

## TMD in Consecutive Patients Referred for Orthognathic Surgery

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### ABSTRACT

**Objective:** To answer the question whether temporomandibular disorders (TMD) were more common in a group of individuals referred for orthognathic surgery than in a control group. The null hypothesis was that neither the frequency of signs and symptoms of TMD or diagnosed TMD would differ between the patient group and a control group.

**Materials and Methods:** A sample of 121 consecutive patients referred for orthognathic surgery at the Department of Oral Maxillofacial Surgery, Malmö University Hospital, Sweden, was interviewed and examined regarding signs and symptoms of TMD and headaches. A control group was formed by 56 age- and gender-matched individuals attending the Department of Oral Diagnosis, Faculty of Odontology, Malmö University, Sweden, and Public Dental Health Clinic in Oxie, County of Skane, Sweden. TMD diagnoses were used according to Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).

**Results:** The patient group showed more myofascial pain without limited opening, disc displacement with reduction, and arthralgia according to RDC/TMD than the control group. The patient group also had more symptoms and signs of TMD in general.

**Conclusions:** The null hypothesis was rejected because patients who were to be treated with orthognathic surgery had more signs and symptoms of TMD and higher frequency of diagnosed TMD compared with the matched control group. (*Angle Orthod.* 2009;79:621–627.)

**KEY WORDS:** Temporomandibular disorders; Orthognathic surgery; Controlled study; Malocclusion

### INTRODUCTION

An increased prevalence of temporomandibular disorders (TMD) from adolescence to adulthood has been reported in longitudinal studies, which also have

shown a fluctuation of signs and symptoms of TMD over time, with both improvement and impairment on an individual basis.<sup>1–3</sup> The most common subtypes of TMD are myofascial pain, disc displacements with reduction, and arthralgia.<sup>4–6</sup>

Factors that have shown associations with TMD are indirect or direct trauma to the masticatory system, anatomic, pathophysiologic, and psychosocial factors.<sup>7–9</sup> The importance of the occlusion and its role in causing the onset or perpetuation of TMD, compared with other factors, has been studied and is still debated.<sup>8,10–12</sup> Subjects with malocclusions have been suggested to have a significantly higher prevalence of signs and symptoms of TMD than others. These malocclusions include Angle Class II, anterior open bite, deep bite, posterior crossbite, and extreme maxillary overjet.<sup>10,12–16</sup> In addition, severe mandibular retrognathism and a hyperdivergent skeletal pattern have been suggested to be risk factors for TMD.<sup>14,17,18</sup>

In a recent systematic review<sup>19</sup> considering alterations of TMD before and after orthognathic surgery, heterogeneous study design and unambiguous results of the selected studies were found.

Thus, no clear picture exists whether individuals re-

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ferred for orthognathic surgery or with dentofacial deformities have higher prevalence of TMD than normal individuals.

The aim of this study was to investigate whether TMD was more common in a group of individuals referred for orthognathic surgery than in a control group. The null hypothesis was that neither frequency of signs and symptoms of TMD or diagnosed TMD according to Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) would differ between the patient and control group.

## MATERIALS AND METHODS

### Subjects

A sample of 121 consecutive patients, mean age  $22.5 \pm 7.4$  years, 70 females and 51 males, with dentofacial deformities was included. All patients were referred to the Department of Oral Maxillofacial Surgery, Malmö University Hospital, Malmö, Sweden, between 1992 and 2002 for orthodontic treatment in combination with orthognathic surgery.

A control group of 56 individuals, mean age  $23.4 \pm 7.4$  years, 33 females and 23 males, were recruited to match the patients in the treatment group, considering age and gender. These individuals were regular patients, with or without minor malocclusion traits that were not needed to be corrected with either orthodontic therapy or orthognathic surgery, attending the Department of Oral Diagnostics, Faculty of Odontology, Malmö University, Sweden, and Public Dental Health Clinic in Oxie, County Skane, Sweden.

The exclusion criteria for the 2 groups were craniofacial syndromes, systemic arthritic and muscle diseases, and a dentition of fewer than 24 teeth.

The study was approved by the Ethics Committee of Lund University, Sweden (Ref No LU-241-01).

### Questionnaire and Clinical Examination

All individuals in the patient group and control group were assessed for signs and symptoms of TMD by means of a questionnaire and clinical examination.

