*Original Article*

# Relationship Between Signs and Symptoms of Temporomandibular Disorders and Orthodontic Treatment: A Cross-sectional Study

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**Abstract:** The aim of this study was to evaluate the prevalence of temporomandibular disorders (TMD) in individuals before and after orthodontic treatment. The sample comprised 200 individuals divided into four groups according to the type of malocclusion (class I or II) and the orthodontic treatment accomplished. An anamnestic questionnaire, comprising questions regarding the most frequent symptoms of TMD, was used to classify the sample according to the TMD presence and severity. A clinical examination, including TMJ and muscle palpation, mandibular range of motion, and joint noise analysis was performed. Based on the anamnestic questionnaire, 34% of the sample was considered as having mild TMD, whereas 3.5% had moderate TMD. A higher TMD prevalence was found in females. Joint noises (15.5%) followed by headache (13%) constituted the most frequent reported symptoms. The presence and severity of TMD have not shown any relationship with either the type of orthodontic mechanics or extraction protocols. On the other hand, a positive association was found between TMD and parafunctional habits and reported emotional tension. Orthodontic treatment is not associated with the presence of signs and symptoms of TMD. (*Angle Orthod* 2003;73:411–417.)

**Key Words:** Orthodontic treatment; Temporomandibular disorders; Malocclusion

## INTRODUCTION

The prevalence of the signs and symptoms of temporomandibular disorders (TMD) has increased considerably in the past decades. The higher frequency of unavoidable factors like emotional stress plus the availability of accurate diagnostic tests can account for this fact.

Many theories related to the etiology of TMD have been presented in the past, but a specific and unique etiologic factor has not been detected.[1]

In this context, the role of functional and morphological malocclusion as a TMD-contributing factor has been widely discussed. The first report correlating occlusal factors and TMD symptoms is attributed to Costen[2] in 1934. Since that time different types of therapies involving orthodontic-orthopedic treatment as well as occlusal adjustment have been proposed to correct malocclusion and improve TMD signs and symptoms. According to these theories, functional and morphological malocclusion cause TMD, and the achievement of an ideal occlusion through orthodontics or occlusal adjustment must eliminate pain and dysfunction.[2,3]

Orthodontic therapy as a possible TMD etiologic factor has been the subject of discussion lately, especially after a lawsuit, in which orthodontic treatment was considered the main cause of pain.[4] The deleterious effects of orthodontic mechanics in the stomatognathic system would be due to a new occlusal design,[5,6] with the premolar extraction and incisor retraction causing posterior displacement of the condyle and consequent overload to pain-sensitive areas.[6]

In 1981, Janson and Hasund[7] evaluated 60 orthodontically treated patients divided into two groups according to different premolar extraction protocols. Patients with a severe malocclusion could be treated with no risk for developing temporomandibular joint (TMJ) dysfunction.

In 1987, Wyatt[6] pointed out some procedures that could compromise TMJ conditions and increase the risk of developing TMD. According to the author, the use of class-II elastic and headgear are examples of these procedures,

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as well as elastics to correct midline deviation, chin cups, and retention appliances. These procedures would displace the disk-condyle complex posteriorly, initiating pathological processes in the joint.

In 1990, Nielsen et al[5] compared orthodontically treated and nontreated adolescents to study the role of orthodontic treatment in the masticatory system. The prevalence of muscular and TMJ tenderness to palpation was higher in the treated group, but both groups showed a similar frequency of joint sounds.

Reynders[8] reviewed the literature concerning the relationship between orthodontics and TMD from 1966 to 1988. From the articles analyzed, 55 reflected personal points of view, 30 were clinical case reports, and only six had a sample studied. On the basis of these six articles, it was concluded that orthodontic treatment performed during adolescence does not influence TMD development. When the type of appliance was considered, longitudinal studies also did not show differences in the incidence of TMD signs and symptoms.

Dibbets and Van Der Weele[9] conducted a 20-year longitudinal study to evaluate the relationship between orthodontic treatment performed with extractions and TMD signs and symptoms. Two decades later, 172 patients were examined; they found no relationship between the presence of TMD signs and symptoms and orthodontic techniques or extractions.

Kremenak et al[10] also analyzed 109 treated patients divided according to gender, type of malocclusion, and extraction protocols. Most patients (90%) improved or showed no change, according to a TMD index. Among those who got worse (10%), only 2% had an increase of five points in the Helkimo scale.

