Chewing and swallowing in young women with temporomandibular disorder

**ABSTRACT**

**Purpose:** To evaluate chewing and swallowing functions in women with and without temporomandibular disorder (TMD) and investigate the position of the mandible and the hyoid bone as they are important structures in the development of these functions. **Methods:** Seventy women were evaluated in relation to TMD diagnosis according to the Research Diagnostic Criteria, among them, 34 composed the study group (SG) with TMD and 36 took part in the control group (CG). Evaluation of the masticatory and swallowing functions was performed according to the Protocol of Orofacial Myofunctional Evaluation with Scores. Mandibular and hyoid bone position variables were measured by cephalometric analysis. **Results:** TMD subjects showed a significant difference on tongue (p=0.03) and lip (p=0.04) posture during swallowing function, and a more frequent adoption of a chronic unilateral chewing pattern as well (p=0.03). Moreover, they presented a lower position of the hyoid bone in relation to the mandible (p=0.00). **Conclusion:** TMD presence resulted on a higher frequency of myofunctional alterations during masticatory and swallowing functions. A greater distance from hyoid bone to the mandible in addition with the presence of painful symptom can justify, partly, the atypical behaviors of the tongue and lips observed on TMD group. The TMD repercussion on alimentaires functions in a young age group justifies the importance of an earlier diagnosis and therapeutic intervention in these individuals.

**Keywords**

Temporomandibular joint disorders  
Mastication  
Deglutition  
Cephalometry  
Hyoid bone

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**RESUMO**

**Objetivo:** Avaliar a mastigação e a deglutição em mulheres com e sem desordem temporomandibular (DTM) e investigar a posição da mandíbula e do osso hioide, por serem estruturas importantes para a realização destas funções. **Métodos:** Setenta mulheres foram avaliadas quanto à presença de DTM segundo o instrumento Critérios de Diagnóstico para Pesquisa de Desordem Temporomandibular, sendo que 34 delas, com DTM, constituíram o grupo de estudo (GE) e 36 participaram do grupo controle (GC). A avaliação da mastigação e deglutição foi baseada no Protocolo de Avaliação Miofuncional Orofacial com Escores (AMIOFE). As variáveis referentes à posição da mandíbula e osso hioide aferidas pela análise cefalométrica. **Resultados:** Os indivíduos com DTM apresentaram diferença significativa quanto à postura da língua (p=0,03) e lábios (p=0,04) durante a função de deglutição, bem como a adoção mais frequente de um padrão mastigatório unilateral crônico (p=0,03). Além disso, apresentaram posição mais baixa do osso hioide em relação à mandíbula (p=0,00). **Conclusão:** A presença de DTM promoveu maior frequência de alterações miofuncionais orofaciais durante as funções de mastigação e deglutição. A maior distância entre o osso hioide e a mandíbula, bem como a presença da sintomatologia álgica, podem justificar, em parte, os comportamentos atípicos da língua e dos lábios observados no grupo com DTM. A repercussão da DTM sobre as funções alimentares em uma faixa etária jovem explica a importância do diagnóstico e da intervenção terapêutica precoce nestes indivíduos.

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**Correspondence address:**
Priscila Weber  
Av, Presidente Vargas, 1855/1101, Santa Maria (RS), Brazil, CEP: 97015-513.  
E-mail: prifisio07@yahoo.com.br

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INTRODUCTION

Temporomandibular disorders (TMDs) involve a set of signals and symptoms represented by joint and/or muscle pain, limitation of mandibular movements, changes in muscle function during chewing, and presence of joint noise \(^{(1)}\). The manifestation of one of these factors or the combination of several of them can negatively influence the development of stomatognathic functions, especially those related to chewing and deglutition \(^{(2)}\).

The compromised integrity of the temporomandibular joint and the action of masticatory and supra and infrahyoid muscles may be the answer to the atypical behaviors observed in these functions \(^{(3)}\). Besides, it is possible that the concomitant presence of TMD and orofacial myofunctional alterations be related to chronic pain as a response to the perpetuation of craniomandibular symptoms for a prolonged amount of time \(^{(4)}\).

Still concerning the modulation of chronic pain, individuals with TMD are more sensitive to pain due to flaws in the modulation of nociceptive stimuli at the central level. Thus, hyperalgesia may increase susceptibility for the occurrence of orofacial myofunctional disorders in individuals affected by this condition \(^{(5)}\).