In the questionnaire, the individuals reported reasons for seeking treatment (impaired chewing capacity/symptoms from the masticatory muscles, temporomandibular joints [TMJs], and headaches/esthetic reasons), the state of general health, use of painkillers for headache and TMD (yes/no), as well as awareness of oral parafunctions as tooth grinding (yes/no), or tooth clenching (yes/no). Frequency of TMD pain, tiredness of the jaws, TMJ clicking, and headache (never/once or twice a month/once a week/once or twice a week/daily) was registered as well as pain at rest (yes/no) and during mandibular movements (yes/no) and reported TMJ clicking

**Table 1.** Clinical Examination and Registration of Temporomandibular Disorders and Related Muscles

Measurement of mandibular mobility in millimeters
Maximum opening capacity without assistance
Maximum laterotrusion, left/right
Maximum protrusion
Maximum retrusion
Pain on movement of the mandible
Mandibular deviation $\geq 2$ mm on opening
Temporomandibular joint (TMJ) clicking and crepitations registered by palpation and auscultation during opening and closing of the mandible
Tenderness on palpation of the TMJs; laterally and posteriorly and masticatory musculature; the origin and the insertion of the temporal muscles, the superficial and deep portion of the masseter muscles, and the insertion of the medial pterygoid muscle

(yes/no). The questionnaire also included questions about the severity of TMD discomfort on a visual analogue scale (VAS)<sup>20</sup> with the endpoints *none* and *severe* and a verbal scale as follows: 0 = *no or minimal discomfort*, 1 = *slight discomfort*, 2 = *moderate discomfort*, 3 = *severe discomfort*, 4 = *very severe discomfort*. Furthermore, the individuals rated themselves on the VAS regarding their level of anxiousness with the endpoints *calm* and *nervous/anxious*.

Before the orthognathic treatment was started, the clinical examination was performed at the Department of Stomatognathic Physiology at Malmö University, by either one of two calibrated<sup>21</sup> specialists. The examination included measurement of mandibular movements, pain during nonguided mandibular movements, registration of TMJ sounds, and tenderness of the TMJs and related muscles (Table 1). The reliability of the methods used for clinical registrations was improved by calibrating the examination technique between two examiners. Thus, before the study, eight subjects not included in the study were examined.<sup>21</sup> Furthermore, the specialists conducting the examinations were not informed of the group to which the individual belonged, and the extraoral examination was performed before the intraoral one.

Subdiagnoses of TMD were used according to RDC/TMD.<sup>4</sup> The diagnoses are divided into three groups:

1. Muscle disorders: (a) myofascial pain, (b) myofascial pain with limited opening
2. Disc displacements: (a) disc displacement with reduction; (b) disc displacement without reduction, with limited opening; (c) disc displacement without reduction, without limited opening
3. Arthralgia, arthritis, arthrosis: (a) arthralgia, (b) osteoarthritis of the TMJ, (c) osteoarthritis of the TMJ

The functional occlusion was assessed by methods previously described and investigated for observer error.<sup>22,23</sup> Nonworking side interferences within a lateral

excursion of 3 mm, working side interferences, protrusion interferences, and the distance and the direction of the slide between retruded contact position (RCP) and the intercusp contact position (ICP) were registered.

In both groups morphologic occlusion according to Björk et al<sup>24</sup> was registered by intraoral examination. The patient group was further analyzed by dental study casts, lateral cephalograms, and a cephalometric analysis.<sup>25</sup> A hyperdivergent facial profile was classified as an NSL/ML angle of  $\geq 40^\circ$  and a hypodivergent facial profile as an NSL/ML angle of  $\leq 26^\circ$ . A Class II skeletal relationship between the dental arches was classified as an ANB angle of  $\geq 6^\circ$  and a Class III skeletal relationship as an ANB angle of  $\leq 0^\circ$ .

### Statistical Methods

**Power for test of the null hypothesis.** One goal of the proposed study was to test the null hypothesis that the proportion positive was identical in the two populations. The criterion for significance (alpha) was set at .05. The test was 2-tailed, which means that an effect in either direction was interpreted.

With the proposed sample size of 35 in each subgroup, the study had a power of 89.8% to yield a statistically significant result. This computation assumed that the difference in proportions was  $-0.30$  (specifically,  $0.05$  vs  $0.35$ ) in prevalence of TMD pain. This effect was selected as the smallest effect that would be important to detect, in the sense that any smaller effect would not be of clinical or substantive significance.

