Clinical Practice

Jaw clenching effects in relation to two extreme occlusal features: patterns of diagnoses in a TMD patient population

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Objective: The aim of this investigation was to compare the pattern of temporomandibular disorder (TMD) diagnoses in clenching patients with different occlusal features, the null hypothesis being that no between-group differences exist.

Materials and methods: Two groups of subjects receiving a jaw clenching diagnosis and having large overjet or anterior open bite (Group A; N=45, 75.5% females, mean age: 38.1±15.9 years) or normal occlusion (Group B; N=69, 71% females, mean age: 34.6±13.8 years) were recruited among a TMD patient population and were given Research Diagnostic Criteria for TMD (RDC/TMD) axis I diagnoses, namely, group I muscle disorders, group II disc displacements, and group III arthralgia/osteoarthritis/osteoarthrosis.

Major findings: The distribution of RDC/TMD single and combined group diagnoses was significantly different between the two groups (P<0.05), with Group A subjects showing a higher prevalence of multiple diagnoses (60% versus 43.3%), as well as a higher prevalence of combined RDC/TMD axis I group II and III diagnoses (37.8% versus 20.2%). All TMD signs and symptoms were more frequent in the patients with large overjet or anterior open bite with respect to the patients with normal occlusion.

Conclusion: In a TMD patient population, jaw clenching may have different consequences in subjects with large overjet or anterior open bite with respect to subjects featuring normal occlusion.

Keywords: Temporomandibular disorders, Clenching, Occlusion, Bruxism

Introduction

In recent years, increasing attention has been given to bruxism, with focus on its definition, etiology, epidemiology, diagnosis, and consequences on natural tooth and dental implants.[1–8] Also, the relationship of bruxism with temporomandibular disorder (TMD) has been much debated, due to the often contrasting findings of observational investigations assessing the association between the two disorders and studies on experimental tooth clenching and/or grinding.[9,10]

Researches should be performed to unravel several aspects of the TMD–bruxism relationship, especially in light of the potentially different effects of the various motor activities characterizing bruxism, namely, clenching and grinding, as well as the possibly different individual predisposition to develop symptoms based on anatomo-skeletal features. Studies on the role of the occlusal features in the etiopathogenesis of TMD suggested that the importance of dental occlusion as a risk factor for TMD is lower than believed in the past, and that an association exists only with some gross occlusal abnormalities.[11] Among those, a large horizontal overlap, namely, a large overjet, and an anterior open occlusal relationship, namely, an anterior open bite, seem to be the two occlusal features that were found to be associated with TMD in almost all studies on TMD and occlusion.[12–14] Also, occlusion has been considered the battleground on which muscle forces are exerted and through which they are transferred to the temporomandibular joint (TMJ).[15]

With these premises, it should be interesting to assess if patients with the above occlusal features are

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more likely to develop symptoms in relation to bruxism-related overload. In particular, clenching-type bruxism, which is characterized by prolonged isometric muscle contractions of high intensity, may provoke different consequences on the stomatognathic structures of patients with that occlusal predisposition, with respect to those subjects with normal occlusion.[16]

With these premises, the present investigation was performed to answer the clinical question: "in TMD patients who clench their jaws and have abnormal occlusal features, are the symptoms different with respect to those patients having normal occlusion?" Owing to the difficulties of performing longitudinal studies on this particular issue, the most suitable strategy of performing this assessment is focusing on patients seeking TMD advice. Therefore, the specific aim of this investigation was to compare the pattern of TMD diagnoses in patients receiving a jaw clenching diagnosis and having the above occlusal features, namely, large overjet or anterior open bite, with that of patients having normal occlusion. The null hypothesis was that no between-group differences exist.

