Original Article

Dental malocclusion is not related to temporomandibular joint clicking: a logistic regression analysis in a patient population

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ABSTRACT

Objectives: To assess the association of several dental malocclusion features with temporomandibular joint (TMJ) click sounds in a population of temporomandibular disorder (TMD) patients.

Materials and Methods: Four hundred forty-two TMD patients (72% female; 32.2 ± 5.7 years, range 25–44 years) were divided into a TMJ clicking and a no-TMJ clicking group, based on the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) assessment. Seven occlusal features were recorded for each patient: (1) posterior crossbite, (2) overbite, (3) open bite, (4) overjet, (5) mediotrusive and (6) laterotrusive interferences and (7) retruded contact position to maximum intercuspation (RCP-MI) slide length. A logistic regression model was created to estimate the association of occlusal features with TMJ clicking.

Results: The difference between the groups as for the prevalence of the various occlusal features was generally not statistically significant, with minor exceptions. Mediotrusive interferences ($P = .015$) and RCP-MI slide ≥2 mm ($P = .001$) were the two occlusal features that were associated with the probability of having TMJ clicking, even if the adjusted odds ratios for TMJ clicking were low for both variables (1.63 and 1.89, respectively). Moreover, the amount of variance in the prevalence of TMJ clicking that was predicted by the final model was as low as 4.5% ($R^2 = 0.045$).

Conclusions: Findings from the present investigation suggested that in a population of TMD patients, the contribution of dental malocclusion features to predict TMJ click sounds is minimal with no clinical relevance. (*Angle Orthod.* 0000;00:000–000.)

KEY WORDS: Temporomandibular joint; Dental occlusion; Clicking; Disc displacement

INTRODUCTION

Temporomandibular disorders (TMDs) are a heterogeneous group of conditions affecting the temporomandibular joint (TMJ) and/or the jaw muscles.[1] These disorders have a multifactorial etiology, providing that a number of risk factors interact at the individual level and determine the onset of clinical signs and symptoms.[2] Through a compelling insight on the mutual interactions of pain, bruxism, and psychosocial factors, the pathophysiology of TMDs may be further clarified.[3] In general terms, and in line with other similar musculoskeletal disorders, the onset of signs and symptoms may be the result of an altered equilibrium between those factors that load the musculoskeletal system and others that influence the resistance to load.[4]

In spite of early suggestions,[5] the role of dental malocclusion in the etiology of TMDs has been diminished over the years,[6] also due to the wide use of dedicated approaches for the study of multifactorial biological models.[7] In this regard, multiple variable models have shown that the various dental malocclusion features have much lower importance than believed in the past to explain, among the others, the presence of TMJ inflammatory-degenerative disorders,[8] myofascial pain of jaw muscles,[9] and pain in the TMJ.[10]

Notwithstanding that there are still some claims that malocclusion traits may be associated with the onset of temporomandibular disorders, there are still some issues to be clarified.[11,12] In particular, it must be

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Accepted: June 2013. Submitted: April 2013.
Published Online: August 19, 2013

pointed out that the role of dental occlusion cannot be considered negligible because it may determine the patterns of load distribution on the temporomandibular joints, thus acting as a factor that could influence the overall resistance of the musculoskeletal system.

Thus, the potential role of malocclusion in TMD patients is still worthy of exploration. This is especially true if one considers the high prevalence of purported malocclusion traits,[13,14] the clinical relevance of which should be assessed by evaluating their potential association with functional disturbances. For instance, focus should be put on the relationship between the various malocclusion features and positional abnormalities of the TMJ discs, as identified by joint click sounds, which are an early sign of altered TMJ biomechanics. Based on this premise, the present investigation was performed to assess the association of several dental malocclusion features with TMJ clicking in a population of temporomandibular disorder patients.

The primary hypothesis under testing was that dental malocclusion features are associated with TMJ clicking, irrespective of the joint side. The secondary hypothesis was that side-specific associations between clicking joints and dental malocclusion features exist.

MATERIALS AND METHODS

Patients and Study Design

The study sample was composed of 442 consecutive TMD patients (72% female; 32.2 $\pm$ 5.7 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 2011. Patients were divided into two groups that were referred to as a "TMJ clicking group" and a "no-TMJ clicking group."

