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Prevalence of static and dynamic dental malocclusion features in subgroups of temporomandibular disorder patients: Implications for the epidemiology of the TMD-occlusion association

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Objective: The hypothesis that dental malocclusions may be a risk factor for temporomandibular disorders (TMD) has been greatly debated in the literature. Whilst the association between features of dental occlusion and TMD has been proven weak, if existing, it seems that the transfer of such knowledge into clinical practice is yet to be completed. This study evaluated the prevalence of static and dynamic malocclusion features in a population of TMD patients and compared it with literature data on the general population. **Method and Materials:** A total of 625 consecutive TMD patients (75% female; aged 34.2 ± 6.7 years, range 25–44 years) were examined and were clustered into four groups on the basis of pain absence (ie, disk displacement and/or arthrosis without pain), or pain presence within the muscles and/or the temporomandibular joint (TMJ). As for the occlusal features, posterior crossbite, excessive overbite, anterior open bite, excessive overjet, and molar and canine asymmetry were recorded as static malocclusion findings. Medio-/laterotrusive interferences and slide length from retruded contact position (RCP) to maximum intercuspation (MI) ≥ 2 mm were also recorded as dynamic malocclusion findings. The ϕ correlation coefficient assessed the strength of the correlation between each occlusal feature and the presence of pain-related TMD condition. **Results:** No significant correlation was seen between the various malocclusion findings and the presence of any pain-related TMD condition, with ϕ values ranging from -0.081 to +0.043 for molar asymmetry and laterotrusive interferences, respectively. The prevalence findings in this TMD population were within the range reported from general population studies. **Conclusions:** In adult subjects, static or dynamic malocclusion findings show similar prevalence irrespective of the presence of any specific pain-related TMD condition. Also, the prevalence values are similar to the available data at general population level. Based on the above, general practitioners should note that occlusal features may not be considered a discriminant factor for TMD. *(doi: 10.3290/j.qi.a32986)*

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The term temporomandibular disorders (TMD) is an umbrella grouping together heterogenous conditions affecting the temporomandibular joint (TMJ), the masticatory muscles, and the near structures. The hypothesis that features of dental occlusion may be a risk factor for TMD has been debated in the literature. Recent papers summarized findings from complex multiple

variable studies and suggested that the role of the various occlusal features is less important than believed in the past.[1,2] According to this recent evidence, the paradigm for TMD etiology is shifting from peripheral (eg, occlusal and anatomical factors) to central (eg, psychosocial, neurologic) factors.[3,4]

In spite of this suggestion, some communities of clinical practitioners still focus most teaching and clinical activities on the diagnosis of purported malocclusion features as an important issue for TMD treatment and prevention, also suggesting that their correction should be part of TMD practice.[5-7] However, such an approach would not be supported by the evidence-based suggestions, according to which irreversible occlusal changes (ie, occlusal adjustments, prosthodontics, or orthodontic treatments) are not recommended to either prevent or treat TMD.[8,9] Nonetheless, the proponents of an occlusally oriented approach may find support in some experimental research findings that TMD patients may have some occlusal peculiarities with respect to healthy subjects.[10,11] Also, the fluctuating and self-limiting nature of TMD symptoms and the good treatment outcomes that can be achieved with simple therapies in the majority of patients may lead practitioners to interpret positively the effects of an invasive treatment approach.[12,13]

Within this framework, general dental practitioners, who are not always able to draw the mainstream messages of the literature, are exposed to cognitive errors[14] and experience difficulties in the translation of research findings into their clinical activities (known as the science transfer process).[15,16] For instance, whilst the amount of multiple regression studies showing that occlusal features account only for a minimal part of the variance for TMD is impressive,[17-21] it can also be argued that such a statistically oriented approach to the etiology of a disease is not easily verified at the general practitioners' chairside.

A possible strategy to ease the science transfer process is to simplify the investigations on this issue, so as to improve their readability and diffusion among general dentists. In the case of TMD practice, reporting the prevalence of dental occlusion features in patient populations, with focus on potential malocclusion findings, and critically discussing the data with respect to the available information on the corresponding prevalence in non-patient samples might help readers visualize better the findings on the TMD-occlusion relationship.

