

# Measurement of Mandibular Movements in Patients with Temporomandibular Disorders and in Asymptomatic Subjects

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## ABSTRACT

*The aim of the study was to investigate the range of mandibular movements and to analyze the difference in range of mouth opening, right and left lateral movements, and protrusive movement between patients with clinical diagnoses of temporomandibular disorders and asymptomatic subjects (control group) in a young male population. A total of 240 subjects, aged 19–28, were included in the study. The TMD sample comprised 180 patients (60 patients with muscle disorders; 60 patients with disc displacement with reduction; and 60 patients with muscle disorders and disc displacement with reduction) and was compared with 60 healthy control subjects. All participants were evaluated by the attending dentists at baseline by means of a physical examination of the masticatory system and a history questionnaire which included the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I measures. Analysis of variance (ANOVA) with the post hoc Bonferroni criteria showed significant difference in ranges of mandibular movements between and within the groups of asymptomatic subjects and TMD patients for active mouth opening ( $p = 0.001$ ), right lateral movement ( $p = 0.002$ ), left lateral movement ( $p = 0.006$ ), and protrusive movement ( $p = 0.05$ ). It has been found that there are statistically significant differences in the range of mandibular movements that separate asymptomatic subjects and patients with muscle disorders and disc displacements with reduction in this young male population. However, we cannot conclude that measurements of active mandibular movements can discriminate one group (TMD patients) from the other (asymptomatic subjects), because the mean ranges of these active movements between the groups were measured in clinically »normal« values.*

**Key Words:** measurement, mandibular movements, temporomandibular disorders

## Introduction

Temporomandibular disorders (TMD) are a cluster of medical and dental conditions affecting the temporomandibular joints, masticatory muscles and surrounding tissues. They encompass a wide range of conditions that may include as facial pain, jaw joint pain, headaches, earaches, dizziness, masticatory musculature hypertrophy, limited mouth opening, closed or open lock on the temporomandibular joint, abnormal occlusal wear, and clicking or popping sounds in the jaw joint. Individuals often display with TMJ clicking or popping and, consequently, may have limited mouth opening and decreased functional capacity. Temporomandibular disorders are often characterized as chronic, recurrent, nonprogressive pain conditions. Mandibular movements were analyzed extensively in the past for prosthodontics reasons, and more recently also for studying the function of the masticatory system. Impairment of mandibular movement is a common sign in patients with temporomandibular disorders (TMD)<sup>1–4</sup>.

In order to define the diagnostic group of patients with TMD, measurement and recording of active mandibular movements should be completed for opening, lateral and protrusive movements. The quality and symmetry of jaw movement should be noted and diagrammed. It is also recognized that restricted mandibular movements are caused by either extracapsular or intracapsular factors<sup>5</sup>. Some studies have pointed to significant differences in mandibular movement between asymptomatic subjects and patients with TMD<sup>6–9</sup>. On the other hand, a correlation between the extent of active mandibular movement and overall joint mobility was either nonexistent<sup>10</sup> or was present only weakly in isolated cases<sup>11,12</sup>. Studies<sup>13,14</sup> examining the reliability of mandibular movements have indicated

good to excellent agreement between calibrated examiners for mandibular movement measurements and for patients with TMD.

The aim of the study was to investigate the range of mandibular movements (mouth opening, right and left lateral movement, and protrusive movement) in young male population with TMD in comparison with healthy subjects and to examine whether the differences between the range of mandibular movements in TMD patients and asymptomatic subjects can contribute to differential diagnosis between these groups.

## Materials and Methods

A total of 240 subjects have participated in the present study: 180 TMD patients (60 patients with muscle disorders; 60 patients with disc displacement with reduction; and 60 patients with muscle disorders and disc displacement with reduction) and 60 healthy control subjects. Study participants were selected from patients referred for treatment to the Department of Prosthodontics, School of Dental Medicine, University of Zagreb, Croatia. All subjects were men in the age group from 19 to 28 years. Subjects in the control group (average age  $X \pm SD$  21.4  $\pm$  2.3) were group-matched with subjects in the TMD group (average age  $X \pm SD$  21.3  $\pm$  2.1) to achieve a similar age distribution. The individuals in the control group were randomly selected from the same community sample of young male adults as the TMD group.

Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) uses a dual axis system for diagnosing and classifying TMD patients<sup>15</sup>. Axis I assigns physical diagnoses of the most commonly occurring masticatory muscles and/or temporomandibular joint disorders. According to these criteria, the patients of the study were divided into three

groups: muscle disorder (MD), disc displacement with reduction (DDR), and disc displacement with reduction associated with muscle disorder (DDR + MD). Muscle disorder is characterized by the myofascial masticatory pain at rest, during mandibular function or in response to palpation of masticatory muscle sites and by the limited mandibular movements. Disc displacement with reduction is characterized by the reciprocal click in temporomandibular joint during mandibular range of motion (click on both vertical opening and closing at a point at least 5 mm greater interincisal distance on opening than on closing and is eliminated on protrusive opening) and by the click in temporomandibular joint during lateral and protrusive excursion.

#### *Measurement of mandibular movements*

The measurements of mandibular movements were registered according to the following criteria:

1. *Measurement of mouth opening* – millimeter ruler was placed at the incisal edge of the maxillary central incisor that is the most vertically oriented and measured vertically to the labioincisal edge of the opposing mandibular incisor. The amount of vertical incisor overlap was added to each of these measurements to determine the actual amount of opening.

2. *Measurement of lateral movements* – subject opened slightly (physiological rest position) and moved the mandible as far as possible toward the right or left. It was measured by means of the millimeter ruler from the labioincisal embrasure between the maxillary central incisors to the labioincisal embrasure of the mandibular incisors.

3. *Measurement of protrusive movement* – initial position was the physiological rest position from which the subject moved the mandible anterior without tooth contact. The distance from the incisal edge of maxillary central incisor to

the incisal edge of mandibular central incisor was measured in the position. The horizontal overlap is also measured and then added to the distance between the upper labial surface and the lower incisal edge.<sup>4,15</sup>

#### *Statistical methods*

Descriptive statistics (arithmetic means, standard deviation, and standard error, minimum and maximum values) were used for analyzing the range of mandibular movements. Analysis of variance (ANOVA) with Bonferroni criteria was used to test the difference in the range of mandibular movements between and within control subjects and patients with muscle and temporomandibular joint disorders (disc displacement with reduction). Statistical significance was set at  $p < 0.05$ . In order to test interobserver reliability, two calibrated operators three times examined 10 randomly selected adult patients at the Department of Prosthodontics, School of Dentistry, University of Zagreb. All nominal variables in the interobserver examination indicated substantial to almost perfect agreement between them, as assessed by Kappa coefficient (0.71 to 0.89)<sup>16,17</sup>.

#### **Results**

The mean mouth opening was greater for the asymptomatic subjects than for the TMD patients (Table 1). The mean of the lateral movements was 10 mm in the control groups and 8 to 9 mm in the patients groups (Table 2). The mean of protrusive movement in the healthy subjects was 7.9 mm, and 6.7 to 7.2 mm in the patients groups (Table 3).

ANOVA showed statistically significant differences between the group of asymptomatic subjects and the patient groups with muscle and temporomandibular joint disorders for active mouth opening ( $p = 0.001$ ), right lateral move-

**TABLE 1**  
RANGE OF THE MOUTH OPENING IN THE FOUR DIAGNOSTIC GROUPS

		N	X	SD	Min	Max
Mouth opening	0	60	50.8	5.0	40	63
	1	60	48.4	5.1	36	58
	2	60	48.4	4.9	35	57
	3	60	47.0	5.1	35	57
Total		240	48.6	5.1	35	63

0 – no diagnosis; 1 – muscle disorder (MD); 2 – disc displacement with reduction (DDR); 3 – muscle disorder (MD) and disc displacement with reduction (DDR)

**TABLE 2**  
RANGE OF THE LATERAL MOVEMENTS IN THE FOUR DIAGNOSTIC GROUPS

		N	X	SD	Min	Max
Right lateral movement	0	60	10.0	2.8	4	15
	1	60	9.0	2.8	2	13
	2	60	9.0	2.7	2	14
	3	60	8.0	2.7	2	13
Total		240	9.0	2.8	2	15
Left lateral movement	0	60	10.1	3.0	3	15
	1	60	9.1	2.9	2	13
	2	60	8.9	3.1	2	14
	3	60	8.2	2.7	2	13
Total		240	9.0	3.0	2	15

0 – no diagnosis; 1 – muscle disorder (MD); 2 – disc displacement with reduction (DDR); 3 – muscle disorder (MD) and disc displacement with reduction (DDR)

