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Review

PATIENTS WITH TMD IN DEVELOPMENTAL AGE AND CORRELATION WITH MALOCCLUSIONS: A TRANSVERSAL PILOT STUDY

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ABSTRACT

This study investigated the prevalence of different symptoms and signs in a population of children and adolescents with temporomandibular disorders (TMD) by evaluating the correlation with occlusal variables. TMD signs and symptoms were recorded in 40 subjects (age range 5-15 years), divided into two groups: 20 subjects treated in Chieti (Italy) and 20 in Murcia (Spain). Once the Angle dental class was identified, it was recorded for each patient the signs and/or symptoms of T.M.J. dysfunctions and occlusal interferences. The percentages of signs and symptoms were compared using the $\chi 2$-test to determine the differences among the groups for the rates of TMD symptoms, bruxism, joint sounds, deviation during the opening, reduced opening/lateral/protrusive movements, malocclusions, and myofascial pain. There is no statistically significant difference between the two groups ($\chi 2=2.849$, $p>0.05$), an indicator of the same racial origin. Subjects with first dental or skeletal class and deep bite showed a higher prevalence of TMD symptoms. According to literature, it is considered more linked to TMD problems with the deep bite rather than the first skeletal or dental class.

KEYWORDS: *temporomandibular disorders, orthodontics, malocclusion*

INTRODUCTION

There are five major causative factors associated with TMD: occlusion, trauma, emotional distress, deep nociceptive stimuli, and parafunctional activities (1). The importance of occlusal factors in TMDs is a critical topic in dentistry, and

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there is no overwhelming evidence for or against the hypotheses of significant correlation or of null role in etiology.

The parafunctional activity, which includes clenching or grinding the teeth, can be responsible for the onset of TMD symptoms; during the day, oral habits such as biting the cheeks or the tongue, sucking a finger, nibbling pencils, pins, holding an object under the chin, are often performed unconsciously; on the other hand, during single sleep episodes (clenching) or rhythmic contractions (bruxism) may occur, certainly related to emotional stress, probably also to a genetic predisposition or to C.N.S. disorders. However, parafunctional activity may not be the primary cause of TMD symptoms but a factor that maintains or accentuates the symptoms: in this case, both the primary etiological agent and the parafunction must be treated to achieve complete remission of symptoms. Bruxism is a very common phenomenon in children, with a prevalence between 20 and 38%, but it is self-limiting, without significant symptoms, and tends to brux in adulthood.

According to the study by Pullinger et al., four occlusal aspects occurred more frequently in subjects with TMD, and they are a skeletal anterior open bite, slipping greater than 2 mm between intercuspation position and retruded contact position, overjet greater than 4 mm, and 5 or more missing posterior teeth. (1, 2). Deviations greater than 3 mm are more important risk factors for TMDs, while small discrepancies between 1 and 3 mm are epidemiologically normal. (3-7).

Acute or unexpected changes in the occlusion could induce symptoms of TMD due to the important influence on the chewing muscles; the parafunctional activities, different from the functional ones, instead of being inhibited by the contact of the teeth, seemed to be caused by them. So, perfect occlusion is the basis of healthy muscle function, and occlusion disorders can lead to increased muscle tone (co-contraction) and symptoms. The signs of TMDs are muscle pain, joint pain, joint noises, and limited mandibular range of motion.

Some clinicians suggest that deep bites, cross bites, and double bites are predisposing factors. Other factors such as trauma, emotional stress, bruxism, and some systemic conditions can favor the development of a T.M.J. disorder.

The opportunity to start orthodontic therapies at an early age is increasingly accepted with fixed, orthopedic, or mobile devices. During orthodontic treatment, pharmacological agents (nonsteroidal anti-inflammatory drugs and topical anesthetic formulations) have been generally recommended by dentists to get pain relief (8, 9). Nonpharmacological methods also exist, such as vibratory stimuli, transcutaneous nerve stimulation, and low-level laser therapy (LLLT) (10-11-12, 13). These findings confirm previous research on the efficacy of LLLT in controlling pain during orthodontic treatment; in fact, intraoral administration of LLLT significantly enhances the orthodontic treatment to achieve dental alignment; it produces dental movement with reduced time of wearing, minimum of 12 hours per day (14, 15).

In another study, it was found that patients with teeth erupted in an ectopic position get benefit from the use of LLLT and self-ligating orthodontic appliance with the formation of new keratinized gingiva, about 2,7 mm, 0.45 per month (16).

Epidemiology

Temporo-mandibular disorders (TMD) are one of the most common causes of orofacial pain after dental pain, and there is a peak incidence between 20 and 40 years of age, with a higher prevalence in women.