Hirata et al[11] studied 102 orthodontic patients using three clinical examinations given before and one and two years after orthodontic treatment. Patients were compared with a control group of 41 subjects. No differences were found in the incidence of TMD signs and symptoms between treated and untreated subjects.

Wadhwa et al[12] compared TMD signs and symptoms in groups of 30 untreated subjects with normal occlusion, 41 untreated subjects with malocclusion, and 31 orthodontically treated subjects. The values of Helkimo's anamnestic index were similar between groups, but when the clinical dysfunction index was evaluated, the normal occlusion group showed 46.7% of the individuals free of signs compared with 19.6% of the untreated malocclusion group and 22.6% of the orthodontically treated group.

In 1995, McNamara et al,[13] on the basis of an extensive literature review, established five occlusal risk factors for TMDs. They cited skeletal open bite, overjet greater than 6–7 mm, discrepancies from centric relation (CR) to intercuspal position (IP) greater than four mm, unilateral crossbite, and the absence of five or more posterior teeth. The chances of developing TMD could not be correlated to any type of orthodontic mechanics performed during adolescence.

Henrikson et al[14] studied the prevalence of TMD signs and symptoms before, during, and after orthodontic treatment. They examined 30 females treated without extraction and 35 females treated with extraction. The prevalence of TMD signs and symptoms was detected using an anamnestic questionnaire and a clinical evaluation before, during, and after treatment and another one year after the third examination. They found a decrease in the prevalence of muscle tenderness to palpation and in the reported symptoms during and after treatment. They also found no differences in the prevalence of joint noises regardless of the extraction protocol.

This study was designed to compare the prevalence of TMD signs and symptoms in treated and nontreated individuals.

## MATERIALS AND METHODS

A sample of 200 individuals (80 males and 120 females) was selected from patients of the Department of Orthodontics of the Bauru School of Dentistry, University of São Paulo, Bauru, Brazil. Exclusion criteria were the presence of systemic arthritis or previous treatment for TMD symptoms.

The individuals were divided into four groups, according to the malocclusion and the orthodontic treatment accomplished. Groups I and II were adolescents between 9 and 14 years of age (mean age 12.8), with untreated class-I and class-II malocclusions, respectively. Groups III and IV were adolescents between 15 and 20 years of age (mean age 16.5), with previously treated class-I and class-II malocclusions, respectively. For the whole sample the mean mouth opening was 48.2 mm (range 65–17 mm), the mean overbite 2.8 mm (range 7–1 mm), and the mean overjet 3.3 mm (range 11–1 mm). The mean number of occlusal contacts in intercuspal position was 6.2 for the whole sample (range 15–1), the mean right lateral movement was 9.0 mm (range 15–4 mm), the mean left lateral movement was 8.7 mm (range 14–3 mm), and the mean protrusive movement was 6.9 mm (range 12–1 mm).

The whole sample was asked to answer an Anamnestic Questionnaire[15–17] to classify them according to the most frequently reported TMD symptoms. This questionnaire is modified from the Helkimo's anamnestic index and was previously used with a 5% level of significance.[15,16]

### Anamnestic questionnaire

1. Do you have difficulty in opening your mouth?
2. Do you have difficulty in moving or using your jaw?
3. Do you have tenderness or muscular pain when chewing?
4. Do you have frequent headaches?
5. Do you have neck aches or shoulder pain?

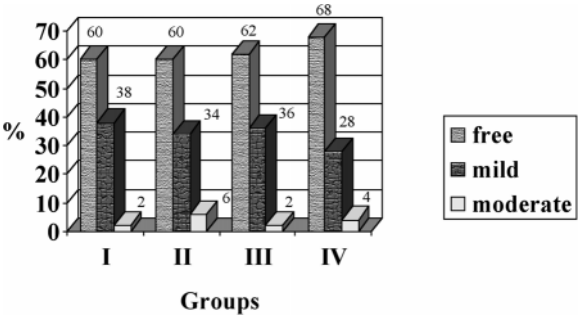


**FIGURE 1.** Prevalence and severity of TMD symptoms ($P > .05$).

6. Do you have pain in or about the ears?
7. Are you aware of noises in the jaw joints?
8. Do you consider your bite ''normal''?
9. Do you use only one side of your mouth when chewing?
10. Do you have morning facial pain?

Questions related to emotional tension and awareness of deleterious parafunctional habits also were answered by the sample. Habits included in the anamnestic file were clenching, bruxing, nail biting, and others.