Inclusion criteria were as follows: (1) age between 25 and 45 years; (2) absence of fibromyalgia, as diagnosed in accordance with the American College of Rheumatology criteria[15]; (3) absence of rheumatoid arthritis or other rheumatic disorders, as diagnosed in accordance with the American Rheumatism Association criteria,[16] (4) no history of drugs or alcohol abuse; and (5) absence of any mental or psychiatric disorders. Main occlusal features were recorded in each patient and their associations with the presence of TMJ clicking were investigated. The protocol was reviewed and approved by the institutional review board of the University of Padova.

Diagnosis of Temporomandibular Disorders

A clinical assessment for TMD was performed according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) guidelines[17] by the same trained operator with expertise in TMD clinical assessment and research methodology.[18] Patients were divided into two groups on the basis of the RDC/TMD Axis I Group II diagnosis; they were assigned on the presence of either (1) reciprocal clicking in TMJ (click on both vertical opening and closing that occurs with an interincisal distance at least 5 mm greater on opening than on closing and is eliminated on protrusive opening), reproducible on two of three consecutive trials; or (2) clicking in TMJ on both vertical range of motion (either opening or closing), reproducible on two of three consecutive trials, and clicking during lateral excursion or protrusion, reproducible on two of three consecutive trials.[17]

Recording of Occlusal Features

The following occlusal features were also accurately recorded for each patient, based on protocols adopted in previous studies[10,14,19]: (1) 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; (2) overbite recorded as normal if the maxillary central incisors overlapped the crown of the mandibular central incisors for up to 3 mm, normal as $<$4, and increased when $\geq$4 mm; (3) open bite recorded when no overlap was seen between the maxillary and mandibular incisors, including an edge-to-edge relationship; (4) overjet defined as the horizontal distance between the labial surface of the anterior upper maxillary and the anterior mandibular central incisor, parallel to the occlusal plane (overjet values $<$5 mm were considered normal and values $\geq$5 mm were considered increased); (5) mediotrusive and (6) laterotrusive interferences within the first millimeters of the lateral excursions identified by 40-μm thick articulating paper (Baush Dental KG, Köln Germany); and (7) retruded contact position to maximum intercuspation (RCP-MI) slide length calculated in the three spatial axes after manual mandibular distraction. The RCP-MI slide values $<$2 mm were considered normal and present when $\geq$2 mm. Finally, the laterotrusive interferences were also recorded as being on the left or right sides.

Statistical Analysis

Descriptive statistics, as percentages and counts, are reported for the following occlusal variables (categories): posterior crossbite (no, yes); overbite (normal, $\geq$4 mm); open bite (no, yes); overjet (normal, $\geq$5 mm); mediotrusive/laterotrusive interferences (no, yes); RCP-MI slide (normal, $\geq$2 mm). The prevalence of each occlusal feature was crosstabulated with either the TMJ clicking or the no-TMJ clicking group.

Table 1. Prevalence (as Percentage) of the Various Malocclusal Features in Each Group and Univariate Inferential Analyses[a]

	Group		
Occlusal Features	TMJ Clicking (n = 253), %	No-TMJ Clicking (n = 189), %	Diff
Crossbite	65.3	54.2	0.035
Overbite ≥4 mm	60.7	56.7	0.503
Open bite	52.9	57.8	0.579
Overjet ≥5 mm	57.6	57.1	0.944
Mediotrusive interferences	63.1	52.6	0.027
Laterotrusive interferences	58.6	56.9	0.742
RCP-MI slide ≥2 mm	64.7	50.4	0.003

[a] TMJ indicates temporomandibular joint; Diff, significance of the difference between the groups; RCP-MI, retruded contact position to maximum intercuspation.

A chi-square test was used to assess the significance of the differences in the distributions of these categories within each variable between the groups. Then, logistic regression models were created to test the primary and secondary hypotheses.

