnosis, all of the subjects selected were submitted to the measurement of MBF, on each side (right and left), in three different positions (sitting, lying and standing), by means of a digital gnatodynamometer. Results: No significant difference in mean MBF was found between the two groups; however, the mean MBF for the subjects, comparing the same side and different positions, was significantly different, being smaller when the individual was lying down. Conclusions: According to the results, it was concluded that the MBF is influenced by the change of position.

Keywords: Temporomandibular Joint Disorder, Maximum Bite Force, Posture.

INTRODUCTION

Temporomandibular Dysfunction (TMD) is defined as a set of musculoskeletal and neuromuscular conditions that affect temporomandibular joint (TMJ), masticatory muscles and associated structures[1]. Its etiology involves several factors, among them: occlusal, traumatic, muscular and articular alterations, being therefore considered of multifactorial origin[2].

The TMJ is most frequently observed in individuals between 20 and 45 years of age[3] and is classified, according to the American Academy of Orofacial Pain, in two major groups: muscular (dysfunctions related to masticatory muscles) and articular (disorders related to joint articulation)[4].

The most common signs and symptoms are: orofacial pain, reduction of joint movements, ringing in the ear, cracking and / or crackling, vertigo and postural abnormalities[3]. In addition, the presence of dysfunction may alter the maximum bite force (MBF)[5]. The MBF is considered the force generated by the greatest effort of the lower teeth against the upper teeth and is responsible for the ascension of the mandible through the action of the temporal, medial pterygoid and masseter muscles[6]. Their measurement indicates, quantitatively, the muscular efficiency of dental tightening[7]. Their values are influenced by several factors. Individual characteristics, the recording device and the posture of the individual's head are some of these conditions[8-10]. Since the latter could be influenced by the positioning of the individual, it would also cause a change in the force.

It is necessary to emphasize that these aspects will not, necessarily, cause a decrease in the MBF. An example is patients with TMD. There are no consistent findings in the literature concerning individuals with TMD having a lower MBF than individuals without the dysfunction[11, 12].

It has also been found that, like the MBF, the DTM is in relation to head position. This is because the TMJ constitutes the connection between the mandible at the base of the skull. The latter being linked to the cervical region by muscular and ligamentous connections, forming the craniocervical mandibular system. It is this relationship between the head and neck area and the TMJ that makes it possible to measure this link between TMD and posture[13]. The action of the mandibular muscles is thus correlated with that of the neck and trunk muscles[14]. This connection is perceived, in practice, during the maximum voluntary contraction in healthy people, when the activity of the masseter and of the temporal differentiates, depending on body position[15,16]. However, no studies were found that investigated whether this change is also capable of modifying MBF. This variable is directly related to individuals' quality of life since the greater the masticatory capacity and efficacy, the better the food fragmentation will be and the better the digestion[17]. It is

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for these reasons that such a study is primordial. Differences in this parameter, according to body position, are important since most diagnoses and dental interventions are performed in only one position, the supine.

The general objective of this study was to evaluate the MBF of subjects with and without TMD in three different positions (lying down, sitting and standing).

MATERIALS AND METHODS

Sample

Sixty subjects of both sexes, aged between 19 and 35 years, were evaluated from May to September, 2016. The selected subjects were divided into two groups. One group diagnosed with temporomandibular dysfunction of muscular origin (n=30) determined by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). This group consisted of patients with at least 20 functional teeth in the oral cavity, with bilateral posterior occlusion and with adequate mandibular stability. The second group, without TMD (n = 30), was composed of asymptomatic individuals, with bilateral posterior occlusion and without muscular or articular involvement. Among all individuals (60), the majority (47) presented masticatory preference on the left side. The research project was approved by the Human Research Ethics Committee of the Federal University of Uberlândia, nº 832182.

Instrument

An electromyograph composed of 10 channels (EMG System do Brasil, Sao Jose dos Campos, Brazil) was used for measurement. This device permitted the acquisition of signals received from the digital gnatodynamometer connected to the electromyograph in the channel configured to receive signals from the EMG. The gnatodynamometer supplied signals corresponding to the strain gauge and thus provided a data acquisition system from 0 to 100 kg/f, registered in kg/f or N. In addition, the device featured a flexible two meter cable, 30 AWG wires and twisted pairs with shielding and 2mV/V sensitivity.