**Differences between groups and precision to estimate the effect size.** Pearson's chi-square test with Yate's correction for continuity was used when  $2 \times 2$  cross-tabulations were applicable. When the expected cell value in a  $2 \times 2$  table was less than 5, Fisher's exact test was used. To compute the difference between ranks and groups with ordinal data, the Mann-Whitney rank sum test was used.

A second goal of this study was to estimate the difference between the two groups. Based on these same parameters and assumptions, the study enabled us to report the difference in proportions with a precision (95% confidence level) of approximately  $\pm 0.17$  points. Specifically, an observed difference of  $-0.30$  would be reported with a 95% confidence interval of  $-0.47$  to  $-0.13$ .

When comparing means in numerical variables, the two-sample *t*-statistic was used. Median value and percentiles (Q) were calculated when estimating reported anxiety on the VAS. All statistic procedures were performed with statistical software SPSS 13.0 for Windows (SPSS Inc, Chicago, IL).

## RESULTS

### Anamnestic Findings

Twenty-one percent in the patient group and 2% in the control group used painkillers for headache and/or TMD pain ( $P < .001$ ). The self-rated level of anxiousness on the VAS was similar in the two groups, with a median of 19.5 ( $Q_1 = 7$ ,  $Q_3 = 47$ ) and 19.0 ( $Q_1 = 6$ ,  $Q_3 = 43$ ). There were no differences between the groups concerning reported weekly headaches ( $P = .373$ ) or awareness of parafunctional habits such as tooth clenching ( $P = .665$ ) and tooth grinding ( $P = .080$ ). When the patients registered their reasons for seeking treatment, 75% answered impaired chewing capacity and 72% symptoms from masticatory muscles, TMJs, and headaches. Sixty-six percent reported esthetic reasons.

### Symptoms of TMD

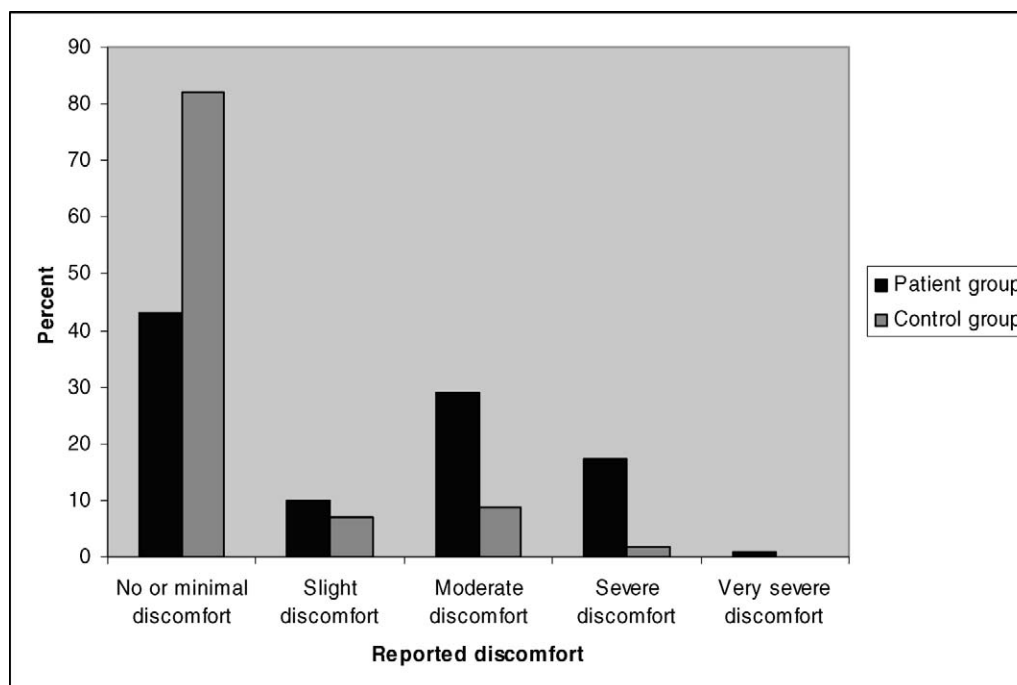
The patient group reported more subjective TMD discomfort on a verbal scale ( $P < .001$ ) than did the control group (Figure 1). Also, pain in the TMJs and/or masticatory muscles during rest, wide opening, and chewing were significantly more commonly reported in the patient group than in the control group, as well as weekly TMD pain, weekly jaw tiredness, and weekly joint clicking (Table 2).