For the primary hypothesis, all of the dental malocclusion features were entered in a backward stepwise multiple logistic regression to estimate the adjusted odds ratios (ORs), along with the 95% confidence intervals with the presence of TMJ clicking irrespective of the side. The normal condition for every occlusal feature was considered the reference category. Significance needed for removal was set at $P \geq .10$ and significance for reentry at $P \leq .05$. The adjusted OR describes the association between a particular explanatory variable and the TMJ clicking group, while simultaneously controlling for all other variables. The Nagelkerke R^2 was also retrieved for each model as an estimation of the total log likelihood explained by a summation of the significant occlusal factors. In particular, the R^2 in a logistic regression model represents the amount of variability in the dependent variable (prevalence of TMJ clicking) that can be accounted for by the explanatory variables (occlusal factors).[20]

For the secondary hypothesis, the same regression analysis was performed separately for either right or left TMJ clicking, entering the side-specific mediotrusive/laterotrusive interferences among the explanatory variables.

All data were analyzed using the statistical software Statistical Package for the Social Sciences, SPSS 19.0 (SPSS Inc, Chicago, Ill), and a P value $< .05$ was considered statistically significant.

RESULTS

Demographic Data

The TMJ clicking group included 253 patients (70% female) with a mean age of 31.8 ± 6.7 years; the no-TMJ clicking group included 189 patients (74% female) with a mean age of 33.9 ± 4.5 years. The groups were similar for sex distribution and age.

Prevalence of Occlusal Features in Patients With TMJ Clicking

The prevalence of the different occlusal features in the TMJ clicking group ranged between 52.9% in subjects with an anterior open bite to 65.3% in subjects with posterior crossbite, while prevalence of the various occlusal features in the no-TMJ clicking group ranged between 50.4% and 57.8% (Table 1). The differences between the groups were generally not statistically significant, with the exception of the RCP-MI slide ≥2 mm ($P = .003$), mediotrusive interferences ($P = .027$), and posterior crossbite ($P = .035$), the prevalence of which was greater in the TMJ clicking group than in the no-TMJ clicking group.

Primary Hypothesis Testing

Mediotrusive interferences ($P = .015$) and RCP-MI slide ≥2 mm ($P = .001$) were the only two occlusal factors that were associated with TMJ clicking in the multiple logistic regression analysis. The adjusted ORs for the presence of TMJ clicking were generally low for both variables (1.63 and 1.89 for mediotrusive interferences and RCP-MI slide ≥2 mm, respectively). Moreover, the amount of variance in the prevalence of TMJ clicking that was predicted by the final model was as low as 4.5% ($R^2 = 0.045$) (Table 2).

Secondary Hypothesis Testing

Regarding the association of the side-specific mediotrusive/laterotrusive interferences and RCP-MI slide with side-specific TMJ clicking, only laterotrusive interferences on the left side of the dental arch

Table 2. Occlusal Features Remaining in the Final Multiple Logistic Regression Model Predicting TMJ Clicking (n = 442)[a]

Malocclusal Features	OR (95% CI)	P	R^2
Mediotrusive interferences	1.63 (1.09–2.42)	.015	0.045
RCP-MI slide ≥2 mm	1.89 (1.27–2.79)	.001	

[a] RCP-MI indicates retruded contact position to maximum intercuspation.

Table 3. Malocclusion Features Remaining in the Final Multiple Logistic Regression Models Predicting Either Left or Right TMJ Clicking (n = 442)[a]

Side of TMJ Clicking	Malocclusion Features	OR (95% CI)	*P*	R^2
Right	Left laterotrusive interferences	1.77 (1.06–2.97)	.029	0.033
	Right laterotrusive interferences	0.60 (0.33–1.08)	.092	
	RCP-MI slide ≥2 mm	1.49 (0.99–2.23)	.052	
Left	RCP-MI slide ≥2 mm	1.76 (1.17–2.64)	.006	0.024

[a] RCP-MI indicates retruded contact position to maximum intercuspation.

($P = .029$) were significant predictors for TMJ clicking in the right side. The final regression model also included the variables RCP-MI slide ≥2 mm ($P = .052$) and laterotrusive interferences on the right side ($P = .092$), with a low correlation value for TMJ clicking ($R^2 = .033$). On the contrary, RCP-MI slide ≥2 mm was the only predictor for TMJ clicking in the left side ($P = .006$), with an R^2 value of 0.024 (Table 3).

DISCUSSION

Through the analysis of a large sample of TMD patients, the present study showed no clinically relevant associations between several malocclusion features and the presence of TMJ clicking.

