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The incidence of temporomandibular disorder signs in orthodontic patients. A cross-sectional clinical study.

[1]Raghda W. Al-Shammout, BDS. JBOrth. FCFOrth, Senior Specialist, Orthodontist, Head of Orthodontics, Department of Orthodontics, Royal Rehabilitation Center, King Hussein Medical Center, Royal Medical Services, Amman-Jordan.

[2]Osama A. Al-Jabrah, BDS. MSc. JBPD. FICOI, Consultant and Head of Prosthodontics and Implant Dentistry Department of Dentistry, Al-Hussein Hospital, King Hussein Medical Center, Royal Medical Services, Amman, Jordan

Corresponding author: Osama A. Al-Jabrah, BDS. MSc. JBPD. FICOI, Consultant and Head of Prosthodontics and Implant Dentistry Department of Dentistry, Al-Hussein Hospital, King Hussein Medical Center, Royal Medical Services, Amman, Jordan

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Abstract

Purpose: To determine the incidence of clinically objective temporomandibular disorders (TMD) signs in orthodontically-treated adolescent and young adult Jordanian patients with fixed appliances and their correlation with gender and age.

Materials and method: A clinical examination was performed to assess 93 randomly selected orthodontic patients aged 15 to 34 years. The clinical examination involved palpation of the joint and masticatory muscles, detection of Joint sounds and mouth opening limitation and/or deviation and examination for possible signs of dental attrition. All patients were examined before and re-examined 6 months after orthodontic treatment has begun. Results were compared and related to age and gender.

Results: The mean age of the patients was 22.2±5.39 years. Approximately 70% were females. Males were younger than the females but the differences were not significant. Significantly, females were more than males in each age group (P <0.05). Most of patients had multiple TMD signs, whereas approximately 20% experienced only one sign. Presence of one sign was more prevalent in "after 6 months" group. However, 2 or more signs were more recorded at the "baseline" group. Significant associations (p<0.05) in "gender differences" (39.3% and 42.8% in males versus 24.6% and26.2% in females) at the base line and after 6 months, respectively. Significant associations (p<0.05) in "15-19 age group" had fewer signs compared to older groups. When compared to baseline, all TMD signs, except "muscle tenderness" were reduced after 6 months sign but the differences were not significant. At the baseline, more females significantly recorded joint sounds, however, more males had more wear facets (P <0.05). After 6 months, more females significantly recorded joint sounds and mouth opening limitation/deviation, however, more males had wear facets

(P <0.05). Significantly; Joint and muscle tenderness signs were associated with age groups 20-24 and 25-29 and joint sounds and limitation/deviation of mouth opening were associated with age groups 20-24.

Conclusion: The incidence of newly developed signs was 2.1%. Orthodontic treatment with fixed appliance did not increase the incidence, treat the preexisting signs or prevent TMD. TMD signs showed variation in distribution in different age groups and between genders.

Keywords: Temporomandibular disorder, Orthodontic treatment, Temporomandibular joint, Signs, Orthodontics

Introduction

Temporomandibular dysfunction (TMD) is a collective term embracing a number of subjective symptoms and clinical signs that involve the temporomandibular joint (TMJ) and surrounding structures, and is considered a cause of nondental pain in the orofacial region [1]. The main signs and symptoms are: pain from the TMJ or jaw muscles, pain on mandibular movement and joint sounds, as well as restricted mandibular movement [2].

Patients seeking treatment for TMD symptoms represent a small proportion (approximately 2%) of the general population. [3]. More women than men appear to seek treatment for TMD symptoms and are predominantly between 18 and 45 years old. [4,5]. This makes them common in the orthodontic population [6,7]. It has been reported that orthodontic treatment with fixed appliance either with or without tooth extractions did not increase the prevalence of symptoms and signs, or worsen preexisting symptoms and signs of TMD [2]. Recently, some studies have found less prevalent TMD signs and symptoms in patients who have received orthodontic treatment, compared with orthodontically untreated patients [8-10].