For every response indicating the presence of dysfunction, a grade of 2 was given. A score ''0'' indicated the absence of symptoms, whereas ''1'' was given for a report of an occasional occurrence. A score of ''3'' was used to indicate severe pain or bilateral symptoms. The sum of the scores was used to classify the sample into four categories (1) from 0 to 3, TMD free; (2) from 4 to 8, mild TMD; (3) from 9 to 14, moderate TMD; and (4) from 15 to 23, severe TMD.

Clinical examinations were performed by two previously calibrated examiners and divided into three sections, ie, TMJ evaluation, muscular examination, and occlusal and dental inspection. The evaluation of jaw movement, the amount of maximum active opening, and left and right lateral and protrusion movement were also part of the clinical examination. The presence of joint noises and joint pain were detected during TMJ palpation performed bilaterally in the TMJ lateral and posterior aspects. Occlusal factors such as anterior open bite or posterior crossbite were recorded. The presence of anterior and lateral guidance and sagittal slides from CR to IP also were registered.

The types of appliance as well as the extraction protocol for treated groups also were recorded.

One-way analysis of variance (Kruskal-Wallis) and chi-square test with a 5% level of confidence were used for the statistical analysis.

## RESULTS

When the TMD anamnestic index for the whole sample was considered, 34% of the subjects had mild TMD, 3.5% had moderate TMD, and 62.5% were considered TMD free (Figure 1).

**TABLE 1.** Association Between TMD Signs and Symptoms and Sex

| | TMD | | | |
|---|---|---|---|---|
| Sex | Free | Mild | Moderate | Total |
| Males | 75% (60) | 24% (19) | 1% (1) | 100% (80) |
| Females | 54% (65) | 41% (49) | 5% (6) | 100% (120) |

**TABLE 2.** Association Between TMD Presence and Severity and Self-Reported Emotional Tension ($P < .01$)

| Emotional tension | TMD | | | |
|---|---|---|---|---|
| | Free | Mild | Moderate | Total |
| Yes | 43% (15) | 49% (17) | 9% (3) | 100% (35) |
| No | 71% (77) | 28% (30) | 1% (1) | 100% (108) |
| Sometimes | 58% (33) | 37% (21) | 5% (3) | 100% (57) |

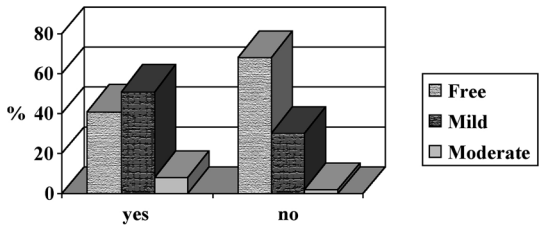


**FIGURE 2.** Association between TMD severity and clenching ($P < .01$).

There was no statistically significant difference between groups ($P > .05$) and no subject was classified as having severe TMD in this study.

When comparing TMD prevalence between males and females, a statistically a significant difference ($P < .01$) was present. Although 75% of males were TMD free, only 54% of females had no TMD symptoms (Table 1).

When TMD presence was associated with bruxing, clenching, and self-reported emotional tension (Table 2), a statistically significant association was found ($P < .01$). The association between TMD severity and clenching is seen in Figure 2.

Those previously exposed to treatment (groups III and IV) were divided into four groups according to premolar extraction protocol—nonextraction and upper, lower, or both arches extraction groups. When this variable was associated with TMD presence, no statistically significant association was found (Figure 3).

A lack of association was also found when testing the association between TMD and headgear wearing ($P > .05$). Among these adolescents treated with headgear, 65% were TMD free and 32% had mild TMD compared with 67% and 33% of the adolescents who did not use this appliance as a part of their orthodontic treatment. Clinically detected joint noises were presented in the entire sample with no significant differences (Figure 4). As for occlusal factors, only 5% had an anterior open bite, 11.5% had a unilateral