Several studies have demonstrated that individuals with TMD usually present some sort of alteration in the oral phase of deglutition. In order to avoid pain during deglutition, the tongue acts in a compensatory way, being interposed between the dental arches during the propulsion of food to the pharynx. Concomitantly, a contraction in periorbital and mentalis muscles can be observed, which shows the effort to develop the function \(^{(2-3)}\). Mastication is equally influenced by pain, once the adoption of a chronic unilateral pattern in cases of TMD is commonly observed \(^{(6,7)}\).

Considering the implications of the disorder on orofacial myofunctional performance, this study aims to assess chewing and deglutition in young women with and without TMD. Due to the comprehensiveness of the subject, it was chosen to emphasize the analysis of these functions excluding breathing and phono-articulation, which can be investigated in depth in future studies. This research also aimed to assess the position of the mandible and the hyoid bone in both groups, because they are important structures for the performance of the mentioned tasks.

MATERIALS AND METHODS

This is a cross-sectional, observational, and quantitative research. The project was approved by the Health Research Ethics Committee at Universidade Federal de Santa Maria (UFSM), according to report No. 0048.0.243.000-8, acknowledged by the National Committee for Ethics in Research.

By means of the electronic and print media, women aged between 19 and 35 years old who were interested in receiving a free evaluation of the orofacial and cervical regions were invited to participate in the study. After being informed about the objectives and procedures, they were included in the research after signing the informed consent.

Considering the occurrence of TMD, it is worth to mention that the choice of age group was intentional, since most of the signs and symptoms of this disorder has been reported in the literature among female young adults \(^{(8)}\). On the other hand, because they were young, they would not present possible morphofunctional orofacial changes, likely to be present in the aging process.

By means of anamnesis, some participants were excluded from the research — those who reported facial trauma and/or previous craniomandibular and/or cervical orthopedic surgical procedures, and musculoskeletal deformities (scoliosis, congenital malformation of the bone).

Some of the other exclusion criteria were: Angle class II and III occlusion changes \(^{(9)}\), dental flaws, anterior and posterior open bite, cross, level, and over bites, and use of orthodontic appliance during the performance of the research.

In order to assess malocclusions, three intraoral photographs made by the same examiner were taken of individuals with maximal intercuspation, which were analyzed afterwards by an orthodontist.

Out of the 94 participants who got in touch with the researcher, 24 were excluded: 10 due to malocclusion, two for having undergone orthognathic surgery, nine for wearing orthodontic appliance, and two for being diagnosed with scoliosis.

Those who presented with occlusion and speech language alterations were oriented to look for specialized treatment, but this initiative was up to the participant. Women diagnosed with TMD were invited to participate in the physical therapeutic project related to TMDs performed in the Orofacial Motricity Laboratory at UFSM.

The diagnosis of TMD was conducted in order to divide the participants into two groups, according to the presence or the absence of the disorder, and this action was verified by the Research Diagnostic Criteria for TMD \(^{(10)}\). The following items were assessed: mandibular opening pattern, regions of reported pain, amplitude of mandibular movements, presence of joint noise during mandibular movements, and painful sensitivity to joint and muscle palpation.

Possible diagnoses involve three subgroups: muscle disorders (Group I), disk displacement (Group II), and arthralgia and osteoarthritis (Group III).

Out of the 70 women who were part of the inclusion and exclusion criteria, 34 were in the study group for presenting one or more TMD diagnoses, while the control group (CG) was formed by 36 volunteers.

The weight and height of the participants were registered, and body mass index (BMI) was calculated with the formula BMI=weight/height\(^2\). This information was obtained in order to characterize and unify the groups together with the age factor.

For the cephalometric analysis, a right lateral skull and a cervical spinal x-ray were performed in the orthostatic position with the natural head position. In order to reproduce natural head position, participants were asked to keep staring at their own eyes in the mirror placed 1 m away \(^{(11)}\).

The x-ray was performed with the Orthophos Plus equipment (Siemens, Germany), maintaining a stable...
focal film distance of 1.52 m. The examination was performed according to the radioprotection protocol, which is in accordance with ordinance 453, from June 1 1998, of the Secretariat of Sanitary Surveillance of the Ministry of Health.

Variables were measured by a single examiner with the manual cephalometric tracing. In a weeks’ interval, 20 x-rays were randomly chosen for a second analysis in order to verify the reliability of the performed tracing.

Cephalometric variables concerning mandibular position and hyoid bone are described in Chart 1 and demonstrated in Figure 1.