### Clinical Findings

**Signs of TMD.** There were statistically significant differences between the patient group and the control group with regard to pain on palpation of the TMJs and related muscles, deviation during opening and/or closing of the mandible, and TMJ clicking (Table 3). However, no differences were found in registered reciprocal clicking or crepitations. During maximum opening, laterotrusion, and protrusion, the individuals in the control group had significantly larger mandibular movement capacity than the patient group did (Table 4).

**Occlusal interferences.** A sagittal and vertical distance of  $\geq 1$  mm between RCP and ICP was significantly more common in the patient group than in the control group. Significantly more individuals in the patient group had interferences in laterotrusion, mediotrusion, and protrusion compared with the control group (Table 5).

**TMD diagnoses according to RDC/TMD.** The patient group had a significantly higher frequency of myofascial pain, disc displacement with reduction, and arthralgia compared with the control group (Table 6). The frequency of myofascial pain with limited opening, osteoarthritis, and osteoarthrosis was low, and no differences could be found between the two groups.



**Figure 1.** Reported temporomandibular disorder discomfort on a verbal scale.

*Subgrouping into different malocclusion traits.* The distribution of malocclusion traits is shown in Table 7. No certain malocclusion trait could be associated with symptoms of TMD or headache. No differences in the frequency of diagnosed RDC/TMD could be seen between different malocclusion traits.

## DISCUSSION

The null hypothesis was rejected because patients who were to be treated with orthognathic surgery had more signs and symptoms of TMD and a higher frequency of diagnosed TMD compared with the matched control group.

Previous studies assessing the frequency of TMD in patients with dentofacial deformities have been heterogeneous in study design and have shown ambig-

uous results.<sup>13,14,17–19,26,27</sup> However, neither of these studies used RDC/TMD as a diagnostic tool.

It is well known that signs and symptoms of TMD are common in a healthy population and do not have to be an indication of disease. Therefore, the use of the RDC/TMD is important since it allows standardization and replication of the most common forms of muscle- and joint-related TMD.<sup>4</sup> The RDC/TMD demonstrates sufficiently high reliability for the most common TMD diagnoses,<sup>6</sup> supporting its use in clinical research as well as in decision making. In the present study, all individuals were diagnosed according to RDC/TMD, and the patient group had a significantly higher frequency of myofascial pain, disc displacement with reduction, and arthralgia than the control group.

**Table 2.** Percentage Distribution of Self-reported TMD Symptoms in the Patient Group (n = 121) and the Control Group (n = 56)<sup>a</sup>

Symptoms of TMD	Patient Group	Control Group	P Value
TMJs/muscles, pain at			
Rest	18	2	.003
Wide opening	34	11	.006
Chewing	50	11	.000
Rest, wide opening, and/or chewing	57	16	.000
Weekly TMD pain	38	5	.000
Weekly jaw tiredness	64	9	.000
Weekly TMJ clicking	47	8	.002

<sup>a</sup> TMD indicates temporomandibular disorder; TMJ, temporomandibular joint.

**Table 3.** Percentage Distribution of Clinical Signs of TMD in the Patient Group (n = 121) and the Control Group (n = 56)

Signs of TMD	Patient Group	Control Group	P Value
Pain on palpation			
Muscle pain on palpation $\geq$ three sites	31	5	.000
TMJ pain on lateral and/or posterior palpation	21	5	.009
TMJ sounds			
Clicking during opening and/or closing	31	14	.021
Reciprocal clicking	19	11	.166
Crepitations	4	2	.422
Deviation on opening/closing of the mandible $\geq$ 2 mm	41	13	.000

<sup>a</sup> TMD indicates temporomandibular disorder; TMJ, temporomandibular joint.



**Table 4.** Mandibular Movement Capacity (in mm) in the Patient Group (n = 121) Compared with the Control Group (n = 56)

Maximum Mandibular Movements	Patient Group		Control Group		95% CI	P Value
	Mean	SD	Mean	SD		
Maximum opening capacity	49.8	8.0	54.3	6.1	2.1–6.8	.000
Maximum laterotrusion, left	8.0	2.6	9.7	2.0	1.0–2.5	.000
Maximum laterotrusion, right	8.2	2.6	9.7	2.1	0.8–2.3	.000
Maximum protrusion	8.1	3.1	9.9	1.9	0.9–2.7	.000

These TMD diagnoses were also the most prevalent in this material, as in the study by John et al.<sup>6</sup>

Because it is well known that signs and symptoms of TMD fluctuate over time<sup>3</sup> and because symptom frequencies appear to be age dependent,<sup>28</sup> it is important to include an age- and gender-matched nonpatient control group as a comparison when evaluating the frequency of TMD. In evidence-based research, usually a randomized controlled trial methodology is recommended. However, in this kind of clinical trial, it is often not possible for ethical or practical reasons to randomize and enroll subjects or patients into a treatment or a nontreatment group. Thus, the control group deliberately consisted of individuals with or without minor malocclusion traits. No limitations were done considering previous orthodontic treatment.