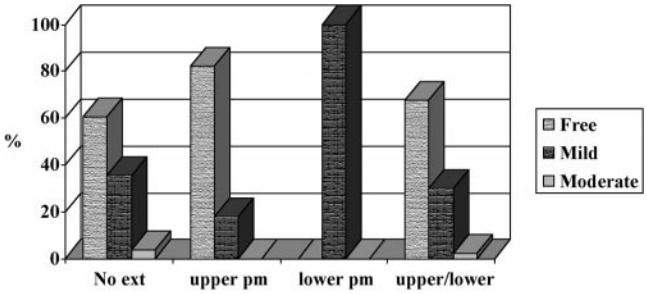


**FIGURE 3.** Association between TMD presence and severity and premolar extraction protocol.

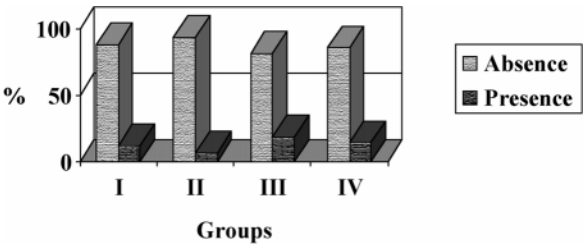


**FIGURE 4.** Association between joint noises and groups.

**TABLE 3.** Association Between the Presence of TMJ Noises and Tenderness to Palpation

| TMJ tenderness | TMJ Noise | |
|---|---|---|
| | Yes | No |
| Yes | 52% (13) | 18.28% (32) |
| No | 48% (12) | 81.71% (143) |
| Total | 100% (25) | 100% (175) |

posterior crossbite, and 91% of the whole sample had CR-IP slides less than two mm. Anterior guidance was present in 79% and canine guidance in lateral disclusion in 43.2% of the individuals. Statistical association with TMD presence and severity was found only for the absence of anterior guidance ($P < .05$).

Bruxing and clenching were reported by 20.5% and 18.5% of the sample, respectively. The most commonly reported symptoms were joint noises (15.5%) and headaches (13%).

During the clinical examination, joint noises were detected in 12.5% of the patients, whereas only 1.5% of the sample exhibited joint crepitation. During palpation procedures 22.5% presented at least one TMJ tender site, 26% showed masticatory muscle tenderness, and 31% reported cervical muscle tenderness. Joint noises were detected in 9% in the orthodontically untreated groups and in 16% of the treated groups. The association between joint noises and joint tenderness to palpation was statistically significant (Table 3).

## DISCUSSION

In the last decade, much effort has been made to clarify the supposed relationship between orthodontic treatment and TMD. Even the availability of modern and sophisticated diagnostic tools such as magnetic resonance imaging and long-term follow-up studies has not lessened the controversy concerning the relationship between the variables.

The main goal of this study was to investigate the association between malocclusion and orthodontic treatment and the prevalence and severity of TMD signs and symptoms. The difference in the mean ages between the groups was not statistically significant ($P > .05$). This fact is important when judging TMD prevalence because some authors report a higher prevalence in older samples.[18–20] When compared with previous research,[21–23] the figures found in this study revealed a lower prevalence (3.5%) with moderate TMD. Wigdorowicz-Makowerowa et al[23] found 10.5% with moderate and severe TMD, whereas 13% had moderate TMD in the study conducted by Wänman and Agerberg.[21,22] Differences between these findings and the whole sample in the present study may be related to the age of the sample because half the adolescents were under 15 years of age and, therefore, at an age of lower risk to develop TMD problems. The inclusion criteria in the present study also could be contributory because the sample comprised selected patients treated in Bauru Dental School and that eliminates people with many missing teeth and other occlusal factors considered a risk to develop TMD signs and symptoms. Figures for mild TMD (34%) in this study are in agreement with those in previously mentioned studies (27%[24] and 43.1%,[25] respectively).

Joint noises (15.5%) and headaches (13%) were the most commonly reported symptoms. The report of joint noises is similar to the 14.5% found by Conti et al[15] in 1996. In another study conducted by Solberg et al,[26] 8.9% of joint noises were found when asked about the awareness of annoying sounds.

Our figures for reported frequent headaches are similar to those found by Lagerstrom et al[27] in a sample of orthodontically treated and untreated subjects.

The headache complaints may be the result of either pain in the head due to muscle contraction or primary headaches because no differential diagnosis was done. The relationship between primary headaches and TMD signs and symptoms deserves further investigation because both conditions share the same pain pathway to CNS, ie, the trigeminal system.