The authors of a study on children in primary dentition reported that the prevalence of TMD signs and/or symptoms was 34%, and the prevalence of joint click was 2.7% in primary dentition, 10.1% in late mixed dentition, and 16.6% in permanent teething (17, 18). Xie, Lin et al. investigated a group of Chinese students from 1979 to 2017 and reported a 29.1% TMD prevalence and joint noise as the most frequent sign (19). According to previous studies in European countries, TMD prevalence rates were 26.5% in Poland (Loster et al., 2015) and 22.58% in Italy, slightly lower than the rate observed in China (20-22). In contrast, higher prevalence rates appeared in the Middle East and South American countries: 34.9% in Brazil, 34.7% in Iran, and 46.8% in Riyadh (Saudi Arabia) (22-25). This discrepancy could be related to race, different economies, war, and eating habits.

It is generally accepted that T.M.J. disorders have a multifactorial etiology, and one of these factors is the occlusal condition, although it is still a debated topic in the literature.

In the Oral, Medical, and Biotechnological Sciences Department of the G. D'Annunzio University of Chieti-Pescara, we carried out a study to establish the prevalence of T.M.J. dysfunctions in developmental age and to assess the relationship with malocclusions. Subsequently, a comparison was made with the data collected at the Clinica Universitaria Odontologìca of Murcia (Spain).

MATERIALS AND METHODS

A total of 40 patients were selected, 20 from the University G. D'Annunzio, Chieti-Pescara and 20 from "Clinica Universitaria Odontologìca", Universidad de Murcia (Spain).

The following inclusion criteria were used for subject participation in the study: 1. age between 5 to 15 years old, 2. orthodontic treatment according to well-defined malocclusion.

Patients were excluded if they had a history of polyarthritis, muscle spasms, neurological or psychiatric disorders, vascular diseases, genetic syndromes, cleft lip, abnormalities of the palate, craniofacial syndromes, or PBM therapy for TMD pain.

The occlusal assessment was made considering Angle malocclusion classification, myofascial pain in various body areas (head, neck, shoulders, back) measured with the VAS, T.M.J. sounds and bruxism, flawed habits, such as onychophagy or atypical swallowing, then the overjet, the overbite, the facial symmetry, the dental crowding, the deviation during the opening, the reduced opening, lateral, and protrusive movements and finally the chosen orthodontic treatment. The examination for TMD signs and symptoms was based on the standardized Research Diagnostic Criteria for Temporomandibular Disorders (25). Muscles were digitally palpated to assess muscle tenderness and pain.

Photos and radiographic examinations of each patient are viewed at the beginning and end of the treatment is finished. All the patients underwent regular routine and orthodontic clinical checks. The data collected in Chieti Clinic were then compared with those ones collected in the Murcia Clinic, calculating the statistical value chi-square. As for the statistical analysis, the chi-square test was used to compare the two percentages obtained in the study and to evaluate the existing statistical significance or to verify whether the difference between the two values is due to chance or not. Everything is calculated at the 5% probability level, considering 1 degree of freedom and n equal to 40.

RESULTS

In this study, about Chieti data, 16 patients have bruxism and/or clenching, 7 patients have class I, 9 patients have Class II, and 8 patients have Class III (Table Ia).

Only one patient, aged 11 years, has a noticeable joint click on the right and left, sometimes in an opening on the right side; he has a first molar class on the right side and a second molar class on the left side. It also reports back pain in the lower back, neck pain, and headache, with pain 8-9 (VAS) in the temples and in the T.M.J. About myofascial pain, it was found that in 12 patients, the pterygoid muscle palpation is painful, and in 10, the Temporalis Tendon palpation, in 6 patients, the sternocleidomastoid palpation, and in 3 patients, the masseter one.

The intraoral examination revealed that 11 patients have a deep bite (range 4-7 mm), 3 an open bite, 5 a posterior cross-bite, 3 an anterior cross-bite, and 3 have a deviation during the opening with a displacement of the lower midline. As for the overjet, 6 patients have an increased O.J. (range 3-11 mm) and 1 decreased (with a value of -5 mm). Three patients also have crowding, 1 has atypical swallowing, and 1 has low lingual posture. Depending on the problem, patients are treated with Frankel devices of type I, II, III, and V (with base 3), RPE, or Multibrackets.

