Coincidence and Awareness of the Relationship Between Temporomandibular Disorders and Jaw Injury, Orthodontic Treatment, and Third Molar Removal in University Students

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Aims: To determine whether there is an association between temporomandibular disorders (TMD) and a history of facial/jaw injury (FJI), orthodontic treatment (OT), or third molar removal (TMR) in university students, and to evaluate the students' awareness of a possible relationship between jaw pain or other TMD symptoms, FJI, OT, and TMR, and the presence of TMD. **Methods:** This cross-sectional study involved 1,381 Oporto District university students. The Portuguese version of the Research Diagnostic Criteria for TMD was used for TMD diagnosis. FJI, OT, and TMR histories were evaluated by questionnaire. Univariate associations between categorical variables were tested by using chi-square tests. Multivariate logistic regression was applied to predict independent factors associated with TMD. **Results:** Of the 1,381 students (mean age ± standard deviation [SD]: 21.7 ± 3.9 years), 39.3% had TMD, 23.2% had a history of FJI, 44.5% had undergone OT, and 26.2% had undergone TMR. Univariate analyses showed significant associations between OT and TMD ($P = .044$) and between TMR and TMD ($P = .003$). Multivariate regression analyses using FJI, OT, TMR, OT × TMR interaction, sex, and age in the first step showed TMR (Odds Ratio [OR] = 1.30; $P = .041$), sex (OR = 1.59; $P = .001$), and age (OR = 1.04; $P = .013$) as significant. A positive correlation between TMD and awareness of the relationship between jaw pain or TMD symptoms and a history of FJI or OT ($P < .001$ and $P = .002$, respectively) was documented. **Conclusion:** TMR, female sex, and older age were risk factors independently associated with TMD. The results also suggest that patients' awareness of potential risk factors for TMD should be taken into account on an individual basis. *J Oral Facial Pain Headache 2016;30:221–227. doi: 10.11607/ofph.1587*

Keywords: *jaw injury, orthodontic treatment, RDC/TMD Axis I, third molar removal, university students*

Temporomandibular disorders (TMD) are a public health problem that is particularly important in dentistry because of the number of people affected by TMD and its effects on quality of life (QoL).[1,2] University students in particular are vulnerable to psychoemotional disorders, sleep disorders, eating disorders, headache, and chronic musculoskeletal pain, including TMD.[3] Studies using the Research Diagnostic Criteria for TMD (RDC/TMD) have shown a high prevalence of TMD in university students.[2,4]

TMD research is controversial and many clinicians and researchers differ in their views of TMD etiology, diagnosis, and management.[5] The reason for these differences lies in the fact that TMD are a multifactorial group of musculoskeletal disorders that involve the temporomandibular joints (TMJs), masticatory muscles, and all associated tissues.[6] TMD commonly present as combined etiologies and a patient's perception of how a specific occurrence affected their TMD can influence the clinician. Patients frequently believe that procedures such as orthodontic treatment (OT) or third molar removal (TMR) were important etiologic factors in the development of their TMD, thus considering the professionals who carried out these treatments responsible for their symptoms.[7,8]

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OT is a controversial topic because in such cases scientific evidence cannot refute patients' beliefs; OT lasts around 2 years and is normally performed at an age (teenage and young adult) when the incidence of TMD signs and symptoms increases.[9] According to recent reviews, no association has been found between OT and the development of TMD,[10,11] and there is no evidence to support or refute the use of OT for the treatment of TMD.[12] Additionally, a long-term follow-up study concluded that OT does not cause or prevent TMD.[13] Likewise, many studies have reported that TMR is a recognized etiologic factor for TMD[14–16] while others have found no relationship between TMR and TMD.[17,18]

Patients also frequently relate facial or jaw injury (FJI) to their TMD symptoms[19] and many studies have reported the importance of jaw macrotrauma as an initiating factor in the development of TMD.[14,15,20,21] However, a population-based study did not confirm this finding.[22]

Therefore, the present study was conducted in a university student sample and had two aims: *(1)* to determine whether there is an association between TMD and a history of FJI, OT, or TMR; and *(2)* to evaluate the students' awareness of a relationship between jaw pain or other TMD symptoms, FJI, OT, and TMR, and the presence of TMD.