TMJ tenderness was detected in 22.5% of the subjects compared with 12.9%,[15] 13%,[18] and 5.3%[26] reported in the literature. Differences in palpation techniques and pressure make comparisons very unreliable. At least one muscle point was tender to palpation for the masticatory and cervical areas in 26% and 31% of the sample, respectively. These data agree to the 30% found by Solberg et al.[26]

As for gender, the present investigation found a statistically significant association between sex and TMD prevalence. This finding is in agreement with previous studies.[15,26,28–33] Higher levels of joint laxity, stress, and the presence of specific pain receptors have been proposed as predisposing factors for females. The percentage of bruxing (20.5%) and clenching (18.5%) was similar to the 23% and 22% in a class-II sample, respectively,[34] and is in agreement with the 25% found by Lageerstrom et al[27] and the 22% by Sonnesen et al.[35] A higher TMD prevalence in bruxing subjects was also reported by Wigdorowicz-Makowerowa et al[23] and others.[15,36]

A statistically significant association was also observed between TMD signs and symptoms and self-reported emotional tension ($P < .05$). The reported emotional tension, a very frequent complaint in our days, can affect general health as well as predispose and cause muscle contractions and parafunctional habits increasing the risk of initiating TMD symptoms.

No differences in the prevalence of TMD between the four groups were detected. The similarity in the TMD prevalence does not support the role of orthodontic treatment either as a risk factor or as an acceptable method of prevention and cure of this disorder. Others[9,11,13,25,27,37–43] found similar results, but still others consider orthodontic treatment an etiologic factor for TMD[31,44,56] or a definitive treatment for these symptoms.[34,45–48]

Despite the endless controversy about the role of occlusion and malocclusion in the etiology of TMD, some occlusal factors seem to constitute risk factors for developing TMD signs and symptoms, as pointed out by McNamara et al.[13] In the present study, the absence of anterior guidance was associated with TMD. Other factors such as open bite, crossbite, and slides from CR to IP, although more prevalent in TMD individuals, did not reach the level of significance.

The introduction of occlusal interferences during orthodontic treatment and premolar extraction and consequent condyle posterior displacement were the factors most commonly reported as causing increased risk of TMD in orthodontically treated subjects.[5,6]

Wyatt[6] reported that premolar extractions and anterior retraction in patients treated with class II, division 1 malocclusion might cause a posterior displacement of condyles and an anterior disk displacement. The condyle posterior displacement due to premolar extraction was contested by Gianelly et al,[49] Artun et al,[50] and Major et al.[51] These authors did not find differences in condyle position in a sample of orthodontically treated subjects with or without extractions. Kundinger et al[52] investigated the condyle position using tomograms, and condyle position was not associated with premolar extraction protocols. Our results agree with these studies. The use of headgear appliance also did not influence TMD prevalence.

When considering the presence of TMD signs through a clinical examination, differences between groups also were not found. TMJ and muscle tenderness to palpation, considered as important signs in epidemiological studies, were used in this study to detect TMD.[26] A comparison of masticatory and cervical muscles and TMJ tenderness to palpation in the four groups showed a similarity in the results. However, Nielsen et al[53] reported a higher prevalence of muscle tenderness in orthodontically treated subjects. On the other hand, Henrikson et al[47] observed an improvement in muscle tenderness in a longitudinal study of patients of class-II malocclusion when compared with a normal occlusion control group.

The possible association between orthodontics and joint noises has been extensively discussed in the literature. Joint sounds are more frequent in TMD patients,[36,54] although also present in an asymptomatic sample. A slightly higher, not significant, prevalence of TMJ sounds was found for treated groups in this study. Considered in the past as a cardinal sign to indicate for treatment, the presence of this finding in a painless individual is no longer indicative of need for any type of management.[55] The higher recidive indices (return of joint noises after treatment) and the benign natural course of TMJ sounds discourage treatment, especially those irreversible ones.

Joint noises are frequently associated with anterior or anteromedial disk displacement with reduction. These results are only based on clinical evaluation because a gold standard for disk position was not used. When the presence of joint noises was correlated with joint tenderness to palpation, a statistically significant association was found. In the subjects presenting with joint noises, 52% had tenderness, whereas only 18.2% in the subjects without noises had pain. Tasaki et al[56] also observed higher levels of pain in individuals with sounds.

The improvements in diagnostic procedures, associated with well-controlled clinical trials have highly influenced techniques today. The clinical application of controlled findings seems to be the right way to perform effective and conscientious dentistry.

This concept of ''evidence-based dentistry''[57] can be perfectly applied to orthodontics in relation to TMD.

## CONCLUSIONS

Orthodontic treatment does not seem to predispose subjects to TMD problems nor is it indicated as an initial therapy for TMD patients.

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