According to data from the University Hospital of Murcia, 13 patients have a first molar and/or skeletal class, 9 patients a second molar and/or skeletal class, and 6 patients have a third molar and/or skeletal class (Table Ib). 5 patients have bruxism and/or clenching, 2 painless joint noise and 2 joint noise with pain. As for malocclusions, 4 patients have a mono/bilateral posterior cross-bite and 2 anterior cross-bite; 9 patients have atypical swallowing, 2 onychophagy, 7 have a mandibular deviation in the opening, 9 an increased overjet (range 3-6.5 mm), 5 patients have an open bite and 4 have oral respiration and/or lingual interposition between the teeth.

The chi-square value (1, n = 40) is 2,849 and the p-value is .091431, so the difference between the two groups isn't statistically significant at the 5% probability level ($p > 0.05$). The results of the $\chi 2$ test revealed that there is a greater correlation between the first molar and/or skeletal class and a sign/symptom of TMD. Considering the cases in which there is a clinically evident articular noise, we notice that in 3 out of 5 cases, there is a posterior cross-bite, and in 2 out of 5 cases, a mandibular deviation in the opening.

Table Ia. *Classification of patients.*

Patient	Age	ID	Disorders TMJ	VAS	Palpation	Intraoral exam	Treatment
1 T C	13	SC	no	no	Pterygoids, tt, scm, masseter	OB closed 3 mm	FR II
2 V P	12	SC	clenching		tt, pt, scm	2 class, I, OB closed	FR V, 2
3 FM	9	SC	bruxism			2 class, I, OB closed	FR V, III
4 S D	13	TC	bruxism, chenching	headache	Tempolaris tendon		RPE
5 D C	12	FC, SC (canin right and left)	bruxism, chenching		Trapezes, medial pterygoid	OB open 1 mm, super space 5mm, crowding lower 2 mm, deviation right side 2 mm	FR II
6 A D	11	TC		Headache 2-3 times/month	SCM, TT, medial and lateral pterygoids	Dev left 2 mm, OJ 0 mm	FR III
7 G T	8	II mol e canin, I division SC	bruxism, chenching			OB cloded, dev left	FR V, base 3
8 I C	9	FC	clenching	headache		OJ 3 mm, CB post left	FR V, 3
9 V P	11	TC	clenching		Masseter, TT, medial and lateral pterygoids	OB open	FR V, 5 shields
10 A D	15	FC mol, TC canin, II division	clenching			OB closed, OJ 1 mm, midline right 2 mm, crowding upper 2 mm, lower 6-7 mm	brackets

11 N S	8	TC	clenching		SCM, pterygoids	CB 5 mm ant, concave profile, wide lower arch, Spee reverse, low lingual posture, OJ 5 mm, dev right	RPE
12 S A	10	FC	Clenching, strong bruxism			OB closed	FR II
13 F B	11	FC mol, TC r and I canin	clenching		pterygoids	OB closed, OJ 2 mm, atypical swallowing, crowding	FR III
14 G D	12	TC mol and can		Neck ache	SCM, upper trapeze	CB ant and post, OB open	RPE + FR III
15 M F	11	SC mol	Clenching, bruxism	Yes, VAS 3-4, SCM pain		OJ 6 mm	FR II, structure 5
16 I P	12	SC	clenching	Random headache due tu study, pulsating right side	TT, lateral pterygoids	CB post, convex profile, OB closed 4-5mm, OJ 2-3 mm	FR 5 + RPE
17 M M	11	PC mol left, TC mol right, TC can right + SC left	clenching		Lateral pterygoids, masseter, TT, upper trapeze	OB closed 7 mm	FR 3
18 V A	11	FC mol right, SC mol left	Click both sides, opening on right side sometimes, clenching with attrition, bruxism	Neckache, backache, lumbar, headache, pain 8 temples and 9 TMJ right	TT, pterygoids	CB post, OB closed 4 mm, OJ 2-3 mm	RPE + FR I
19 S B	13	SC, I division	clenching	Shoulder and frontal pain (10)	TT, medial pterygoid	OB closed 5 mm, OJ 8 mm	FR 5, base 3
20 S C	8	TC mol and can, I division		Frontal pain: 6	SCM, TT, pterygoids, supra and suborbital	CB post right, incompetent lips, OB open	RPE + FR III