Historically, dental occlusion was assigned a central role in the etiology and management of TMDs because dental professionals had achieved a better know-how and had seen more TMD patients than other professionals. Over the years, however, a growing body of evidence has been gathered in support of a diminished role of occlusal abnormalities and misalignments in the etiology of TMDs.[21] In particular, findings from studies adopting multifactorial models of disease suggested that dental occlusion features are poorly associated with muscle and TMJ pain,[7,9,10] thus confirming that other factors (ie, bruxism activities, psychosocial factors) are fundamental for pain symptoms to occur.[22] On the other hand, there is some orthodontic and maxillofacial surgery literature suggesting the existence of a possible skeletal predisposition to TMJ disc displacement due to peculiar features of facial morphology.[23,24] Thus, the possibility that certain occlusal features may be associated with an increased risk for disc displacement was worthy of investigation.

In the present investigation, the presence of a click sound as diagnosed according to the RDC/TMD,[17] the strength of association between occlusal variables, and TMJ clicking in a population of TMD patients was low (Table 2). In particular, the amount of variance for TMJ clicking explained by the malocclusion features was very poor (4.5%) and suggestive of the fact that other factors need to be investigated to find more reliable predictors of disease-specific signs and symptoms. The only variables that were seen to be significantly associated with TMJ clicking in the multivariate models were the presence of mediotrusive interferences and a RCP-MI slide ≥2 mm. However, neither of these malocclusion features reached OR values for the presence of TMJ clicking that can be considered clinically relevant, ie, greater than 2, as suggested in previous publications.[7]

Notwithstanding that, it must be pointed out that both malocclusion features have a common characteristic, ie, they are a sign of occlusal instability, thus being potentially associated with orthopedic instability at the level of the TMJ. Some early literature studies suggested that this condition may be considered a risk factor for the development of an anterior TMJ disc displacement.[25,26] Thus, the present findings of an association between dental instability and TMJ clicking, although with little clinical relevance (Table 2), may support at least in part the hypothesis that a stable occlusion is important to keep the physiologic relationship between joint structures. Further studies adopting magnetic resonance imaging (MRI) as the standard of reference to depict the TMJ disc status are needed to confirm these findings and the actual relationship with disc displacement. In particular, the clinical relevance of the presence of TMJ clicking in patient care should be further appraised in light of recent suggestions that disc displacements that are predicted by clinical RDC/TMD assessment show good to excellent agreement with MRI findings.[27]

Based on those findings, attempts to define the potential influence of side-specific interferences on side-specific TMJ clicking were also made in the present study. This was to answer the clinical research question, ''Is side-specific (ie, right or left joint) TMJ clicking associated with a specific type of dental interference pattern (ie, RCP-MI slide, right or left mediotrusive/laterotrusive interferences)?'' Actually, no relevant predictive model was identified. The TMJ clicking in the right side was associated with RCP-MI slide ≥2 mm and laterotrusive interferences on both left and right sides of the dental arch, while TMJ clicking in the left side was associated with RCP-MI slide ≥2 mm only.

In any case, the adjusted ORs of those factors for side-specific TMJ clicking were also below the threshold for clinical relevance, and the amount of variance for right or left click sounds explained by those occlusal features was very low (2.4%–3.3%, Table 3). Thus, the presence of those variables characterizing occlusal instability would be not enough to differentiate subjects with and without TMJ clicking in a population of TMD patients. This finding is in line with observations that factors other than occlusal/orthopedic instability must be considered for defining accurately the pathophysiology of TMJ click sounds and disc displacement.[28] For instance, prolonged joint loading, especially in the form of jaw clenching, is a potential factor for overload of the joint structures, and its inclusion in anatomically-oriented regression models may help predict TMJ disorders with an increased accuracy.[29]

Taken together, findings from this investigation lend support to the literature suggesting that it is not possible to define predictable, clinically relevant models for TMDs that are based on the analysis of dental occlusion alone.[6,21] It is likely that the few malocclusion features that were seen to be associated with TMDs, even if weakly, represent a small portion of the complex picture of factors that should be entered in a multifactorial model for disease.

CONCLUSIONS

Findings from the present investigation suggest that:

- In a population of TMD patients, the contribution of dental malocclusion features to predict TMJ clicking is minimal, with no clinical relevance.
- Based on these findings, orthodontic correction of dental malocclusion for managing TMJ click sounds potentially associated with disc displacement should not be performed.

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