The evaluation of mastication and deglutition functions was based on the Protocol of Orofacial Myofunctional Evaluation with Scores. A speech language pathologist skilled to analyze orofacial motricity applied the protocol.

In the deglutition evaluation concerning lip behavior, the effort for labial occlusion or the non-sealing of the oral cavity was considered as being atypical, while the occlusion without apparent effort was considered as being typical for this function. The interposition of the tongue between the dental arches inferred the atypical pattern, and the typical behavior was observed when it was contained in the oral cavity during deglutition. Other evaluated behaviors and signals of changes were the presence of head movement and tension in facial muscles.

As for the masticatory function, when performed on both sides of the occlusal surfaces, the atypical pattern was considered as the vertical bilateral mastication, and the alternate mastication was considered as the typical pattern. If performed only on one side, it was characterized as chronic or preferential unilateral chewing, and these were considered as atypical and typical patterns, respectively. According to the protocol, the chronic pattern is that in which more than 95% of the masticatory function takes place only on one side, while in the preferential unilateral pattern it occurs for 66% of the time. Other behaviors and signs of changes observed in mastication were the presence of movements and/or altered head posture.

Bread was used in both assessed tasks. Particularly in deglutition, water was also offered during the examination.

For the application of the statistical test, mild and moderate classifications were gathered in relation to the tongue behavior of lips during deglutition, as well as the excessively protrusive and adapted classifications in relation to the tongue behavior in this same function.

STATISTICAL ANALYSIS

A descriptive data analysis was performed in a table format. The intraclass correlation coefficient (ICC) was used to check the reliability of cephalometric measures. ICC values were classified into: ICC ≤0.4, weak reliability; 0.4<ICC<0.75, moderate reliability; and ICC≥0.75, excellent reliability. The Lilliefors test was applied to check the normality of data in the following demographic variables: age, BMI, and cephalometric data. In order to identify differences between the groups in these variables, the Student’s t-test was used for independent samples.

Considering cephalometric variables, the effect size (d) was also calculated by the model proposed by Cohen for the mean differences of two independent groups. According to Cohen’s criteria, the value of d=0.20 represents a small effect size; d=0.50, medium; and d=0.80, large. With these results, statistical power was estimated. In this study, it was separately calculated for all cephalometric variables in the comparison between participants with TMD and controls. Power equal to or higher than 0.8 is acceptable so that the chance of finding statistical differences be 80% or higher.

A descriptive statistical analysis was performed to check the percentage of participants in each group according to the presence of TMD, and also in accordance with the aspects evaluated in mastication and deglutition functions. The test for the difference between population proportions pointed out to percentage differences between the groups. All tests admitted a 5% significance level.
RESULTS

The characterization of groups with and without TMD, considering age and (Body Mass Index) is shown in Table 1, in which no statistical difference is observed between the groups in relation to these variables.

Out of the 34 individuals who presented with TMD, 44.12% registered myofascial TMD, 44.12% had mixed TMD (presence of myofascial pain associated to one or more diagnoses of Group II and/or III), and 11.76% had only the diagnosis of Group III.

The results of ICC demonstrated excellent levels of reliability for all angles measured by the evaluator, in two different moments, as shown in Table 2.

As presented in Table 3, the variable concerning the distance of the hyoid bone to the mandible (Hy/ML) was significantly different between groups. In this case, high statistical power was observed (89%), which demonstrates the consistency of this result and that sample size was adequate.

The effect-size analysis for the other variables demonstrated small effect. Considering the low statistical power observed for these variables, these results should be carefully analyzed since statistical significance could have been observed in relation to the increased sample size.

The association between the presence of TMD and the orofacial myofunctional evaluation of the deglutition and mastication functions is demonstrated in Table 4.

The group with TMD indicated a significantly higher frequency of participants with effort of the lips and tongue interposition during deglutition. In relation to the masticatory pattern being unilateral or bilateral, groups showed no differences.