Based on these premises, this investigation had the twofold aim to:

- describe the prevalence of malocclusion features in a population of adult patients seeking advice for TMD signs and symptoms
- discuss such prevalence data in the light of the available knowledge on the prevalence of the same dental malocclusion features at the community level.

METHOD AND MATERIALS

The study sample was composed of 625 consecutive TMD patients (75% female; 34.2 ± 6.7 years, range 25–44 years) who satisfied inclusion criteria and were referred to the Temporomandibular Disorders Clinic, Department of Maxillofacial Surgery, University of Padova, Italy, for TMD advice during the years 2011 and 2012. Inclusion criteria were as follows:

- age between 25 and 45 years
- absence of any dental, periodontal, or other intraoral causes for pain
- absence of partial edentulism that determined the absence of molar support
- absence of fibromyalgia, as diagnosed in accordance with the American College of Rheumatology criteria[22]
- absence of rheumatoid arthritis or other rheumatic disorders, as diagnosed in accordance with the American Rheumatism Association criteria[23]
- no history of drugs or alcohol abuse
- absence of any mental or psychiatric disorders.

Clinical assessment for TMD was performed according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) guidelines[24] by the same trained operator with expertise in TMD clinical assessment and research methodology.[25] According to such

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Fig 1 Posterior crossbite. The prevalence in our TMD patient population (25.0%) was similar to the prevalence described in studies on adult general population, ranging from 7.9% to 30.6%.

Fig 2 Excessive overbite (≥ 4 mm) had a prevalence in the current TMD patient population (21.1%) that is within the range of the prevalence at the general population level (12.3% to 23.8%).

Fig 3 Open bite was shown in 7.4% of the study population. It was the only feature showing a slightly higher prevalence with respect to the available literature data at the general population level (3.3% to 7.1%).

Fig 4 Excessive overjet (≥ 5 mm), as shown in this lateral view, had a prevalence in the current TMD patient population (11.6%) that is within the range of the prevalence at the general population level (6.2% to 36.8%).

guidelines, standardized techniques for muscle and joint palpation are performed to assign axis I physical diagnoses of muscle disorders (ie, myofascial pain with or without limited opening), disk displacement (ie, disk displacement with or without reduction, with or without limited opening), and/or other joint disorders (ie, arthralgia, osteoarthrosis, osteoarthritis). In this regard, it should be borne in mind that the updated version of such diagnostic criteria, now called DC/TMD,[26] was not available at the time of this investigation.

The following occlusal features were accurately recorded for each patient, based on protocols adopted in previous studies:[20,21,27,28]

- posterior crossbite recorded when the buccal cusps of any of the maxillary premolars and molars totally occluded lingually to the buccal cusps of the antagonist mandibular teeth (Fig 1)
- overbite recorded as normal if the maxillary central incisors overlapped the crown of the mandibular central incisors for up to 3 mm, and excessive when ≥ 4 mm (Fig 2)
- open bite recorded when no overlap was seen between the maxillary and mandibular incisors, including an edge-to-edge relationship (Fig 3)
- overjet defined as the horizontal distance between the labial surface of the anterior maxillary and the anterior mandibular central incisor, parallel to the occlusal plane (up to 4 mm of overjet were considered normal and values ≥ 5 mm were considered excessive) (Fig 4)

Fig 5a Among the various dynamic malocclusion features, a slide from RCP to MI ≥ 2 mm has been shown by the literature to be a potential, even if weak, risk factor for TMD.[21] Its prevalence in our TMD patients was up to 42.9%, but it was not comparable with general population data due to the absence of investigations on the topic. The figure shows centric relation contacts on the palatal surface of the maxillary incisor that force backward the inferior teeth.

Fig 5b Maximum intercuspation. Note the posterior shift from the previous centric position.

- molar and canine asymmetry between Angle classes of the two sides
- mediotrusive and laterotrusive interferences within the first millimeters of the lateral excursions identified by 40-µm thick articulating paper (Baush Dental)
- retruded contact position to maximum intercuspation (RCP-MI) slide length calculated in the three spatial axes after manual mandibular distraction (the RCP-MI slide was considered normal when < 2 mm, and excessive when ≥ 2 mm)
- laterotrusive interferences (Fig 5).

The protocol was reviewed and approved by the Institutional Review Board of the University of Padova.