Materials and Methods

This investigation was based on data recorded on patients attending the TMD Clinic, Department of Maxillofacial Surgery, University of Padova, Italy, to seek TMD advice during the years between 2007 and 2010. All patients were assessed in accordance with the Italian version of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD),[17] by one of two trained operators with expertise in TMD clinical assessment and research methodology (DM and LGN). Occlusal features were also accurately recorded for each patient, in accordance with protocols already adopted in a previous study,[14] and the two variables horizontal overlap, namely, overjet, and anterior open occlusal relationship, namely, anterior open bite, were considered for including patients in the study sample. The patients were then clinically assessed for the presence of bruxism, in accordance to a set of clinically oriented criteria that were used for the validation of polysomnographic criteria for sleep bruxism diagnosis.[18] Such criteria provided that diagnosis of bruxism was made when the patient exhibited, at least five nights a week, grinding bruxism sounds during sleep during the last 6 months, as reported by his/her bed partner, and at least one of the following adjunctive criteria: observation of tooth wear or shiny spots on restorations; report of morning masticatory muscle fatigue or pain; masseter hypertrophy upon digital palpation. In addition, patients satisfying bruxism criteria were interviewed and examined for the presence of jaw clenching-related signs (e.g. lingual scalloping, line alba). Only patients who were positive for jaw clenching were included in the data analysis.

With the above premises, the patients' clinical records were searched to identify two groups of subjects:

- Group A: patients with a clenching diagnosis showing either an overjet >5 mm or an anterior open bite;
- Group B: patients with a clenching diagnosis showing molar class I and an overjet comprised between 0 and 2 mm, with no slide from RCP (retruded contact position) to ICP (intercuspal position).

The patients were given axis I physical diagnoses on the basis of the 1992 RDC/TMD classification guidelines: group I muscle disorders, group II disc displacements, group III arthralgia/osteoarthritis/osteoarthrosis.[17] The RDC/TMD classification system allows multiple diagnoses, so that eight possible axis I diagnostic combinations ranging from the absence of any diagnoses to all the possible single and combined group diagnoses were determined to categorize patients. The prevalence of the following parameters, collected as part of the clinical RDC/TMD examination protocol, was compared between groups by means of a Chi-square test: different single and combined RDC/TMD group diagnoses; TMJ and/or muscle pain; TMJ click and crepitus sounds; pain evoked with masseter and temporalis muscles palpation. The null hypothesis was that no differences existed between the two groups of patients in the prevalence of any of the assessed clinical parameters. The level of significance for refuting the null hypothesis was set at $P<0.05$. All statistical procedures were performed with the Statistical

Table 1 Percentage of patients between the two study groups receiving the different combinations of axis I RDC/TMD diagnoses (differences were significant at $P<0.05$)

RDC/TMD group diagnoses	Group A	Group B
No axis I diagnoses	8.9	11.6
MP alone	17.8	23.2
DD alone	8.9	11.6
JD alone	4.4	10.1
MP+DD	20.0	18.8
MP+JD	2.2	4.3
DD+JD	22.2	1.4
MP+DD+JD	15.6	18.8
Any multiple diagnoses	60	43.3

Note: MP, myofascial pain (axis I group I diagnoses); DD, disc displacement (axis I group II diagnoses); JD, other joint disorders (axis I group III diagnoses).

Table 2 Percentage of patients of the two study groups referring pain upon joints or muscles and significance of the between-group differences (Chi-square test)

Pain location	Group A	Group B	Sig.
TMJ	60	39.1	0.026
Jaw muscles	40	39.1	0.926

Table 3 Percentage of patients of the two study groups with click and crepitus joint sounds and significance of the between-group differences (Chi-square test)

Joint sounds	Group A	Group B	Sig.
Click	54.8	47.0	0.430
Crepitus	38.1	31.8	0.503
Bilateral click	21.4	12.1	0.195
Bilateral crepitus	22.7	14.3	0.280

Package for the Social Sciences 19.0 (IBM Italia S.p.A, Segrate, MI, Italy).