### Table 1. Demographic variables of the groups with and without temporomandibular disorder

<table>
<thead>
<tr>
<th>Variables</th>
<th>TMD (n=34)</th>
<th>No TMD (n=36)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.38±4.00</td>
<td>23.77±3.47</td>
<td>0.50</td>
</tr>
<tr>
<td>BMI (Kg/cm²)</td>
<td>22.20±3.37</td>
<td>22.61±4.38</td>
<td>0.66</td>
</tr>
</tbody>
</table>

*Significance level (Student’s t-test)

### Table 2. Intraexaminer reliability of cephalometric variables

<table>
<thead>
<tr>
<th>Angles</th>
<th>ICC</th>
<th>Confidence interval</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSL/ML</td>
<td>0.918</td>
<td>0.797–0.967</td>
<td>0.00*</td>
</tr>
<tr>
<td>Hy/C3</td>
<td>0.994</td>
<td>0.984–0.997</td>
<td>0.00*</td>
</tr>
<tr>
<td>Hy/ML</td>
<td>0.990</td>
<td>0.976–0.996</td>
<td>0.00*</td>
</tr>
<tr>
<td>Hy/Me</td>
<td>0.990</td>
<td>0.975–0.996</td>
<td>0.00*</td>
</tr>
</tbody>
</table>

*Statistically significant - p<0.01; (Student’s t test); n=20

### Table 3. Variables concerning the position of the mandible and the hyoid bone in individuals with and without temporomandibular disorder

<table>
<thead>
<tr>
<th>Variables</th>
<th>TMD (n=34)</th>
<th>No TMD (n=36)</th>
<th>p-value</th>
<th>d</th>
<th>Statistical power (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSL/ML</td>
<td>32.41±7.02</td>
<td>31.02±5.80</td>
<td>0.37</td>
<td>0.21</td>
<td>21</td>
</tr>
<tr>
<td>Hy/C3</td>
<td>40.29±5.43</td>
<td>42.13±5.51</td>
<td>0.13</td>
<td>0.34</td>
<td>40</td>
</tr>
<tr>
<td>Hy/Me</td>
<td>55.08±10.82</td>
<td>57.86±7.88</td>
<td>0.22</td>
<td>0.24</td>
<td>25</td>
</tr>
<tr>
<td>Hy/ML</td>
<td>16.70±6.01</td>
<td>12.77±5.48</td>
<td>0.00*</td>
<td>0.70</td>
<td>89</td>
</tr>
</tbody>
</table>

### Table 4. Orofacial myofunctional evaluation of deglutition and mastication functions in individuals with and without temporomandibular disorder

<table>
<thead>
<tr>
<th>No TMD (n=34)</th>
<th>With TMD (n=36)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Lip occlusion during deglution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>30</td>
<td>83.33</td>
</tr>
<tr>
<td>With effort</td>
<td>6</td>
<td>16.67</td>
</tr>
<tr>
<td>Tongue posture during deglutution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>35</td>
<td>97.22</td>
</tr>
<tr>
<td>Interposed</td>
<td>1</td>
<td>2.78</td>
</tr>
<tr>
<td>Head movement in deglutution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>33</td>
<td>91.67</td>
</tr>
<tr>
<td>Present</td>
<td>3</td>
<td>8.33</td>
</tr>
<tr>
<td>Tension of facial muscles during deglutution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>29</td>
<td>80.56</td>
</tr>
<tr>
<td>Present</td>
<td>7</td>
<td>19.44</td>
</tr>
<tr>
<td>Masticatory pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alterned bilateral</td>
<td>17</td>
<td>47.28</td>
</tr>
<tr>
<td>Unilateral</td>
<td>19</td>
<td>52.78</td>
</tr>
<tr>
<td>Unilateral chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td>18</td>
<td>94.74</td>
</tr>
<tr>
<td>Absent</td>
<td>1</td>
<td>5.26</td>
</tr>
<tr>
<td>Movement of the head during mastication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>1</td>
<td>2.78</td>
</tr>
<tr>
<td>Altered posture of the head during mastication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>34</td>
<td>94.44</td>
</tr>
<tr>
<td>Present</td>
<td>2</td>
<td>5.56</td>
</tr>
</tbody>
</table>

*Test for the difference between two population proportions - p<0.05

**Caption:** TMD = temporomandibular disorder; f = frequency
However, when the pattern was unilateral, the chronic form was more frequent in the group with TMD.

**DISCUSSION**

From the cephalometric analysis, it was observed that the position of the hyoid bone in women with TMD is lower than in those of the CG. The literature confirms the existence of changes in the vertical position of the hyoid bone at the presence of this disorder, once 50% of the participants had it placed lower in relation to the normality pattern, while in the CG this percentage was 23%\(^\text{[17]}\). At the same time, when the distance from the hyoid bone to the mandibular plane was verified in two groups of health young women\(^\text{[13,18]}\), it was observed that mean values were similar to those observed for the CG in this study.