The available evidence-based data demonstrate that orthodontic treatment has little to do with TMD signs and symptoms. Some conditions, such as muscle incoordination, unstable disc-condyle relationship and bone alterations can interfere with the occlusal relationship and interfere with orthodontic analysis [11]., there is no evidence for a cause-effect relationship between orthodontic treatment and TMD, or that such treatment might improve or prevent them [7,12-15]. On the contrary, in the recent systematic literature review by Mohlin et al. the associations between certain malocclusions and TMD were reported [16]. In addition, symptoms and signs of TMD are relatively common in children and adolescents and about 30 per cent of this population receive orthodontic treatment in most western European countries during this period. This led to opinion that appeared in the literature that orthodontic treatment is a risk factor for the development of TMD [17-20]. But in recent literature reviews these claims have been questioned and discussed. Because of the high prevalence of symptoms and signs of TMD in children and adolescents, it is likely that patients receiving orthodontic treatment could experience TMD before, during, or after their orthodontic treatment. It is generally agreed that signs and symptoms are mostly mild in childhood and that they increase slightly with age up to adolescence, both in prevalence and severity [21]. Occlusion has been an important consideration in orthodontics since emphasis was placed on the alignment of the teeth, the stability of the intercuspal position, and the esthetic value of proper tooth positioning. Orthopedic stability in the masticatory structures should be a routine treatment goal to help reduce risk factors associated with developing TMD [22].

Lack of obvious evidence to the assumption that orthodontic treatment is associated with the occurrence of TMD promotes the need for extensive follow-up studies representing broader population sample and more rigorous methodology encompassing all confounding factors in

relation to TMD [23]. The null hypothesis was that there is a significant association between orthodontic treatment and the development of TMD signs in orthodontically treated patients. Therefore, this study aimed to estimate the incidence of clinically objective signs associated with TMD and their correlation with orthodontic treatment among Jordanian adolescents and young adults.

Materials and method

This study was carried out at the Orthodontic Department, Royal Rehabilitation Center, King Hussein Medical Center, Royal Medical Services, Amman, Jordan.

Ethical approval: The study was conducted for all patients who provided verbal and written informed consent after it was approved by the Head of the Specialty of Orthodontics and The Human Research Ethics Committee (No: 1/20 dated 28th January 2020) at the Royal Medical Services.

Participants: The original sample comprised 120 patients who were planned to be treated with fixed orthodontic appliances for a variety of reasons (i.e. correction of malocclusion, teeth alignment,…etc.). of these, 27 patients were excluded (4 patients discontinued orthodontic treatment and 23 patients did not wish to participate in the study), The study sample comprised 93 (28 male and 65 female) patients who met specific selection criteria and agreed to participate and to undergo the clinical examination, were included in this study, giving a response rate of 77.5%.

Inclusion/exclusion criteria: Any patient with any factor that may lead to TMD were excluded. Orthodontic treatment cases with extraction, dental and periodontal conditions, such as defective restorations, missing teeth or periodontal problems that could contribute to pain onset were excluded [11], patients who have undergone orthognathic surgery that may have TMD signs and symptoms TMD were also excluded [20]. Inclusion criteria involved those who had fixed appliances for 6 month and above at the second examination appointment. All included patients were required to provide informed consent of participation.

Clinical examination: All included patients were interviewed to fill a questionnaire at the beginning of the study regarding sociodemographic status (age, gender, national ID number and educational level) before they were examined at the beginning of the study (before bonding of fixed appliances) and re-examined 6 months later (during the active treatment phase). The clinical examination of the patients involved Joint tenderness which was determined by bilateral digital palpation posteriorly via the external auditory meatus and laterally over the condyle in the immediate peri-auricular region, joint sounds were determined by direct hearing (without the aid of a stethoscope) of sound in front of the external auditory meatus. Clicking and crepitus of the TMJ, either unilateral or bilateral, was recorded. The maximum mouth opening was measured using a millimeter ruler after asking the patient to open as wide as possible while remaining comfortable. The maximum opening was recorded between the incisal edge of the maxillary central incisor that is the most vertically oriented and measured vertically to the incisal edge of the opposing mandibular incisor (at the midline). The amount of vertical incisor overlap (the distance between the incisal edges of the upper and lower central incisors) was added to each of these measurements to determine the actual amount of opening [24]. The pathway of mandibular opening for each patient was recorded as follows: straight opening with no deviation, deviation to the right side, or deviation to the left side. Any mandibular deviation on opening and closing was recorded. A patient's tendency to deviate towards the affected side was regarded as a positive diagnostic sign [6,22]. The medial pterygoid, masseter and