Results

Retrospective assessment of the patients' clinical records allowed including 45 patients (75.5% females, mean age: 38.1±15.9 years) in Group A, while group B comprised 69 patients (71% females, mean age: 34.6±13.8 years). The two groups of patients did not differ as for sex distribution ($P=0.594$) and mean age ($P=0.217$).

The distribution of RDC/TMD single and combined group diagnoses was significantly different between the two groups ($P=0.042$). Subjects with large overjet or anterior open bite showed a higher prevalence of multiple diagnoses (60% versus 43.3%) as well as a higher prevalence of combined RDC/TMD axis I group II (i.e. disc displacements) and III (i.e. other joint disorders) diagnoses (37.8% versus 20.2%) (Table 1).

The percentage of patients reporting pain with joint palpation was significantly higher in group A ($P=0.026$), while the prevalence of muscle pain was not significantly different between the two groups of patients (Table 2). For all variables, higher prevalence values were found in the patients belonging to group A with respect to the group B subjects, even if the prevalence of joint sounds (Table 3) and the percentage of patients reporting pain upon palpation of the masseter and temporalis muscles were not significantly different between the two groups (Table 4).

Table 4 Percentage of patients of the two study groups with pain upon palpation of the masseter and temporalis muscles and significance of the between-group differences (Chi-square test)

Muscles	Group A	Group B	Sig.
Masseter	59.5	49.7	0.203
Anterior temporalis	24.4	16.7	0.328
Medium/posterior temporalis	31.0	21.2	0.254
Bilateral masseter	33.3	24.2	0.304
Bilateral temporalis	16.7	7.6	0.143

Discussion

The etiology of temporomandibular disorders has always been a subject of debate, as suggested by the evolving theories on TMD physiopathology abandoning occlusally-focused concepts to embrace patient-centered biopsychosocial approaches.[19,20] Recently, a unified concept of TMD physiopathology, postulating that some subjects with anatomo-skeletal predisposition are more prone to develop inflammatory-degenerative changes in reaction to prolonged overload, has been proposed.[16] Jaw clenching may be viewed as the most detrimental motor activity among those included in the bruxism definition,[1] since it features no degrees of freedom for the joint under constant load and an isometric, fatigue-inducing contraction of the jaw closing muscles. The literature on the relationship between the different bruxism activities and temporomandibular disorders has not been conclusive so far,[9,10] likely due to the very poor specificity of many studies for both bruxism activities and TMD symptoms.[21] Also, the hypothesis that subjects with different occlusal and/or skeletal morphologies may react differently to clenching-related muscle and joint loads must be taken into account as a main confounding factor for the available literature.

The present investigation was performed to assess if the effects of jaw clenching in subjects with normal occlusion are different with respect to those with two extreme occlusal features, which were frequently associated with TMD (i.e. large overjet and anterior open bite). To do that, the patterns of TMD signs and symptoms in two selected populations of TMD patients were assessed. The design of this kind of study was very complicated, due to the difficulties of performing longitudinal studies on healthy subjects, who should probably be monitored for years to assess the possible relationship between clenching and its effects on subjects with different dental occlusion. As a compromise solution to delve deeper into the issue and to provide a preliminary set of data for future comparisons, the investigation was performed on subjects belonging to a population of attendees of our clinic already showing TMD symptoms. Patients with either large overjet or anterior open bite were selected for comparison with patients with purportedly normal occlusion (i.e. molar class I and overjet values between 0 and 2 mm, with no RCP–ICP slide).

To be included in the analysis, all patients needed to be positive for clenching, in order to assess its effects with respect to dental occlusion. The working hypothesis was that the two groups of patients have different patterns of TMD diagnoses.