On the other hand, recent studies which also confirmed the vertical position of the hyoid bone in participants with and without TMD did not find any differences between them\(^\text{[19,20]}\).

It is suggested that the tension of the masticatory muscles, usually observed in individuals with TMD, may have compromised the length-tension ratio of supra and infrahyoid muscles, thus changing the vertical position of the hyoid bone.

A greater distance between this hyoid bone and the mandible was also observed in children who presented with atypical deglutition\(^\text{[21]}\). According to the authors, among the anatomical changes related to the atypical events observed during deglutition, the position of the hyoid bone stands out because it is the structure that inserts many muscles involved in this function, especially those related to the tongue.

In this study, it was observed that the group with TMD presented interposition of the tongue between the dental arches during deglutition. It is believed that the altered position of the hyoid bone may have collaborated for that, once the inferior placement of this structure may lead to posterior-inferior tongue traction, thus compromising its performance during\(^\text{[18]}\).

Thinking otherwise, it is possible to infer that the atypical behavior of the tongue, previously reported as a compensatory mechanism caused by the pain experimented by individuals with TMD\(^\text{[1,22]}\), makes hyoid to be replaced in order to keep the integrity of the function.

Facing these considerations, it is suggested that future studies be conducted to investigate the cause-effect relationship between the increased vertical distance of the hyoid bone and the atypical tongue behaviors during deglutition.

Also at the time of deglutition, it was observed that the group with TMD presented effort in the lips more frequently, which corroborates with the findings in another study\(^\text{[21]}\). This atypical behavior can be a result of the need to avoid pain resulting from dental intercuspation, which stabilizes the mandible before the tongue pushes the bolus into the pharynx\(^\text{[20]}\).

It is known that myogenic facial pain can affect the action of masticatory muscles\(^\text{[25]}\) and, consequently, the stomatognathic functions\(^\text{[4]}\). This fact was previously observed, once individuals with TMD presented less muscle contraction strength in intercuspation\(^\text{[4]}\), which was justified by pain of myogenic origin\(^\text{[26,27]}\). Also, people with TMD present hyperalgesia due to flaws in the system that processes pain, which is more vulnerable in female individuals\(^\text{[5]}\).

Therefore, considering that most of the participants in this study presented with myogenic pain, and since they were exclusively represented by women, it is suggested that the atypical behavior of lips and tongue be partly a result of painful stimulus.

Besides the pain, it is suggested that the exaggerated participation of perioral muscles in these individuals is used to oppose to the strength of tongue interposition, whose goal is to prevent food from escaping the oral cavity during deglutition.

At the time of chewing, individuals with TMD more frequently presented the chronic unilateral pattern, as previously reported in other studies\(^\text{[3,6,7]}\), being referred as an atypical pattern\(^\text{[9]}\).

Alterations in the masticatory muscle function at the presence of TMD have been demonstrated in electromyographic studies. The asymmetric electrical activity of the masseter and the right and left anterior temporalis muscles during the maximum voluntary contraction in clenching\(^\text{[28]}\) was observed. This muscle imbalance was also correlated with the severity of TMD\(^\text{[29]}\). Therefore, changes in masticatory muscle recruitment can be seen, among other things, as a compensatory mechanism to relieve the algic symptoms.

In this study, the act of chewing assuming a chronic unilateral pattern in individuals with TMD may be due to the presence of pain and/or joint compromise observed in this group. Besides, it is also suggested to be a reflex of an asymmetric activity between pairs of masticatory muscles.

The repercussion of TMD on eating functions in a young age group justifies the importance of diagnosis and early therapeutic intervention in these individuals. It is worth to mention that, in the group with TMD, none of the participants knew about the work of the physical therapist and the speech language pathologist to treat for TMD and to readapt eating functions, respectively. Finally, the results in this study reinforce the need for the professionals to consider the possibility of TMD being related to atypical behaviors observed during eating functions.

**CONCLUSION**

The presence of TMD resulted in the higher frequency of orofacial myofunctional alterations during the functions of mastication and deglutition. It was observed that individuals with TMD presented effort of the lips and tongue interposition during deglutition more frequently.

A greater distance from the hyoid bone to the mandible was also observed in the group with TMD, which can explain the atypical behavior of the tongue during deglutition.

The chronic unilateral pattern, qualified as an atypical masticatory pattern, was more frequently observed in the group with TMD, and it may be attributed to the influence of painful symptomatology.
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