Materials and Methods

Subjects

The study was carried out from March 2014 to July 2014. A total of 1,381 students participated from the University of Oporto (six faculties), Polytechnic Institute of Oporto (five institutes), and six private universities in Oporto, Portugal. The study protocol was first approved by the Ethics Committee of the University Fernando Pessoa and subsequently by all the other institutions. All participants were required to sign an informed consent form prior to their participation. The exclusion criteria were presently undergoing OT, lesions on the lips, a recent history of oral or orthognathic surgery, and physical impossibility of being properly seated in the observation chair.

Questionnaire

Before the clinical examination, each student completed a questionnaire that included demographic data (sex and age) and the questions from the Portuguese version of the RDC/TMD patient history questionnaire,[23] which permit Axis I RDC/TMD classification (TMD symptoms of facial pain, difficulty on mouth opening, clicking, crepitus, and headache), as well as the questions of the RDC/TMD Axis II that are used for application of the Graded Chronic Pain Scale (GCPS). The students were categorized into two groups according to age: 18 to 25 years, and over 25 years. Three groups of questions were added to this questionnaire, each group containing three dichotomous questions (yes/no) about the students' experience with FJI ("Have you had a recent injury to your face or jaw?"), OT ("Did you undergo orthodontic treatment [dental correction] with fixed or removable appliances?"), and TMR ("Were you subject to third molar extraction [wisdom teeth] even if you had only one extracted?"). All the students were required to answer these first three questions. If they answered "no" to the entire RDC/TMD patient history questionnaire (and thus were not symptomatic) but answered "yes" to the first question of any group, they were requested not to answer the two following questions. If symptomatic students answered "yes" to the first question of any group, they were also required to answer the other two questions in the group: "Did you have jaw pain before [FJI, OT, or TMR]?" and "Do you relate the beginning of your jaw pain or symptoms with [FJI, OT, or TMR]?"

Clinical Examination

A clinical examination was performed by an experienced TMD clinical professional (C.B.) following the RDC/TMD protocol. This researcher was trained and calibrated in accordance with the adopted norms presented on the official website of the International RDC/TMD Consortium and the RDC/TMD Portuguese version.[23] Because this protocol omits a pressure calibration, a finger algometer was used (Wagner 0–5 lb) before palpation of the TMJs and muscles, as suggested in the examination specifications of the Diagnostic Criteria for TMD protocol[24] in order to reduce the bias on this parameter.

Axis I of the RDC/TMD provides specific criteria for diagnosing three groups of TMD, which are subsequently divided into eight subgroups: Group I, Muscle Disorders (myofascial pain [Ia], myofascial pain with limited opening [Ib]); Group II, Disc Displacements (disc displacement with reduction [IIa], disc displacement without reduction and with limited opening [IIb], disc displacement without reduction and without limited opening [IIc]); and Group III, Arthralgia, Arthritis, and Arthrosis (arthralgia [IIIa], osteoarthritis [IIIb], and osteoarthrosis [IIIc]).[25] After application of the Axis I RDC/TMD Decision Algorithms, all students were classified as follows: no TMD; only one RDC/TMD diagnosis; or two or more RDC/TMD diagnoses with a maximum of five RDC/TMD diagnoses (Groups II and III were evaluated separately for each TMJ). The students were also categorized as follows: with or without TMD, one of the three single RDC/TMD diagnoses (Group I, Group II, or Group III), or one of the four combined RDC/TMD diagnoses (Groups I and II; Groups I and III; Groups II and III; or Groups I, II, and III).

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Statistical Analyses

Categorical variables are expressed as percentages and continuous variables as mean ± standard deviation (SD) unless otherwise specified. The 95% confidence intervals (CI) for single and combined RDC/TMD Axis I diagnoses were calculated using the adjusted Wald method or the exact method. Continuous variables were compared between groups by using an unpaired *t* test. Univariate associations between categorical variables were tested using chi-square tests. Univariate logistic regression was used to predict the relationships between TMD and FJI, OT, and TMR; jaw pain before FJI, OT, and TMR; and the students' awareness of the relationship between jaw pain or other TMD symptoms and FJI, OT, and TMR. Multivariate binary logistic regression models (Wald backward stepwise method, $P = .05$ for covariate inclusion and $P = .10$ for exclusion) were used to predict independent factors associated with different RDC/TMD diagnoses and the presence of TMD. For all analyses reported, probability values are two-tailed and the significance level was set at $P < .05$. IBM SPSS Statistics for Windows, Version 22.0 (IBM Corporation) was used.