Descriptive statistics, as percentages of patients in which they were recorded positively, were reported for all the above occlusal variables and categorized as:

- posterior crossbite (no, yes)
- overbite (normal, excessive)
- open bite (no, yes)
- overjet (normal, excessive)
- molar and canine asymmetry (no, yes)
- mediotrusive/laterotrusive interferences (no, yes)
- RCP-MI slide (normal, excessive).

With the purpose of comparing the prevalence of the occlusion features, the patients were clustered into four groups on the basis of the absence of any painful diagnosis (ie, painless disk displacement [n = 115], painless osteoarthrosis [n = 33], painless combined disk displacement and osteoarthrosis [n = 112], absence of any RDC/TMD diagnoses [n = 42]), or presence of muscle pain (n = 80), joint pain (n = 113), or combined muscle and joint pain (n = 130).

Comparison of the prevalence of the assessed malocclusion findings with respect to sex (male or female) and pain-related TMD diagnoses (no pain, muscle pain, joint pain, or combined pain) was performed by means of the Phi (ϕ) coefficient. This coefficient is a measure of the degree of association between two binary variables and is similar to the correlation coefficient in its interpretation. ϕ coefficient values range from −1.0 to +1.0, indicating different levels of negative or positive correlation. As a general rule for correlation analyses, values higher than 0.7 are considered supportive of a strong positive correlation.[29] All statistical procedures were performed with the software SPSS.

RESULTS

The prevalence of each malocclusion feature in the whole group and according to the sex, irrespective of the TMD diagnosis, is summarized in Table 1. The prevalence was higher for the dynamic malocclusion features

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Table 1 Prevalence of the various malocclusion findings in the overall study group (n = 625), male (n = 153) and female subjects (n = 472)

Occlusal feature	Overall prevalence (%)	Prevalence in males (%)	Prevalence in females (%)	ϕ coefficient (correlation with gender)*
Posterior crossbite	25.0	22.9	25.7	0.028
Increased overbite (≥ 4 mm)	21.1	23.5	20.3	–0.340
Anterior open bite	7.4	7.8	7.2	–0.011
Increased overjet (≥ 5 mm)	11.6	7.4	13.0	0.076
Molar asymmetry	20.5	18.7	21.1	0.153
Canine asymmetry	23.9	21.9	24.2	0.135
Mediotrusive interferences	42.9	40.1	43.7	0.031
Laterotrusive interferences	29.9	24.2	31.7	0.071
Slide RCP-MI ≥ 2 mm	42.4	48.7	40.4	–0.072

*Phi coefficient refers to the values of correlation of the various occlusal features with sex.

Table 2 Prevalence of the various malocclusion findings in subjects without TMD pain (ie, having TMJ disk displacement and/or arthrosis without pain or not receiving any RDC/TMD diagnoses), with muscle pain alone, joint pain alone, or combined muscle and joint pain

Occlusal feature	Prevalence in subjects without pain (n = 302) (%)	Prevalence in subjects with muscle pain (n = 80) (%)	Prevalence in subjects with joint pain (n = 113) (%)	Prevalence in subjects with combined pain (n = 130) (%)	ϕ coefficient (correlation with pain)
Posterior crossbite	23.9	31.6	29.2	20.0	0.024
Increased overbite (≥ 4 mm)	20.1	22.7	19.4	23.8	0.031
Anterior open bite	6.6	3.7	10.6	8.4	0.000
Increased overjet (≥ 5 mm)	11.1	5.2	10.8	17.1	0.002
Molar asymmetry	22.1	17.8	23.3	15.8	–0.081
Canine asymmetry	24.1	20.8	24.2	24.7	–0.047
Mediotrusive interferences	41.1	42.3	46.0	44.9	0.025
Laterotrusive interferences	28.9	35.0	25.6	33.0	0.043
Slide RCP-MI ≥ 2 mm	42.6	34.1	43.3	46.8	–0.017

*Phi coefficient refers to the values of correlation of the various occlusal features with pain groups.

(ie, medio/laterotrusive interferences and slide RCP-MI ≥ 2 mm), which ranged from 29.9% to 42.9%, than for all the other static malocclusion findings. In the study population, the static malocclusion findings showed a prevalence of between 7.4% for anterior open bite and 25.0% for posterior crossbite. Regarding sex comparison, no relevant correlations were shown by the ϕ coefficients, with the highest value being as low as 0.153 for molar asymmetry between the two sides (Table 1).