temporalis muscles were palpated bi-manually for any signs and tenderness. The lateral pterygoid muscle was examined by recording its response to resited movements since this muscle is not readily accessible to manual palpation [25].

The presence of incisal or occlusal dental attrition is also an indicator of possible parafunctional habits. The severity of attrition facets was quantified on a five-point scale (0 = none, 1 = slight, 2 = noticeable flattening within the normal planes of contour, 3 = flattening of cusps or grooves, and 4 = total loss of contour and/or, when identifiable, dentinal exposure). Grades 3 and 4 were interpreted to be significant wear. The highest grade in each of seven specific arch segments (anterior - incisors, right and left canines; posterior right and left premolars and right and left molars) was recorded. This gave rise to a maximum possible score of 48 for the posterior dentition (4 segments x 3 facets x maximum score of 4) and 12 for the anterior dentition (3 segments x 1 facet x maximum score of 4) [26]. Based on evaluation of dental status, patients who had one or more severe attrition facets (3 or 4 on the scale of 0-4) and was assumed correlated with TMD.

All patients with no TMD signs were assumed as controls, and they were subjected to re-examination after 6 months from the start of the treatment. Clinical examination of the patients was performed by two "specialist" dentists'examiners who applied a standardised procedure before the collection of the data. Replicate examinations were conducted on 6 (22.2%) patients with positive TMD signs and 6 (9.1%) of control patients. Each examiner was paired with each of the other examiner on five examinations. Reliability for measures of maximum jaw opening ±1 mm, exceeded 90% for the examiners, for joint and masticatory muscles tenderness was 0.88, for joint sound was 0.80 and for wear facets was 0.95. . Intraexaminer correlations exceeded 0.90 for both examiners. An Intraexaminer correlation was 0.92 for clinical examination of the patients. As there was very small difference s and very strong correlation it was assumed that the results of the clinical examination were reliable.

Statistical analysis: Statistical analysis of data derived from the clinical examaination was performed using SPSS Statistic Version 17 (SPSS Corporation, Chicago, IL, USA). Mean values, standard deviations and percentages were obtained using descriptive analyses. Chi square test were used to compare the percentages of signs between the two examinations. Multiple regression model was constructed to evaluate gender and age differences. Statistical significant values were exposed to chi square analyses to correlate each single sign with age and between gender. Ninety-five percent confidence intervals about the mean were constructed for differences. Level of significance was set at 0.05.

Results

The mean age of the patients was 22.2±5.39 years (range: 15-34). Males were younger than the females but the differences were not statistically significant (20.6±4.87; and 22.9±5.62, respectively).

Table 1 shows gender distribution of the patients among different age groups in the study. Approximately, 70% of patients included in this study were females. Significantly, females were more than males in each age group (P <0.05).

Table 2 shows distribution of TMD signs before and after 6 months of orthodontic treatment. Presence of one sign was more prevalent in "after 6 months" group. However, 2 or more signs were more recorded at the "baseline" group. The differences between the 2 groups were insignificant. Simple logistic regression analysis revealed significant associations (p<0.05) in "gender differences" with odds

ratio (OR) 36% (95% CI=32-46), in males. (39.3% of males have signs compared with 24.6% of females) at the base line and odds ratio (OR) 40% (95% CI=32-46), in males. (42.8% of males have signs compared with 26.2% of females) after 6 months.Significant associations ($p<0.05$) in "15-19 age group" with odd ratio (OR) 6% (95% CI=48-72), had fewer signs compared to older groups. **(Table 3)**

Table 4 shows the differences between TMD signs at the baseline and after 6 months. All signs, with the exception of "muscle tenderness" (which was the only sign that reported an increase after 6 months), were reduced but the differences were insignificant. The incidence of newly developed signs was 2.1% (two new patients with a single "muscle tenderness" sign each).