Table Ia. *Classification of patients.*

Patient	Age	ID	Disorders TMJ	VAS	Palpation	Intraoral exam	Treatment
1 M M	11	FC molar				Posterior bilateral cross bite, premature contact, no deviation	Hyrax appliance + lingual arch
2 N G	11	SC mol left, FC mol right				OJ 3 mm, deviation right, atypical swallowing	Lingual arch + Hawley plaque
3 M R	14	FC mola, SC skeletal				OJ 4 mm, onycophagy, oral breathing, OB 1/3	multibrackets
4 J P	13	TC skeletal, FC molar	Left articular noise with pain			OJ 1 mm, deviation (S at the opening), atypical swallowing, open bite, posterior bilateral cross bite	Hyrax appliance + Hawley plaque + speech therapist
5 R B	14	FC molar, SC scan				OJ 2.5 mm, OB 2/3	Twin block + brackets
6 C C	11	Molar left FC, TC molar right TC, FC skeletal	Left articular noise with pain, bruxism and cleching				Quad-helix without arms + brackets
7 M M	8	SC mol and can, SC skeletal				Atypical swallowing	McNamara for maxillary disjunction + Hawley plaque + speech therapist
8 D M	10	FC skeletal, SC mol and can				Opening left deviation	Quad-helix without arms + brackets

9 M T	8	TC mol and can, TC skeletal				OJ 2 mm, atypical swallowing, open bite, posterior right cross bite, maxillary retrognathia	Maxillary disjunction with McNamara + facial mask
10 A T	12	TC mol and can				Anterior cross bite	brackets
11 S S	11	SC skeletal, FC mol and can				Anterior cross bite, OJ 2.5 mm, Atypical swallowing, reduced airways	McNamara + transpalatine bar
12 J F	12	SC mol incomplete right, FC mol left				Atypical swallowing, OJ 6.5 mm right-left, opening deviation	Quad-helix without arms + brackets
13 I F	10	FC mol and can, TC skeletal	Articular noise, bruxism and cleching			OJ 2.5 mm, atypical swallowing, lingual interposition	Hawley plaque, McNamara + multibrackets
14 L T	9	FC, TC can	clenching			OB 1 mm	FR I
15 A S	14	SC skeletal, SC mol and can	bruxism			OJ 4 mm, atypical swallowing	Brackets + Hyrax
16 P H	13	SC skeletal, FC mol				OJ 5.5 mm, atypical swallowing, right deviation 1 mm	Multibrackets
17 I N	8	SC skeletal, FC can				OJ 0.5 mm, opening deviation (does "S"), oral breathing, atypical swallowing	McNamara + Hawley plaque + lingual arch

18 C F	14	FC skeletal, SC mol and can	Articular noise			OJ 4 mm, oral breathing, bilateral posetior cross bite	Multibrackets
19 E H	7	FC skeletal, mol and can	Bruxism			Atypical swallowing, onycophagy, right deviation 2 mm	Multibrackets
20 S C	8	TC molar and canin				Posterior right cross bite, incompetent lips, open bite	RPE + multibrackets

Considering the cases of bruxism and/or clenching, in 6 cases out of 22, there is also a mandibular deviation to the right or left, in 7 cases, the palpation of the temporalis tendon is painful, in 11 cases, there is a deep bite, in 4 cases an anterior or posterior cross-bite and in other 4 cases an overjet increased in a range from 4 to 11 mm.

The patients are treated, according to the problem, with Hyrax appliance, lingual arch, Hawley plaque, Twin-block, Multibrackets, Quad-helix, Mc Namara for maxillary disjunction, Frankel I, transpalatine bar, and face mask. Therapy with the speech therapist is also often associated.

Correlating the molar class, the overbite, and the orthodontic treatment with the TMD and parafunctions result that in the first class, there is a higher prevalence of TMD and of parafunctions, that more patients with normo and deep bite have TMD while more patients with open bite have parafunctions (Table IIa-c). Finally, there is a higher prevalence of TMD in treatments with mobile devices and of parafunctions in interceptive treatment with R.E.P./maxillary disjunctor.

Table II. *Correlation between the molar class, the overbite, and the orthodontic treatment with the TMD.*

a.

	TMD	Parafunctions
I class	11/40 patients	10/40 patients
II class	10/40 patients	8/40 patients
III class	6/40 patients	8/40 patients

b.

	TMD	Parafunctions
Normo-bite	10/40 patients	2/40 patients
Deep bite	10/40 patients	1/40 patients
Open bite	3/40 patients	5/40 patients

c.