Table 1 Distribution and Prevalence of Single and Combined RDC/TMD Axis I Diagnoses in the Study Population

RDC/TMD Group	n	%	95% CI[a] (%)
I	100	7.2	6.0–8.7
II	129	9.3	7.9–11.0
III	92	6.7	5.5–8.1
I + II	36	2.6	1.8–3.6[b]
I + III	71	5.1	4.1–6.4
II + III	52	3.8	2.8–4.9[b]
I + II + III	63	4.6	3.5–5.8[b]

[a]Adjusted Wald method unless otherwise stated.
[b]Exact method. CI = confidence interval for the prevalence of TMD.

Table 2 Frequency and Relative Frequency of Students With and Without Diagnosis of TMD by Sex and Age Group, Their Associations, and Evaluation of TMD Risk for Females and For the Age Group of ≥ 25 years

Variable	TMD-free	TMD	*P* value	OR (95% CI)
Sex				
Female	607 (58.3)	435 (41.7)	.001	1.53 (1.18–1.99)
Male	231 (68.1)	108 (31.9)		
Age				
18–25	769 (61.6)	480 (38.4)	.038	1.46 (1.02–2.10)
> 25	69 (52.3)	63 (47.7)		

Chi-square test was used. All values reported are n (%) unless otherwise stated. OR = odds ratio; CI = confidence interval.

Results

Of the 1,381 students who participated in this study (mean age [± SD] = 21.7 ± 3.9 years), 75.5% (n = 1,042) were female and 24.5% were male (n = 339). The mean age of females was 21.3 ± 7.2 years and that of males was 22.6 ± 4.5 years; statistically significant differences in the age of females and males were observed (*t* test, $P < .001$).

With respect to the distribution of TMD diagnoses, 60.7% (n = 838) of the students had no TMD diagnosis and 39.3% (95% CI = 36.7% to 41.9%, n = 543) had some type of TMD; of these, 23.2% had a single TMD diagnosis and 16.1% had combined TMD diagnoses (Table 1). The prevalence of TMD in females was 41.7% and in males it was 31.9%. With regard to the prevalence of TMD by age, students aged 18 to 25 years had a prevalence of 38.4% and those older than 25 years had a prevalence of 47.7%. Therefore, the assessment of the relationship of TMD with sex and age group indicated that being female (chi-square test, $P = .001$) and older than 25 years ($P = .038$) were significantly associated with TMD (Table 2).

With the exception of one student, all students with facial pain were classified as having a GCPS grade of I (low intensity of pain with no or low disability). The one student mentioned above was classified as having grade II (high intensity of pain with no or low disability). Therefore, students with a history of facial pain had no or low disability.

Recent FJI affected 23.2% of the students and significantly more of these students were male (chi-square, $P < .001$). These students had greater awareness of the relationship between their pain or other symptoms and FJI ($P = .007$). In addition, 44.5% of the students and significantly more women had undergone OT ($P = .004$). Also, TMR was experienced by 26.2% of the sample and by significantly more women than men ($P = .024$) (Table 3).

Univariate analyses showed significant associations between OT and a TMD diagnosis ($P = .044$) and between TMR and a TMD diagnosis ($P = .003$). Jaw pain before FJI or OT was not found to be a significant risk factor for TMD ($P > .05$), but jaw pain before TMR was found to be a risk factor for TMD ($P = .005$). A significant positive correlation between awareness of the relationship between jaw pain or other TMD symptoms and a history of FJI and TMD was shown ($P < .001$), and 72.0% of students with such an awareness actually had TMD. A significant positive correlation between OT and awareness was also shown ($P = .002$); 68.7% of these students had TMD (Table 4).