Experimental procedure

The research was conducted at - University Center of the Triangulo – UNITRI (Uberlandia, Brazil), following completion of the 'Free and Informed Consent' document by the participating individuals. All participants were placed in three positions: lying down, sitting and standing, and a simple randomization was performed for the order of the positions of each. A dental chair was used for both lying and sitting positions so that the individuals kept their heads in a comfortable position throughout the procedure, keeping the Frankfurt plane parallel to the ground.

The RDC/TMD questionnaire was applied for the diagnosis of TMD followed by measurement of the MBF. After the correct positioning of each individual the gnatodynamometer was placed in the region of the first molars, between the upper and lower arches, and the individual was instructed to bite as hard as possible for five seconds. This was repeated three times on each side (right and left). A rest time of 30 seconds was given between each measurement. Between the changes of position there was a time of one minute for rest. The MBF value, on each side of the individual, was calculated from the average of the three measurements performed.

Statistical analysis

The experiment was conducted using a completely randomized design with replicates. The data were separated into two groups (with and without TMD), with the positions considered as treatments and the sides treated as replicates. The data were submitted to an initial analysis of the normality of the residues of the mathematical model, using the Shapiro-Wilk test and homoscedasticity of the variances of the treatments, using the Bartlett test. In order to evaluate whether the position and the treatment that each individual underwent had any influence on the MBF, an analysis of variance (ANOVA) was performed followed by the Tukey averages comparison test. All analyzes used a significance of 5% using R software.

RESULTS

The mean MBF in patients with TMD was 39.36 kg/f (standard deviation = 12.27) and for patients without TMD it was 47.67 kg / f (standard deviation = 7.27). These data were based on the individual MBF values of each individual.

According to Figure 1, the mean MBF is higher when the individual is standing, moderate when seated and low when the patient is lying down. With analysis of the values between the sides, it was noticed that the averages were practically the same but the left side presented higher averages of MBF. To perform the Fully Randomized Design, normality of the data had to be assured. The Shapiro-Wilk test was performed to verify this normality. The hypothesis tested was:

H^o: Sample from a normal population

H^1: Sample from an anormal population

In Table 1. We verified that the data follow a normal distribution. All p-values obtained were > .05. It can be observed in Figure 2 that the variance of the MBF is different between the right and left sides. According to the figure, data for the right side are similar to the mean (shown in Graph 1): greater when the individual is standing, moderate when seated and low when lying down. The same was not observed for the left side, as shown in Figure 2. Since normality of the data was assured by the Shapiro-Wilk test, it was necessary to verify the homogeneity of the variances. The hypotheses tested are:

H^o: variances are equal

H^1: variances are not equal

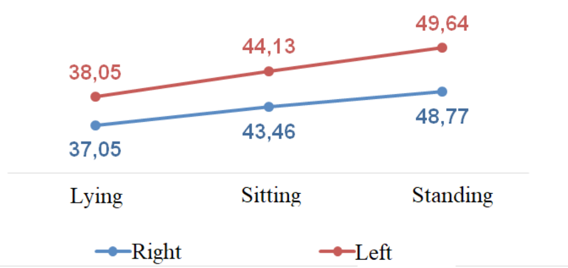

Figure 1. Mean of the MBF considering the position of the patient and the side.

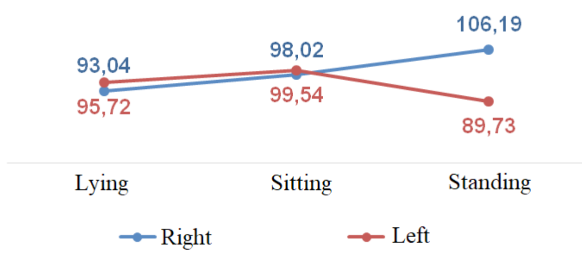

Figure 2. Variances of MBF concerning individuals' position and side.

Table 1. – Values of P obtained from the Shapiro-Wilk test.

Position ⇨ / Side ⇩	Right	Left
Lying	.6963	.2166
Sitting	.3132	.5674
Standing	.2140	.1695

Table 2. P-value obtained using the Shapiro-Wilk test.

	Degrees of freedom	SQMeans	SQF	P-valor
Treatment	5	8237	1647	2E-16*
DTM	1	6209	6209	2E-16*
Residuals	353	28144	80	

* Significant at the .05 level.

Table 3. Confidence intervals obtained from the Tukey test for each of the factors tested.