Table 5 shows the distribution of TMD signs at the baseline and after at least 6 months in regard to gender. At the baseline, more females significantly recorded joint sounds than males. However, more males significantly had more wear facets ($P <0.05$). After 6 months, more females significantly recorded joint sounds and mouth opening limitation/deviation ($P <0.05$). However, more males significantly had more wear facets ($P <0.05$).

Table 6 Shows the distribution of TMD signs at the baseline and after at least 6 months in regard to age. In both examinations, joint and muscle tenderness signs were significantly associated with ($P <0.05$) with age groups 20-24 and 25-29. In addition, joint sounds and limitation/deviation of mouth opening were significantly ($P <0.05$) associated with age groups 20-24.

Discussion

This study aimed to estimate the incidence of clinically objective signs associated with TMD and their correlation with orthodontic treatment among Jordanian adolescents and young adults, the sample was representative of the Jordanian population of dental patients that treated with fixed appliances in the orthodontic department over a period of at least 6 months. In order to evaluate the effect of orthodontic treatment on TMD related signs, two clinical examinations were performed, the first examination was performed at the screening phase during the diagnosis and treatment planning "at the baseline" and the re-examination after 6 months of active orthodontic treatment. The strength of this research comes from being a cross-sectional prospective and short-term longitudinal cohort study in which the patients were their own controls by themselves.

In this study, there were 66 (70%) asymptomatic patients without signs and symptoms and had no history of TMD, were considered control subjects. Only 2 (2.1%) of them developed masticatory muscle tenderness after 6 months of orthodontic treatment, it was difficult to conclude direct association of the treatment with the incidence of TMD signs. McNamara concluded that signs and symptoms of TMD increase with age, particularly during adolescence, and that originate during orthodontic treatment may not be related to the treatment [12].

In this study, 70% of patients were females. Their predominance in all age groups was significant. This might be explained by the fact that more females seek orthodontic correction of their teeth mostly for esthetic reasons. These findings are supported by a previous study who reported that more women than men appear to seek treatment for TMD symptoms and are predominantly between 18 and 45 years old [1]. When comparing the number of signs before the start of orthodontic treatment with those after 6 months, this study showed that orthodontic treatment did not seem to increase the TMD signs. These finding are in accordance with some previous studies [12,14,15]. In general, the clinical examination revealed that approximately 21% experienced single TMD-related sign, however, in the majority of patients

multiple signs were frequently noted. The present findings were much higher than those reported in a previous study carried out by Pow et al., who found only 1% to 3% of their sample experienced more than 1 TMD sign or symptom [27].

The interesting finding in this study was that the significant associations ($p<0.05$) between male patients with TMD-related signs although they comprised only 30% of study population. Approximately 40% of males have signs compared with 25% of females, these findings reflects the actual picture of TMD signs opposite to the subjective responses of female participants obtained from TMD questionnaire who usually have positive answers being more symptomatic compared to males. These findings could be explained by that male patients might neglect or not so much concerned with the signs or symptoms. In addition, another significant ($p<0.05$) association of TMD signs with ≥20 years of age (the third decade). These findings are in accordance with some studies which pointed out that the TMD tends to begin after puberty, and the increase in the severity of signs and symptoms generally reaches its peak during the reproductive age, with higher prevalence in the age 20 to 40 years [28].

The most prevalent sign recorded was tenderness in the periauricular joint region, it was found in about 30% of TMD patients, followed by masticatory muscle tenderness (28%). Similar findings were reported previously [27. Joint sounds were recorded in 18% of patients before the start of orthodontic treatment, however, no definite change occurred during the course of treatment. Different findings were reported previously [18,27]. The least frequently encountered signs were limitation of mandibular movement and attrition of occlusal/incisal tooth surfaces (11.5% and 9.6%, respectively) and the recorded changes in TMD signs after 6 months were negligible.