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Table 3 Absolute and Relative Frequencies of Yes/No Answers to FJI, OT, and TMR in Terms of Jaw Pain Before FJI, OT, and TMR; and Awareness of the Relationship Between Jaw Pain/TMD Symptoms and FJI, OT, and TMR, in the Whole Sample and by Sex

Variable	n	No	Yes	Sex	No	Yes	*P* value
FJI	1,381	1,061 (76.8)	320 (23.2)	Male	234 (69.0)	105 (31.0)	< .001
				Female	827 (79.4)	215 (20.6)	
Jaw pain before FJI	259	140 (57.5)	110 (42.5)	Male	43 (55.8)	34 (44.2)	.721
				Female	106 (58.2)	76 (41.8)	
Awareness of relationship between jaw pain/symptoms and FJI	255	205 (80.4)	50 (19.6)	Male	54 (70.1)	23 (29.9)	.007
				Female	151 (84.8)	27 (15.2)	
OT	1,381	766 (55.5)	615 (44.5)	Male	211 (62.2)	128 (37.8)	.004
				Female	555 (53.3)	487 (46.7)	
Jaw pain before OT	484	361 (74.6)	123 (25.4)	Male	74 (81.3)	17 (18.7)	.102
				Female	287 (73.0)	106 (27.0)	
Awareness of relationship between jaw pain/symptoms and OT	484	417 (86.2)	67 (13.8)	Male	79 (86.8)	12 (13.2)	.841
				Female	338 (86.0)	55 (14.0)	
TMR	1,381	1,019 (73.8)	362 (26.2)	Male	266 (78.5)	73 (21.5)	.024
				Female	753 (72.3)	289 (27.7)	
Jaw pain before TMR	298	139 (46.6)	159 (53.3)	Male	26 (44.8)	32 (55.2)	.757
				Female	113 (47.1)	127 (52.9)	
Awareness of relationship between jaw pain/symptoms and TMR	298	260 (87.2)	38 (12.8)	Male	49 (84.5)	9 (15.5)	.482
				Female	211 (87.9)	29 (12.1)	

Chi-square test was used. All values reported are n (%) unless otherwise stated. FJI = facial/jaw injury; OT = orthodontic treatment; TMR = third molar removal.

Table 4 Univariate Analyses of FJI, OT, and TMR; Jaw Pain/TMD Symptoms Before FJI, OT, and TMR; and Awareness of the Relationship Between Jaw Pain/TMD Symptoms and FJI, OT, and TMR with TMD

		TMD			
Variable		No	Yes	*P* value	OR (95% CI)
FJI	No	648 (61.1)	413 (38.9)	.585	
	Yes	190 (59.4)	130 (40.6)		
Jaw pain before FJI	No	83 (55.7)	66 (44.3)	.103	
	Yes	50 (45.5)	60 (54.5)		
Awareness of relationship between jaw pain/symptoms and FJI	No	117 (57.1)	88 (42.9)	< .001	1
	Yes	14 (28.0)	36 (72.0)		3.42 (1.74–6.72)
OT	No	483 (63.1)	283 (36.9)	.044	1.00
	Yes	355 (57.7)	260 (42.3)		1.25 (1.01–1.55)
Jaw pain before OT	No	186 (51.5)	175 (48.5)	.054	1
	Yes	51 (41.5)	72 (58.5)		1.50 (0.99–2.27)
Awareness of relationship between jaw pain/symptoms and OT	No	216 (51.8)	201 (48.2)	.002	1
	Yes	21 (31.3)	46 (68.7)		2.35 (1.36–4.08)
TMR	No	642 (63.0)	377 (37.0)	.003	1
	Yes	196 (54.1)	166 (45.9)		1.44 (1.13–1.84)
Jaw pain before TMR	No	77 (55.4)	62 (44.6)	.005	1
	Yes	62 (39.0)	97 (61.0)		1.94 (1.22–3.08)
Awareness of relationship between jaw pain/symptoms and TMR	No	124 (47.7)	136 (52.3)	.343	
	Yes	15 (39.5)	23 (60.5)		

All values reported are n (%) unless otherwise stated. OR = odds ratio; CI = confidence interval; FJI = facial/jaw injury; OT = orthodontic treatment; TMR = third molar removal. $P < .05$ was considered significant.