	TMD	Parafunctions
Interceptive treatment with REP/ maxillary disjunctor	7/40 patients	8/40 patients
Treatment with mobile appliances	16/40 patients	6/40 patients
Fixed treatment	6/40 patients	7/40 patients

DISCUSSION

Some clinicians suggest that occlusal conditions such as deep bites, cross bites, and double bites are predisposing factors; other factors such as trauma, emotional stress, bruxism, and some systemic conditions may also be responsible for the development of TMD. Angle's second class, cross-bite, and instability in maximum intercuspation have been associated with higher chances of having a TMD (26, 27). The authors of two studies concluded that there was no relationship between dental classification and TMD, as Akeel and AlJasser also believe; they found no significant association between signs or symptoms of IOTN (Index of Orthodontic Treatment Need) and TMD. (28, 29). However, most authors assessing the features of malocclusions reported that the open bite, the deep bite, and the posterior cross-bite seemed to be most associated with TMD (30, 31). Runge et al. concluded that a wide interincisal angle and an increased overbite were associated with joint noises (32). In contrast, Sadowsky et al. found no significant connection between joint noise and functional occlusion (33). In 4 other studies, no connection was found between TMD and malocclusion (30). A higher TMD prevalence was observed in patients over 18 years in most studies (34, 35).

In the study conducted at the University of Cairo, there was a greater relationship between TMD cases and the first molar class rather than the second or third ones (36). Furthermore, in the cross-sectional study conducted by De Paiva Bertoli et al., the association between anxiety, malocclusion, and TMD prevalence was studied. Adolescents with high anxiety had a prevalence of TMD symptoms 4.06 times greater, while adolescents with moderate anxiety levels had a prevalence of TMD symptoms 1.94 times greater, regardless of gender (37).

Karibe et al. found a significant association between advanced head position, daytime clenching, night grinding of teeth, and TMD in adolescents (38). Thilander and Bilgiç (2017) found a significant association between Class III and TMD (39, 40). It has been stated that an altered occlusion can cause disorders in oral function and also psychosocial problems due to the dentofacial aesthetic compromise; a high prevalence of malocclusions has been reported in children and adolescents, ranging from 39 to 93%.

A significant association was found between TMD pain and negative O.V.B. in the cross-sectional study by Perrotta, Bucci, and Simeon in 2019 (41). There was a statistically significant association also between TMD pain and unilateral cross-bite, such as between TMD pain and bilateral cross-bite. In the sample studied (700 children aged 9 to 11 years), the high frequency of parafunctions was significantly associated with TMD pain. In the study of Tecco, Nota et al. emerges that the TMD signs and/or symptoms were 1.6 times more frequent in subjects with Class II/first division than subjects in Class I, as well as joint noises (2.75 times more frequent). For myalgia, females had a higher prevalence (1.96 times) and were statistically significant than males (42).

Finally, the study by Tecco S., Macrí M., Polimeni A., & Festa, F. demonstrated a higher prevalence of myofascial pain among subjects aged between 12 and 15 years compared to those aged 5 to 11 years and also a higher prevalence in the female sex (21). In addition, TMD signs and symptoms and reduced functional movements were found more frequently in subjects with unilateral posterior cross-bite than in subjects with anterior or posterior bilateral cross-bite.

In the Rinchuse study comparing various systematic reviews, few associations were established between malocclusion or functional occlusion and TMD signs and symptoms. The only positive relationship that emerged was 1) between the number of crowded posterior teeth and the subjective symptoms of dysfunction and 2) between abrasions and clinical dysfunctions. Puberty has been associated with more pain conditions, such as headache, abdominal pain, and musculoskeletal pain, and it is conceivable that puberty development and related hormonal, physical, and psychosocial changes could influence the genesis, onset, and/or the maintenance of temporomandibular disorders (TMD) (43).

In the systematic review of Song, the association between TMD and pubertal development is studied, and the prevalence of temporomandibular pain (of the masticatory muscles and/or the A.T.M.) increases with the advancement of pubertal development; in fact, it affected

Fig. 1. *Interdental brushes in action.*

about 4% in pre-pubertal subjects and 14% in subjects who had completed pubertal development (44, 45) (Fig. 1, 2).

Fig. 2. *Cross-bite.*

CONCLUSION

The results in the current study indicate that the prevalence of temporomandibular dysfunctions is 80% in Chieti patients and 55% in Murcia patients, considering joint clicks, the presence of bruxism, and/or clenching and opening deviation as pathognomonic signs. The chi-square value (1, n = 40) obtained is equal to 2,849, and the p-value is .091431; therefore, the difference between the two groups is not statistically significant at the 5% probability level ($p > 0.05$).

We observed a significant association between TMD and deep bite, considering the occlusal interferences, and also between the first molar and/or skeletal class, considering malocclusions.

Finally, we can conclude that very often, in the presence of joint noise and tooth-grinding and/or bruxism, there is also a mandibular deviation in the opening.

Author contributions

M.M. and F.F. designed the research study. M.S.M. performed the research. M.S.M. and P.C. wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

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