The prevalence of each malocclusal feature according to the absence of pain or the presence of pain-related TMD diagnoses, is summarized in Table 2. Among all the groups, prevalence of posterior crossbite was between 20.0% (combined pain) and 31.6% (muscle pain), prevalence of increased overbite was between 19.4% (joint pain) and 23.8% (combined pain), prevalence of anterior open bite was between 3.7% (muscle pain) to 10.6% (joint pain), prevalence of increased overjet was between 5.2% (muscle pain) to 17.1% (combined pain), prevalence of molar asymmetry was between in 15.8% (combined pain) to 23.3% (joint pain), and prevalence of canine asymmetry was between 20.8% (muscle pain) to 24.7% (combined pain). Finally, for the dynamic malocclusion traits, prev-

Table 3 Prevalence of the various malocclusion findings in the overall study group (n = 625) and comparison with available literature data on adult (> 18 years) general population. Note that no literature data are available on the prevalence of dynamic malocclusion findings at general population level.

	Occlusal feature	Current investigation (%)	Lavelle[30] (%)	Ingervall et al[31] (%)	Tod and Taverne[32] (%)	Proffit et al[33] (%)	Hensel et al[34] (%)	Jonsson et al[35] (%)	Claudino and Traebert[36] (%)
Static features	Posterior crossbite	25.0	17	7.9	30.6	na	29.7	12.3	na
	Increased overbite (≥ 4 mm)	21.1	23.3	16.3	13	15.2	23.8	12.3	na
	Anterior open bite	7.4	4.2	na	4.2	3.3	3.6	1.1	7.1
	Increased overjet (≥ 5 mm)	11.6	16.7	10.7	16.2	na	36.8	6.2	19.5
	Molar asymmetry	20.5	na	na	na	na	na	31.5	26.1
	Canine asymmetry	23.9	na	na	na	na	na	na	na
Dynamic features	Mediotrusive interferences	42.9	na	na	na	na	na	na	na
	Laterotrusive interferences	29.9	na	na	na	na	na	na	na
	Slide RCP–MI ≥ 2 mm	42.4	na	na	na	na	na	na	na

na, not available.

alence of mediotrusive interferences was between 41.1% (no pain) and 46.0% (joint pain), prevalence of laterotrusive interferences was between 25.6% (joint pain) and 35.0% (muscle pain), and prevalence of slide RCP-MI ≥ 2 mm was between 34.1% (muscle pain) and 46.8 (combined pain). No significant correlation was seen between the various malocclusal features and the presence of any pain-related TMD diagnoses, with ϕ values ranging from –0.081 to +0.043 for molar asymmetry and laterotrusive interferences, respectively.

Comparison of findings from this investigation on TMD patients with respect to the available data from previous investigations performed at the community level is shown in Table 3. As a general remark, the absence of general-population literature data on the prevalence of dynamic malocclusions should be noted. As for static malocclusion features, prevalence findings in the present TMD population were within the prevalence range from general population studies, with the exception of a slightly higher prevalence of anterior open bite (7.4% vs 1.1% to 7.1%) and a lower prevalence of molar asymmetry (20.5% vs 26.1% to 31.1%).

DISCUSSION

The purported importance of dental malocclusion as a main cause of joint and muscle disorders has been a paradigm of the dental profession for decades.[37] Based on that, generations of dentists have been educated according to the concept that all dental features not satisfying the requisites for an "ideal" occlusion may lead to detrimental consequences on the stomatognathic structures. As a consequence, it is not surprising that most general practitioners have not yet appraised the ongoing paradigm shift in the field of temporomandibular disorders and orofacial pain. Indeed, the application of multiple variable models to the study of human biology allowed dismantling the old occlusal theories, since it was shown that occlusal features may explain, at best, one-fourth of the variance for TMJ disorders.[17-19] Recent systematic reviews on this topic suggested that the causal relationship between dental occlusion and TMD is weak, whenever existent.[1,38]