Multivariate analyses revealed that FJI was not found to be associated with any of the single or combined TMD diagnoses. OT and TMR were not associated with any of the single TMD diagnoses; nonetheless, both were significantly associated with different combined RDC/TMD diagnoses. OT was found to be a significant risk factor for Groups II and III (Odds Ratio [OR] = 2.0; $P = .017$) while TMR was found to be a significant risk factor for Groups I and III (OR = 1.69; $P = .045$), and Groups I, II, and III (OR = 2.15; $P = .006$) (Table 5).

Upon completion of multiple regression analysis that included the variables FJI, OT, TMR, OT × TMR interaction, sex, and age, the model only retained TMR (OR = 1.30; $P = .041$), sex (OR = 1.59; $P = .001$) and age (OR = 1.04; $P = .013$) as significant and independently associated with the TMD outcome (Table 6).

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Table 5 Multivariate Analyses of RDC/TMD Axis I Diagnoses Associated with OT and TMR with Adjustment for Age and Sex

	RDC/TMD diagnoses					
	I + III		II + III		I+ II+ III	
Variable	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)
OT			.017	2.00 (1.14–3.55)		
TMR	.045	1.69 (1.01–2.83)			.006	2.15 (1.25–3.71)

OR = odds ratio; CI = confidence interval; OT = orthodontic treatment; TMR = third molar removal.

Table 6 Multivariate Analyses[a] of Risk Factors Independently Associated with TMD (OR and 95% CI)

Variable	Category	*P* value	OR (95% CI)
TMR	No	.041	1
	Yes		1.30 (1.01–1.67)
Sex	Male	.001	1
	Female		1.59 (1.22–2.07)
Age (1-year increment)		.013	1.04 (1.00–1.07)

[a]Variables included in the first step of the model: FJI, OT, TMR, interaction between OT and TMR, sex, and age. OR = odds ratio; CI = confidence interval; TMR = third molar removal.

Discussion

In this sample of university students, the prevalence of TMD (39.3%) was lower than that reported in the studies by Casanova-Rosado et al[2] and Wieckiewicz et al[4] (46.1% and 54%, respectively). This is likely the result of sample differences. Nevertheless, as in those studies, an association between female sex and TMD was observed. Age, which was not evaluated in these two earlier studies, was also a risk factor for TMD in the present study, consistent with what was seen in the OPPERA study[26] and a recent nationwide, population-based study in Taiwan.[27]

Few studies in the literature have evaluated the possible association between FJI, OT, and TMR and an increased risk of TMD after adjustment for potentially confounding variables. To the best of the authors' knowledge, this is the first study to evaluate patients' awareness of jaw pain or other TMD symptoms that were associated with FJI, OT, and TMR and its coincidence with TMD through clinical examination. Akhter et al[14] studied the relationship between FJI, OT, and TMR and TMD symptoms in university students in Japan after adjustment for age and sex. They found a relationship between TMJ pain and FJI, clicking, and TMR, but they did not correlate any of the evaluated symptoms with OT. However, unlike the present study, they did not make a diagnostic classification of TMD.

In the OPPERA case-control study, Ohrbach et al[15] found that trauma associated with an external force or prolonged opening was strongly associated with chronic and painful TMD (myofascial pain and/or arthralgia). In the OPPERA prospective study,[28] when the same variables were associated with the risk of first-onset TMD, only injury due to prolonged opening was correlated in the fully adjusted model (adjusted for age, sex, race/ethnicity, and lifetime of residence in the US). The results of this cohort study contradict those of several cross-sectional studies[15,20,29] and a clinical study.[21] The authors stated that these differences could be a bias in their study or that trauma, as an etiologic factor for TMD, could contribute via a delayed body response. In the present study, a relationship between FJI and TMD or any of the single and combined RDC/TMD diagnoses was not found. However, with respect to the relationship between awareness of jaw pain or other TMD symptoms and the occurrence of FJI, 72% of students who correlated the onset of jaw pain or other TMD symptoms with FJI really had TMD. In a study by De Boever and Keersmaekers,[19] 24.5% of the patients referred to a Facial Pain Unit related the onset of the symptoms (pain and dysfunction) with trauma; these results are considerably lower than those of the present study. From a clinical point of view, despite not having found a relationship between FJI and TMD, this information is important because it shows the need to inquire about each patient's trauma history and the relationship between their symptoms and that trauma. In this manner, clinicians should understand the concept of a delayed body response to trauma and adopt appropriate therapeutic measures.