This study has some methodological shortcomings, mainly related with the selection of a convenience sample of patients with certain occlusal features and the strategy here adopted to diagnose clenching. The diagnostic approach to clenching adopted in this investigation was based on a synthesis of literature suggestions for bruxism diagnosis and, in the absence of standards of reference for discriminating between clenching and grinding and for diagnosing wake clenching,[6] it can be viewed as the best available strategy to detect a probable clenching.[1] In any case, further studies providing a quantitative assessment of the sleep-time EMG activity are strongly recommended to validate the hypotheses drawn from this investigation. From a methodological viewpoint, it must be also borne in mind that the single variable analysis here adopted is not the most suitable strategy to credit the two independent variables under investigation, namely, clenching and occlusion, as the only possible explanations for the TMD outcomes.

Within these study limitations, the null hypothesis that no differences existed between the TMD diagnoses patterns between the two study groups of patients was rejected only in part, and it was shown that clenchers with either large overjet or anterior open bite had a significantly higher prevalence of combined diagnoses, namely, disorders involving both the jaw muscles and the temporomandibular joints (60% versus 43.3%). In particular, an almost twofold prevalence of combined diagnoses involving disc position abnormalities (RDC/TMD axis I group II) and inflammatory-degenerative disorders (i.e. arthralgia/osteoarthritis/osteoarthrosis) (RDC/TMD axis I group III) was detected. Also, they showed a higher prevalence of TMJ pain upon palpation (60% versus 39.1%). On the other hand, it must be pointed out that the between-group differences in the prevalence of muscle pain and joint sounds were not significant, despite a common trend for a higher percentage of Group A patients reporting joint sounds and muscle pain evoked with palpation of specific sites.

Taken together, these findings are open to several interpretations.

First, it can be suggested that subjects with either large overjet or anterior open bite are potentially predisposed to develop joint disorders in reaction to jaw clenching. With respect to the comparison group of patients in this investigation as well as with respect to the average literature data (about 30% prevalence for group III arthralgia/osteoarthritis/osteoarthrosis diagnoses in TMD patient populations),[22] patients featuring those occlusal features had a much higher prevalence of inflammatory-degenerative joint disorders, as diagnosed within the RDC/TMD axis I group III. The choice of selecting the two occlusal features under investigation was also based on the observation that, among the occlusal variables which were called into cause for association with TMD, a large overjet and an anterior open bite were potential proxies of hyperdivergent jaw growth. Subjects with jaw hyperdivergency have been described as having small condyles, low-bearing joints, and unfavorable muscle vectors.[23–27] This may explain the higher frequency of TMJ disorders in clenchers with those occlusal features. In any case, it must be borne in mind that large overjet values and an anterior open bite may also depend on non-skeletal factors, so that the hypothesis that joints of patients with hyperdivergent jaw growth pattern are less suitable to bear overload related with jaw clenching needs to be supported with studies based on lateral cephalograms to diagnose hyperdivergency and on TMJ radiological deepening to provide a morphological assessment of the TMJs.[16]

Second, the prevalence of muscle pain is similar between the two groups. This finding may be easily explained with the muscle fatigue and overload associated with prolonged jaw clenching, but needs to be addressed with EMG quantitative studies. Indeed, the validity of the RDC/TMD examination protocols to diagnose muscle pain has been criticized due to the potential risk for overdiagnosing it due to the very low cutoff criteria for axis I group I diagnoses and to the poor reliability of some palpation sites.[28,29] Furthermore, the bruxism literature has repeatedly pointed out the risk for overdiagnosing clenching in pain patients, due to preconceived ideas from both clinicians and patients that pain is the result of jaw/teeth clenching during the night.[5] In any case, the above concerns were not likely to bias this investigation's findings due to the identical diagnostic criteria adopted for the two groups of patients.

Third, bilateral joint sounds, and especially crepitus sounds, which may be viewed as a sign of more advanced disease, were more frequent in group A, even if differences with the other patients' group were not significant. This observation, along with the above data on the higher prevalence of group III disorders in the subjects with gross occlusal abnormalities, suggests

that those patients may have some skeletal features that make them more prone to develop degenerative changes in reaction to prolonged overload. Imaging is needed to provide more objective findings to verify these speculations.