Factor comparisons		Confidence interval
Lying Right	Lying Left	[-3,67;5,67]
Lying Right	Sitting Right	[1,75;11,09]
Lying Right	Sitting Left	[2,41;11,75]
Lying Right	Standing Right	[7,06;16,40]
Lying Right	Standing Left	[7,92;17,27]
Lying Left	Sitting Right	[0,74;10,09]
Lying Left	Sitting Left	[1,41;10,75]
Lying Left	Standing Right	[6,05;15,40]
Lying Left	Standing Left	[6,92;16,26]
Sitting Right	Sitting Left	[-4,01;5,33]
Sitting Right	Standing Right	[0,64;9,98]
Sitting Right	Standing Left	[1,50;10,85]
Sitting Left	Standing Right	[-0,02;9,32]
Sitting Left	Standing Left	[0,84;10,18]
Standing Right	Standing Left	[-3,80;5,54]
With TMD	Without TMD	[-10,16;6,45]

Using the Bartlett test for paired observations, the p-value obtained was .9922 > .05 (level of significance). Therefore we did not reject the Hº hypothesis of equality of variances (Table 2).

The Anova with post-hoc Tukey test table showed that the differences between the means were highly significant. It was concluded that there is significant difference between the MBF of the participants in the different positions, sides and among those who did or did not have TMD. To verify which factors of sample present significant differences the Tukey test was used (Table 3).

The pairs with significant differences are those with lower positive limits. The details of Tukey's test calculation are described by Zar (1999) and Levin (1985). The differences between the following factors: Lying Right-Sitting Right, Lying Right-Sitting Left, Lying Right-Standing Right, Lying Right-Standing Left, Lying Left-Sitting Right, Lying Left-Sitting Left, Lying Left-Standing Right, Lying Left-Standing Left, Sitting Right-Standing Right, Sitting Right-Standing Left and Sitting Left-Standing Left, are significant at the 5% level ($p < .05$). It was these samples that contributed to the differences detected by ANOVA.

The factors that showed no significant differences included: Lying Right-Lying Left, Sitting Right-Sitting Left, Sitting Left-Standing Right and Standing Right-Standing Left. As shown in Table 3, all had lower negative limits. In addition to these, there were no significant differences in the mean MBF among individuals with and without TMD.

DISCUSSION

In this study, it was observed that there was no difference in the mean MBF between the two groups and no disparity for the subjects when the comparison factor was the side, provided that the position was the same. This is to say that the mean MBF for the individual sitting, on the right side, was equal to the MBF average for the individual sitting, on the left side. Machado at al., conducted a study[19] aimed at comparing, among other parameters, the MBF of individuals with and without TMD. Twenty-two women (14 belonging to the TMD group and eight to the control group), aged between 18 and 48 years, were investigated and MBF determined the with three replicates of maximal voluntary contraction. They concluded that there were no significant differences between the two groups. Also, corroborating our findings, an analysis[5] composed of 40 volunteers of both sexes, divided into groups (according to gender and presence/absence of TMD), demonstrated no statistical significance between the groups.

In the present study, no difference in the mean of the MBF was observed between the two groups and there was no disparity, when the comparison factor was the side, provided that the position was equal. The mean MBF for the individual sitting, on the right side, was thus equal to the MBF average for the individual sitting, on the left side. It was also observed that the highest mean was present on the left side. A justification for this may be related to the masticatory preference of the participants (most of them had left side preference). Accordingly, another study[20] evaluated, among other measures, masticatory preference and MBF in adults of both sexes. The author concluded that the side with the highest MBF value was the side of masticatory preference.

The mean MBF for individuals, comparing side, and distinct positions, was significantly different. Thus the mean MBF for individuals sitting, on the right side, was different from the MBF average for individuals standing, on the left side. It is believed that this occurred because the mandibular elevating muscles are mainly responsible for the mandibular position and the temporal and masseter muscle activity is influenced by body position[21].

It was found that the position which presented the lowest values of MBF was lying down. This can be explained by the decrease in the activity of these muscles due to gravity, which formed a right angle with the fibers. The temporomandibular joint received the mandible load[22].

CONCLUSION

The present study concluded that the maximum bite force (MBF) is influenced by the change of position and the masticatory preference. Thus, it is recommended that dental professionals do not make assessments/interventions based on only one positioning. In addition, it is recommended that more studies be done on the subject, since literature in this area is sparse.

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AUTHORS' CONTRIBUTIONS

All authors contributed equally to this work.

DECLARATION OF CONFLICT OF INTEREST

None.

AUTHOR DETAILS

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