The results of the present study showed that OT was related to TMD in the univariate analysis but not in the fully adjusted regression model. This finding is in accordance with what was postulated by McNamara et al[30] and was evaluated in subsequent

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cohort studies.[13,31] Ohrbach et al[15] found in their fully adjusted model that a history of OT was only slightly associated with chronic and painful TMD (OR = 1.4) and Huang et al[29] found no relationship between OT and subgroups of painful TMD. In the present university sample, OT increased only the risk of a combined Groups II and III RDC/TMD diagnosis (OR = 2.0). According to Marklund and Wänman,[32] mandibular instability in college students is associated with persistent joint signs (joint pain and joint clicks), and mandibular instability is common after OT.[33,34] Based on these results, more studies are needed to verify whether postorthodontic mandibular instability may affect the appearance of TMD signs and/or symptoms or specific groups of TMD diagnoses.

With respect to OT, 68.7% of the students with awareness of the relationship between jaw pain or other TMD symptoms and OT had TMD. This result is also significant, although only a relationship between OT and the combined RDC/TMD diagnoses of Groups II and III was found. From a clinical perspective, orthodontists should gather an extensive clinical history and evaluate the TMJs and masticatory muscles of the patient before initiating OT. With these procedures, they could address the belief of some patients that OT is the cause of TMD, because TMD signs and symptoms previous to OT are sometimes underestimated. Clinicians should also be aware that there is no scientific evidence that OT can treat or prevent TMD.[12] Therefore, in the presence of symptoms or signs of TMD previous to OT, clinicians must stabilize these symptoms or signs before proceeding to OT and never use it as a first-line treatment for TMD. When a patient with a TMD requires OT and after signs and symptoms are stabilized, the clinician must reassure the patient that OT has no tendency to aggravate the pretreatment signs and symptoms[35] and that normally improvement should occur,[36] although this depends on the individual's biologic response.[34]

When the scientific evidence cannot refute a patient's belief on a topic that remains inconclusive, such as the role of OT in TMD, it is important for a conscientious practitioner to listen to the patient's beliefs and explore this relationship and to be watchful for the appearance of TMD signs and symptoms during active OT. As Michelotti and Iodice[10] have recommended, when TMD signs or symptoms occur during OT, clinicians should make a TMD diagnosis, temporarily suspend active OT, stabilize the symptoms, and reevaluate the OT plan when the patient is pain-free.

This study found that TMR was associated with an increased risk of TMD. This association only involved combined RDC/TMD diagnoses (Groups I and III [OR = 1.69] and Groups I, II, and III [OR = 2.15]) by multivariate analysis. Huang et al[29] found a relationship between TMR and myofascial pain (OR = 3.2) and between myofascial pain and arthralgia (OR = 4.0); however, they did not exclude disc displacement diagnoses from their painful TMD subgroups. This is a major difference from the present study, in which all single and combined diagnoses were separated. Because other studies did not correlate TMR with TMD[17,18,37] and because no correlation between an awareness of TMD symptoms and TMR could be found, it can be hypothesized that patients with painful, complex TMD are frequently referred for TMR, as De Angelis et al[38] reported. Therefore, TMR was likely not a risk factor for TMD in this sample, but rather an attempt to solve orofacial pain.

Conclusions

In this university student population, TMR, female sex, and older age were independent risk factors for TMD. Additionally, when the students' awareness of the relationships between jaw pain or other TMD symptoms and FJI, OT, or TMR were taken into account, there were significant associations between awareness and FJI and between awareness and OT. Based on these results, screening patients for their awareness of potential risk factors for TMD could help evaluate TMD risk factors at the individual patient level.

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