Pretreatment TMD signs remained almost the same in those patients who also re-examined after 6 months during the course of orthodontic treatment with fixed braces. However, only two more patients developed masticatory muscle tenderness accounted for minor differences which were not statistically significant. In addition, it can be withdrawn that the incidence of newly developed signs was 2%. It is difficult to connect these new TMD related-signs which were recorded after 6 months with the orthdontic treatment per se. Similar findings were reported by Henrikson and Nilner, who concluded that orthodontic treatment with fixed appliance did not increase the prevalence of symptoms and signs, or worsen pre-existing symptoms and signs of TMD [18].

Joint sounds are very common among patients with TMD, and in non-patient populations. They are recorded as clicking or crepitus [29].. Of all the patients in this study with joint sounds, they were detected in the clinical examination. More joint sounds were significantly recorded in males than females, before and after orthodontic treatment. The course of treatment did not seem to cause the occurrence or treat the pre-existing joint sound. However, more males significantly had more pre-existing wear facets ($P <0.05$) compared to female patients. Parafunctional habits such as grinding and clenching are often mentioned as important co-factors in the etiology of TMD. It has been shown that parafunctions, especially tooth grinding, are very common in the general population, males in particular [30].

The limitation of the mandibular movement or a deviation towards a side seem to be a significant gender finding after 6 months of treatment. As this sign did not show significant gender difference before orthodontic treatment, but more females significantly recorded mouth opening limitation/deviation ($P <0.05$) within the course of treatment. This could be due to a "Myospasm of

masticatory muscles specifically causing limited jaw opening" [31] or joint arathralgia which accounted for the association between TMD pain and limitation of jaw movement and female gender [32]. This study showed significant (P <0.05) association of TMD signs with patient's age range between 20 and 24 years. It seemed that this association could be related to orthodontic treatment because the tenderness in the joint region and masticatory muscles which was recorded in 25-29 years in the pre-treatment clinical examination was not any more existed within the course of the treatment. Similar findings have been reported [33,34] The results of this research confirm that there is no significant association between orthodontic treatment and the development of TMD signs in orthodontically treated patients and refutes the null hypothesis The importance of this study comes from the fact that it provided clinical significance regarding the association of TMD with orthodontic treatment based on reliable objective clinical examination of patients who were not originally TMD patients and not on their subjective symptoms derived from a questionnaire.

Conclusion

Based on the clinical examination before and after six months of active orthodontic treatment, and within the limitation of this study, it can be concluded that orthodontic treatment with fixed appliances did not increase the incidence of TMD signs, or worsen or treat preexisting ones. Most of patients had multiple TMD signs, whereas approximately 20% experienced only one sign. Significantly, TMD signs were associated with 40% of males compared with 25% of females and with the age groups ≥ 20 years. Before and 6 months after orthodontic treatment, significantly more females recorded joint sounds and males had more wear facets. However, significantly, more females recorded mouth opening limitation/deviation during treatment. Joint and muscle tenderness signs were significant in the third decade of patients age. In addition, joint sounds and limitation/deviation of mouth opening were significantly associated with age groups 20-24.

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Legends Tables

Table 1 Gender and age distribution of the patients (n = 93) included in this study.

	15-19	20-24	25-29	30-34	Total
Male	14 (26.9%)	8 (34.8%)	4 (33.3%)	2 (33.3%)	28 (30.1%)
Female	38 (73.1%)	15 (65.2%)	8 (66.7%)	4 (66.7%)	65 (69.9%)
Total	52 (55.9%)	23 (24.7%)	12 (12.9%)	6 (6.5%)	93
	P <0.05	P <0.05	P <0.05	P <0.05	P <0.05
Chi square test					

Table 2. Distribution of number of TMD signs before and after 6 months of orthodontic treatment