**TABLE 3**  
RANGE OF THE PROTRUSIVE MOVEMENTS IN THE FOUR DIAGNOSTIC GROUPS

		N	X	SD	Min	Max
Protrusive movement	0	60	7.9	2.5	3	13
	1	60	7.2	2.4	2	12
	2	60	7.0	2.8	2	11
	3	60	6.7	2.4	2	11
Total		240	7.2	2.4	2	13

0 – no diagnosis; 1 – muscle disorder (MD); 2 – disc displacement with reduction (DDR); 3 – muscle disorder (MD) and disc displacement with reduction (DDR)

ment ( $p = 0.002$ ), left lateral movement ( $p = 0.006$ ), and protrusive movement ( $p = 0.05$ ) (Table 4). Within these groups the Bonferroni criteria demonstrated significant differences only between asymptomatic and TMD patient groups (MD + DDR) for all mandibular movements ( $p < 0.05$ ).

## Discussion

Clinical studies in the scientific literature mostly evaluated the range of maximum mouth opening and possible association with TMD. While there is little disagreement on the definition of a physi-

**TABLE 4**  
ANALYSIS OF VARIANCE (ANOVA) OF MEAN RANGES OF THE MANDIBULAR MOVEMENTS  
BETWEEN GROUPS OF ASYMPTOMATIC SUBJECTS AND TMD PATIENTS

	Degree of freedom	F – distribution	p
Range of mouth opening	3	5.7	0.001
Range of the right lateral movement	3	5.3	0.002
Range of the left lateral movement	3	4.3	0.006
Range of the protrusive movement	3	2.6	0.05

ological mouth opening, views vary on what constitutes a limitation of mouth opening, because only 15% adults and elderly people have a mouth opening of less than 40 mm<sup>4,18</sup>. Regardless of the »scientific boundary« (40–42 mm) a limitation of mouth opening always exists when a patient's mandibular mobility is objectively found to be lesser than it was at a previous examination and one should always consider the patient's age and body size.<sup>5,19,20</sup> The mean of »normal« mouth opening averages 53–58 mm<sup>19,20</sup>. In this study the »normal« mean of the mouth opening was 50.8 mm in the control group and 47 to 48.4 mm in the TMD patients groups which could also be considered clinically normal<sup>21,22</sup>. However, several studies<sup>8,14,23–25</sup> have suggested significant differences in mouth opening between asymptomatic groups and groups with TMD. The findings of this study have also demonstrated statistically significant differences between TMD patients and healthy controls at measurement of maximum mouth opening ( $p = 0.001$ ).

Lateral movements of less than 8 mm are generally classified as restricted<sup>15,19</sup>. The study gave an average value of 10.0 mm for the lateral movements in the control group and 8 to 9 mm in the patients' groups. These result are in accordance with studies where the mean lateral movements are ranged from 8.7 to 11.1 mm for the lateral movements<sup>6,19,26,27</sup>. Protrusive movements are neglected in literature and in clinics even more than lateral movements. The reports range

from 8.8 to 9.5 mm<sup>6,19,28,29</sup> and in our study the mean range of protrusive movements exceeded 7.9 mm in the healthy subjects and 6.7 to 7.2 mm in the patients' groups. Protrusive movements of less than 7 mm are considered to be restricted, although they are not always signs of pathology that urgently calls for treatment. Otherwise, there is no sex-related difference in the extent of lateral and protrusive movements<sup>20</sup>. Studies evaluating lateral and protrusive movements in asymptomatic and symptomatic subjects have suggested varied results. Piehslinger et al<sup>27</sup> found a difference in the mean lateral movements in male volunteers (right – 11.1 mm; left – 11.1) and male patients with temporomandibular disorders (right – 9.54 mm; left – 9.37). In two studies<sup>30,31</sup> significant differences were found in lengths and form of protrusive movements of left and right joints between asymptomatic subjects and TMD patients.