In this study, it was found that the patient group had more occlusal interferences than the control group did. In a recent review by Luther,<sup>29</sup> it was concluded that neither static nor dynamic factors can be said to cause TMD, and this current study has not proven otherwise. However, it is interesting to assess whether occlusal interferences are altered by orthognathic surgery. Such a study has been commenced and will be presented later.

The clinical registration of signs of TMD, mandibular function, and functional occlusal interferences was performed by standardized methods, and the reliability of these methods has been evaluated and found to be acceptable.<sup>4,30,31</sup> In addition, it was decided to perform the orthognathic surgery and the clinical TMD exami-

nations separately to ensure the objectiveness of the clinical TMD examination. Furthermore, the reliability of the methods used for clinical registrations was improved by calibrating the examination technique between the two examiners. Thus, before the study, eight subjects not included in the study were examined. In addition, the specialists were not informed which group their patients belonged to, and, moreover, the extraoral examination was carried out before the intraoral examination in an attempt of blinding.

Two studies<sup>32,33</sup> have reported that patients declared an esthetic motive to be the main reason for seeking orthognathic surgery treatment. This was not confirmed in this study. Instead, functional motives were the most frequent, albeit not significantly higher than esthetic reasons. In fact, many of the patients reported more than one motive for seeking treatment. It can be pointed out that many other factors, such as social and psychological concerns, cultural values, cost of treat-

**Table 6.** Percentage Distribution of Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Diagnoses in the Patient Group (n = 121) and Control Group (n = 56)

RDC/TMD Diagnosis	Patient Group	Control Group	P Value
Myofascial pain	30	4	.000
Myofascial pain with limited opening	1	0	.493
Disc displacement with reduction	19	5	.017
Arthralgia	21	5	.007
Osteoarthritis	3	0	.235
Osteoarthritis	0	2	.140
At least one diagnosis (RDC/TMD)	51	18	.000
Having two or more diagnoses (RDC/TMD)	19	2	.002

**Table 5.** Percentage Distribution of Occlusal Interferences in the Patient Group (n = 121) and the Control Group (n = 56)

Occlusal Interferences	Patient Group	Control Group	P Value
Sagittal distance between RCP and ICP $\geq 1.0$ mm	41	18	.002
Vertical distance between RCP and ICP $\geq 1.0$ mm	39	16	.002
Lateral deviation between RCP and ICP $\geq 0.5$ mm	23	20	.602
Laterotrusion interferences	27	9	.006
Mediotrusion interferences	80	18	.000
Protrusion interferences	80	23	.000

<sup>a</sup> RCP indicates retruded contact position; ICP, intercuspal contact position.

**Table 7.** Percentage Distribution of Diagnosed Malocclusion Traits in the Patient Group (n = 121)

Skeletal Diagnosis	%
Mandibular prognathism	45
Mandibular retrognathism	7
Open bite in combination with:	
Orthognathic jaws	17
Mandibular prognathism	8
Mandibular retrognathism	16
Deep bite in combination with:	
Mandibular prognathism	4
Mandibular retrognathism	3

ment, recovery time, and perceived benefits, are involved and can encourage or discourage a patient to pursue surgery.<sup>32</sup>

An attempt was made to evaluate whether psychological stress could be a selection bias when comparing the frequency of TMD between the groups. However, no differences were found between the two groups when the subjects rated their level of anxiousness on the VAS. Even if the VAS is a raw tool to measure psychological distress, it can still give an indication of the level of anxiousness in a group of individuals.

In this study, it was convincingly demonstrated that consecutive patients referred for treatment with orthognathic surgery had a higher frequency of diagnoses according to RDC/TMD<sup>4</sup> before this treatment compared with an age- and gender-matched control group. However, the question still remains whether orthognathic treatment in these patients significantly relieves signs and symptoms of TMD. Such information will be presented in a further study.

## CONCLUSION

- The null hypothesis was rejected because patients who were to be treated with orthognathic surgery had more signs and symptoms of TMD and a higher frequency of diagnosed TMD according to RDC/TMD<sup>4</sup> compared with the matched control group.

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