	Baseline (n=27)	After 6 months (n=29)	
Signs	Number (%)	Number (%)	
One sign	11 (21.2%)	13 (24.1%)	NS
2 signs	9 (17.3%)	9 (16.7%)	NS
3 signs	5 (9.6%)	5 (9.3%)	NS
4 signs	2 (3.8%)	2 (3.7%)	NS

Total	52	54	
chi square test NS: not significant			

Table 3 Distribution of TMD signs at the baseline and after 6 months in relation to gender and age (Simple logistic regression analysis)

	Overall		Baseline (n=27)		After 6 months (n=29)	
Gender						
Males (n=28)	28	30.1%	11	39.3% *	12	42.8% *
Females (n=65)	65	69.9%	16	24.6%	17	26.2%
Age group						
15-19	52	55.9%	2	3.8% *	2	6.9% *
20-24	23	24.7%	15	65.2%	15	65.2%
25-29	12	12.9%	7	58.3%	8	66.7%
30-34	6	6.5%	3	50.0%	4	66.4%
Total	93		27	29.9%	29	31.2%

Table 4 Distribution of each TMD sings between the baseline group and after 6 months group

	Signs / Patients	Joint tenderness	Muscle tenderness	Joint sounds	Opening limitation	Wear facets
at the baseline	52/27	16 (30.8%)	15 (28.8%)	10 (19.2%)	6 (11.5%)	5 (9.6%)
after 6 months	54/29	16 (29.1%)	17 (30.9%)	10 (18.2%)	6 (10.9%)	5 (9.1%)
Significance		NS	NS	NS	NS	NS
chi square test						

Table 5 The gender distribution of each TMD sign at the baseline and after at least 6 months from the start of active orthodontic treatment.

	At the baseline			After 6 months		
Sign	Males (n=11)	Females (n=16)		Males (n=12)	Females (n=17)	
Joint tenderness	7 (63.6%)	9 (56.3%)	NS	7 (58.3%)	9 (52.9%)	NS
Muscle tenderness	6 (54.5%)	9 (56.3%)	NS	7 (58.3%)	10 (58.8%)	NS
Joint sounds	2 (18.2%)	8 (50.0%)	*	2 (16.7%)	8 (47.1%)	*
Mouth opening limitation/deviation	2 (18.2%)	4 (25.0%)		1 (8.3%)	5 (29.4%)	*
Wear facets	4 (36.4%)	1 (6.3%)	*	4 (33.3%)	1 (5.9%)	*
Overall	21/52 (40.4%)	31/52 (59.6%)	NS	21/54 (38.9%)	33/54 (61.1%)	NS

chi square test

* (P <0.05)

Table 6 Distribution of TMD signs at the baseline and after at least 6 months from the start of active orthodontic treatment in relation to age groups.

At the baseline		Joint tenderness	Muscle tenderness	Joint sounds	Opening limitation	Wear facets
	15-19	1 (6.3%) b	1 (6.7%) b	2 (20.0%) b	0 (0.0 %) b	0 (0.0%)
	20-24	7 (43.7%) a	6 (40.0%) a	7 (70.0%) a	4 (66.7%)a	2 (40.0%)
	25-29	6 (37.5%) a	7 (46.6%) a	1 (10.0%) b	2(33.3%) b	2 (40.0%)
	30-35	2 (12.5%) b	1 (6.7%) b	0 (0.0 %) b	0 (0.0 %) b	1 (20.0%)
After 6 months						
	15-19	1 (6.3%) b	1 (5.9%) b	2 (20.0%) b	0 (0.0 %) b	0 (0.0%)
	20-24	7 (43.7%) a	6 (35.3%) a	7 (70.0%) a	4 (66.7%)a	2 (40.0%)
	25-29	6 (37.5%) a	8 (47.1%) a	1 (10.0%) b	2(33.3%) b	2 (40.0%)
	30-35	2 (12.5%) b	1 (5.9%) b	0 (0.0 %) b	0 (0.0 %) b	1 (20.0%)

[a,b] : superscript lowercase letters in columns indicate significant difference at p < 0.05;