By analysis of variance (ANOVA) statistically significant differences were found in the ranges of lateral ( $p = 0.002$ ;  $p = 0.006$ ) and protrusive ( $p = 0.05$ ) mandibular movements between control subjects and patients with TMD diagnoses. The post hoc Bonferroni test showed only significant differences between asymptomatic groups and groups of patients with muscle disorders and disc displacement with reduction (MD + DDR) for all mandibular movements ( $p < 0.05$ ). In spite of these findings, we cannot make a strong conclusion in terms of clinical im-

portance since all the mean ranges of mouth opening, lateral and protrusive movements in groups of patients with muscle disorders and disc displacement with reduction were in values that cannot be considered completely clinically »limited«. A recently published study<sup>32</sup> that analyzed opening, lateral and protrusive mandibular movement data showed that these measurements could not reliably differentiate between patients with osteoarthritis, arthromyalgia, arthromyalgia with disk condyle incoordination and disk condyle incoordination only. The limitations of this study was that we did not take into account the female population and only two clinical diagnoses of TMD were tested regarding the range of mandibular movements.

Because impairment of mandibular movement is one of the signs of many TMD, it is not surprising that the quantification of mandibular movement has been considered important. Mandibular movement measurements can also be determined with electronic jaw-tracking systems; however, there are no scientific data to demonstrate that these techniques are any more useful in measuring mandibular function than a traditional millimeter ruler method. With this in mind, cost efficiency should be considered. Many of the devices have been found to be lacking in

research support, subject to great variability, or have produced no significant findings (unacceptable sensitivity and specificity levels). Thus, the use of jaw-tracking devices at this time is not recommended for the routine mandibular function measurements and for the diagnosis of temporomandibular disorders or other orofacial pains<sup>6,33–36</sup>.

## Conclusion

In conclusion, the evaluation of the mandibular patterns is recommended as a diagnostic criterion for all classifications of temporomandibular disorders. Normally, the physical examination of the masticatory muscles and temporomandibular joint involves thorough muscle palpation, palpation and auscultation for TMJ sounds, and measurement of mandibular range of motion. This assessment is typically performed by a trained examiner who uses palpation, a millimeter ruler, and a stethoscope. The results of the study have shown statistically significant differences in the range of active mandibular movements between control subjects and patients with muscle disorders and disc displacement with reduction. However, these data have no clinical importance because they are in the range of »normal« values.

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## **MJERENJE KRETNJI DONJE ČELJUSTI U BOLESNIKA S TEMPOROMANDIBULARNIM POREMEĆAJEM I U ASIMPTOMATSKIH ISPITANIKA**

### **S A Ž E T A K**

Cilj ove studije bio je istražiti veličinu kretnji donje čeljusti i analizirati razliku u veličini otvaranja usta, desnih i lijevih lateralnih kretnji i protruzijske kretnje između pacijenata s kliničkim dijagnozama temporomandibularnih poremećaja (TMD) i asimptomatskih ispitanika (kontrolna skupina) u populaciji mlađih muškaraca. Ukupno 240 ispitanika, 19–28 godina starosti bili su uključeni u studiju. Uzorak od 180 TMD pacijenata (60 pacijenata s mišićnim poremećajem; 60 pacijenata s pomakom diska s redukcijom i 60 pacijenata s mišićnim poremećajem i pomakom diska s redukcijom) bio je uspoređivan sa 60 zdravih kontrolnih ispitanika. Svi ispitanici bili su ispitivani od stomatologa na osnovu fizikalnog ispitivanja žvačnog sustava i upitnika o povijesti stanja koji su uključeni u protokol Osovine I istraživačkih dijagnostičkih kriterija za TMD (RDC/TMD). Analiza varijance (ANOVA) s post hoc Bonferroni kriterijima pokazala je značajne razlike u veličinama kretnji donje čeljusti između i unutar skupinama asimptomatskih ispitanika i TMD pacijenata za aktivno otvaranje usta ( $p = 0.001$ ), desnu lateralnu kretnju ( $p = 0.002$ ), lijevu lateralnu kretnju ( $p = 0.006$ ) i protruzijsku kretnju ( $p = 0.05$ ). Nađeno je da postoje statistički značajne razlike u veličini kretnji donje čeljusti koja odvaja asimptomatske ispitanike od pacijenata s mišićnim poremećajima i pomacima diska s redukcijom u ovoj populaciji mlađih muškaraca. Ipak, ne možemo zaključiti da mjerenja aktivnih kretnji donje čeljusti mogu razdvojiti jednu skupinu (TMD pacijenti) od druge (asimptomatski ispitanici) budući da su prosječne veličine ovih aktivnih kretnji između skupina bile izmjerene u klinički »normalnim« vrijednostima.