Findings from the present investigation need to be supported by future studies on samples of increased size, in order to have enough statistical power to avoid risks of type II errors, namely, false negative findings. On that basis, this study may serve as a basis to share preliminary data for *a priori* evaluation of the needed sample size for identifying purported clinically relevant differences in TMD diagnoses between groups of patients with different occlusal features. Also, to get deeper into the assessment of skeletal features, the selection of patients on the basis of their cephalometrically-diagnosed skeletal types appears to be a good option to design prospective evaluation studies. Also, imaging techniques are needed to identify bony loss that might explain the occlusal changes. In any case, the dental features under investigation may be viewed as two extreme occlusal features potentially influencing the pattern of TMD diagnoses in bruxism patients, even if their proxy relation with facial morphology was not assessed. Besides, an emerging factor to consider is the external validity of findings,[30] to the point that strategies to its implementation are strongly encouraged. Among these, analyses of data gathered on children and adolescents, their reappraisal with multiple observation points in time, and the assessment of the TMD symptoms onset in bruxism patients with different facial morphology seem to provide an ideal framework to design longitudinal cause-and-effect studies. Finally, the ongoing research, providing suggestions to define the different bruxism-related motor activities, needs to be carefully monitored to define standard of reference strategies for the measurement and objective assessment of clenching diagnosis.

Conclusions

Within the limits of this investigation, data have been provided suggesting that, in a population of TMD patients, jaw clenching may have different consequences in subjects with a large overjet or an anterior open bite with respect to subjects featuring normal occlusion. The distribution of RDC/TMD single and combined axis I group diagnoses was significantly different between the two study groups. The percentage of patients reporting pain with joint palpation was significantly higher in the patients with extreme occlusal features, while the prevalence of muscle pain was not significantly different between the two groups of patients. These findings may support the concept that some subjects with certain dento-skeletal features are more sensitive to the negative effects of prolonged loads due to isometric jaw clenching, resulting in a higher prevalence of TMJ pain. Caution is recommended when interpreting these findings, due to the convenience sample and the single variable analysis adopted in this study, not taking into full account the possible alternative explanations for the study outcomes. Future studies are strongly recommended to delve deeper into the issue of clenching-related joint overload in patients with different occlusal features.

References

1 Lobbezoo F, Ahlberg J, Glaros A, Kato T, Koyano K, Lavigne GJ, *et al*. Bruxism defined and graded: an international consensus. J Oral Rehabil. 2013;40:2–4.
2 Lavigne GJ, Khoury S, Abe S, Yamaguchi T, Raphael K. Bruxism physiology and pathology: an overview for clinicians. J Oral Rehabil. 2008;35:476–94.
3 Manfredini D, Lobbezoo F. Role of psychosocial factors in the etiology of bruxism. J Orofac Pain. 2009;23:153–66.
4 Lobbezoo F, Ahlberg J, Manfredini D, Winocur E. Are bruxism and the bite casually related? J Oral Rehabil. 2012; 39:489–501.
5 Manfredini D, Winocur E, Guarda-Nardini L, Paesani D, Lobbezoo F. Epidemiology of bruxism in adults: a systematic review of literature. J Orofac Pain. 2013;27:99–110.
6 Koyano K, Tsukiyama Y, Ichiki R, Kuwata T. Assessment of bruxism in the clinic. J Oral Rehabil. 2008;35:495–508.
7 Johansson A, Johansson AK, Omar R, Carlsson GE. Rehabilitation of the worn dentition. J Oral Rehabil. 2008;35:548–66.
8 Manfredini D, Bucci MB, Bucci Sabattini V, Lobbezoo F. Bruxism: overview of current knowledge and suggestions for dental implants planning. Cranio. 2011;29:304–12.
9 Svensson P, Jadidi F, Arima T, Baad-Hansen L, Sessle BJ. Relationships between craniofacial pain and bruxism. J Oral Rehabil. 2008;35:524–47.
10 Manfredini D, Lobbezoo F. Relationship between bruxism and temporomandibular disorders: a systematic review of literature from 1998 to 2008. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109:e26–50.
11 Seligman DA, Pullinger AG. The role of intercuspal occlusal relationships in temporomandibular disorders: a review. J Craniomandib Disord. 1991;5:96–106.
12 Pullinger AG, Seligman DA, Gornbein JA. A multiple logistic regression analysis of the risk and relative odds of temporomandibular disorders as a function of common occlusal features. J Dent Res. 1993;72:968–79.
13 Pullinger AG, Seligman DA. Quantification and validation of predictive values of occlusal variables in temporomandibular disorders using a multifactorial analysis. J Prosthet Dent. 2000;83:66–75.
14 Manfredini D, Peretta R, Guarda-Nardini L, Ferronato G. Predictive value of combined clinically diagnosed bruxism and occlusal features for TMJ pain. Cranio. 2010;28:105–13.
15 Türp JC, Schindler HJ. The dental occlusion as a suspected cause for TMDs: epidemiological and etiological considerations. J Oral Rehabil. 2012;39:502–12.
16 Peretta R, Manfredini D. Future perspectives in TMD pathophysiology. In: Manfredini D, editor. Current concepts on temporomandibular disorders. Berlin: Quintessence Publishing; 2010. p. 153–70.
17 Dworkin S, Leresche L. Research diagnostic criteria for temporomandibular disorders: Review, criteria examinations and specifications, critique. J Craniomandib Disord Fac Oral Pain. 1992;6:301–55.