By adopting a very simple strategy for data presentation, the present investigation aimed to help general dental practitioners further appraise this paradigm shift from a dentally based to a non-dentally based TMD practice. In a population of adult patients seeking TMD advice at a specialist tertiary University Clinic, some features of dental occlusion that are commonly considered "malocclusions" were assessed, and the observed data were not supportive of any specific high prevalence values. With the exception of some inter-

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ferences during dynamic occlusion, such as mediotrusive interferences and slide RCP-MI ≥ 2 mm, more than 30% of TMD patients presented some malocclusion features, and similar prevalence of asymptomatic subjects showed the presence of various static malocclusal findings. Such data may intuitively suggest that features of static occlusion are not a relevant factor to determine the presence of TMD symptoms, either in males or in females. On the other hand, dynamic interferences associated with dental instability may represent an important feature to assess in TMD patients because of the potential orthopedic instability at joint level. This observation is in line with studies suggesting that a centric slide is the main occlusal risk factor for TMD.[2]

As for the prevalence of dental malocclusion with respect to various TMD-pain locations, no relevant differences between groups were identified, thus confirming that the discriminatory capability of dental occlusion to detect TMD subgroups would be minimal.

Findings from this investigation are not easily comparable with literature suggestions on the prevalence of the various occlusal features in the adult general population because of the very few papers on the topic. In particular, to our knowledge, the prevalence of dynamic malocclusion findings was never assessed at community level. As for the features of static occlusion assessed in the present investigation, almost all the prevalence data fell within the literature range on general population samples. A study on young adults from Brazil found that the prevalence of anterior open bite (7.1%) is comparable to the present findings (7.4%), whilst other studies reported lower prevalence rates in Swedish, British, Australian, US, German, and Icelandic populations.[30-35] The prevalence of molar asymmetry in the two general population studies assessing such occlusal features was higher than the present TMD patient population (26.1% to 31.5% vs 20.5%).[35,36] As for all the other static variables (ie, large overjet, posterior crossbite, increased overbite), some general population studies showed higher prevalence rates than the present investigation, whilst others reported lower prevalence data. For instance, a Swedish study described lower prevalence rates as far as the posterior cross bite (7.9%), the excessive overjet (10.7%), and overbite (16.3%) were concerned.[31] On the contrary, findings in an adult population from north-east Germany showed that the prevalence of deep bite (23.8%), increased overjet (36.8%), and crossbite (29.7%) are appreciably higher than in the TMD population of the present study.[34] In addition, the same study found that an anatomically correct dentition was present only in 7.8% of the sample, while 92.2% of the subjects had malocclusion findings varying in number and severity.[34] However, that study did not analyze the presence of any TMD. Another work on a representative adult population from central Germany showed that more than 58% of subjects presented some jaw misalignments or dental malocclusions that should require orthodontic treatment.[39]

In spite of this high prevalence of "malocclusion" in the adult population, the prevalence of treatment-demanding TMD is not so common, occurring in approximately 10% of the population over age 18.[40] Also, there is increasing evidence that the severity of clinical TMD symptoms depends more on psychosocial than physical symptoms.[41] Thus, the increasing demand for orthodontic treatment in the adult population should not be based on TMD prevention or treatment and should be justified mainly by the greater importance given to facial esthetics or dento-periodontal health. The request of improvement of oral function is not the primary motivation for receiving orthodontic care.[42-44]

From a methodologic viewpoint, it should be borne in mind that a matched comparison between findings from the present and previous investigations was not possible, due to the age, sex, and racial/ethnic differences between the investigated populations as well as to the different diagnostic strategies adopted to record the occlusal features. On the other hand, the high prevalence of dental "malocclusion" in adult, orthodontically untreated, TMD-asymptomatic populations may help general practitioners to realize that assuming a direct causal link between any particular occlusal feature and TMD is no longer justifiable.

CONCLUSIONS

The present investigation in a TMD patient population was designed to report the prevalence of features of static and dynamic occlusion that were commonly considered malocclusion findings. General dental practitioners had been accustomed for years to provide occlusally based treatments to their TMD patients and are reluctant to accept any paradigmatic shifts in daily practice. Findings from the present study, which showed similar prevalence rates for the various occlusal features in TMD patients with respect to literature data at the general population level, should help to make clear that the assessment of dental occlusion cannot yet be considered an aspect of major importance within the TMD practice.

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