18 Lavigne GJ, Rompré PH, Montplaisir JY. Sleep bruxism: validity of clinical research diagnostic criteria in a controlled polysomnographic study. J Dent Res. 1996;75:546–52.
19 Greene C. The etiology of temporomandibular disorders: implications for treatment. J Orofac Pain. 2001;15:93–105.
20 Suvinen TI, Reade PC, Kemppainen P, Kononen M, Dworkin SF. Review of aetiological concepts of temporomandibular pain disorders: a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. Eur J Pain. 2005;9:613–33.
21 Manfredini D, Winocur E, Guarda-Nardini L, Lobbezoo F. Self-reported bruxism and temporomandibular disorders. Findings from two specialised centers. J Oral Rehabil. 2012; 39:319–25.
22 Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research Diagnostic Criteria for Temporomandibular Disorders: a systematic review of axis I epidemiological findings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;112:453–62.
23 Dibbets JM. Morphological associations between the Angle classes. Eur J Orthod. 1996;18:111–8.
24 Ferrario VF, Sforza C, Sartori M, Ciusa V. The mechanical advantage of the masseter muscle in subjects with different vertical and sagittal facial morphology. Clin Orthod Res. 1999;2:162–70.
25 Gidarakou IK, Tallents RH, Kyrkanides S, Stein S, Moss M. Comparison of skeletal and dental morphology in asymptomatic volunteers and symptomatic patients with bilateral degenerative joint disease. Angle Orthod. 2003;73:71–8.
26 Dibbets JM, van der Weele LT. Signs and symptoms of temporomandibular disorders (TMD) and craniofacial form. Am J Ortho Dentofac Orthop. 1996;110:73–8.
27 Byun ES, Ahn SJ, Kim TW. Relationship between internal derangement of the temporomandibular joint and dentofacial morphology in women with anterior open bite. Am J Orthod Dentofacial Orthop. 2005;128:87–95.
28 Steenks MH, de Wijer A. Validity of the research diagnostic criteria for temporomandibular disorders axis I in clinical and research settings. J Orofac Pain. 2009;23:9–16.
29 Türp JC, Minagi S. Palpation of the lateral pterygoid region in TMD — where is the evidence? J Dent. 2001;29:475–83.
30 Palla S, Farella M. External validity: a forgotten issue? J Orofac Pain. 2009;23:297–8.