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Original Research

Occlusion and temporomandibular joint disorder in orthodontia: Systematic review & Meta analysis

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ABSTRACT:

Introduction: In the present study we intend to conduct a systemic review and meta analysis of the occlusion and temporomandibular joint disorder in orthodontia. **Material and Methods**: An Electronic searching of Pubmed, ScienceDirect and institute library databases to identify studies reporting the occlusion and temporomandibular joint disorder in orthodontia (TMDs). **Results**: A total of 25 papers included in the review, 10 of which with multiple variable analysis. We found that clinically-relevant association between TMD and dental occlusion. Only 2 of the almost forty occlusion features appraised in the various studies were associated with TMD in the majority of single variable analyses in patient populations. The mediotrusive interferences are associated with TMD in the majority of multiple variable analyses. **Conclusions**: We found the absence of a disease-specific association. Based on that, there seems to lack ground to further hypothesize a role for dental occlusion in the pathophysiology of TMD.

Keywords: Dental occlusion; Temporomandibular disorders; Systematic review, meta analysis.

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INTRODUCTION

The relationship between dental occlusion and temporomandibular disorders (TMD) is still a controversial topic in dentistry. TMDs are a heterogeneous group of conditions affecting the temporomandibular joints (TMJ), the jaw muscles, and /or the related structures.[1]

Dental occlusion is the core of dentistry.[2] Observations that conservative management of TMD symptoms is almost always enough to achieve positive outcomes, and that chronic pain subjects are individuals with specific personality, and not occlusal, profiles, support the concept of neutrality as far as the effects of occlusal therapies on TMDs are concerned.[3] This could be due to the association between dental occlusion and TMDs among those who are willing for the orthodontic treatment has never been reviewed systematically. The present knowledge is mainly based on seminal papers and comprehensive reviews. Hence in the present study we intend to conduct a systemic review and meta analysis of the occlusion and temporomandibular joint disorder in orthodontia.

MATERIALS AND METHODS

A comprehensive search of the literature was undertaken. This included electronic searching of the Pubmed, ScienceDirect and institution library. Keywords used in the electronic searches were Systematic Review, occlusion, malocclusion, orthodontics and TMD and temporomandibular joint (TMJ) search terms. The studies from 1995 to 2020 were included. English articles were considered for the studies.

Full-text versions of all the remaining after duplicate removal, potentially eligible studies were retrieved, and two independent reviewers evaluated the articles for compliance with the selection criteria. The following data were extracted: study design, diagnosis, number of patients, epidemiological and etiological, results, quality score, and author's conclusion. This review aimed to include randomized control studies (RCTs), cohort studies, and case/control studies conducted with adults populations that defined TMD as a dysfunction of myofascial pain with the assistance of a clinical examination. A study was awarded a maximum of one star for each item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability. Thus, the highest quality studies are assigned a score of 9.

RESULTS

From a total of 1670 articles, 25 were finalized. **Figure 1**

Seventeen of the included studies had a case-control design, comparing a population of TMD patients with non-TMD individuals, whilst 8 papers compared the features of dental occlusion in individuals with TMD signs/symptoms and healthy subjects in non-patient populations. Structured reading of the included articles showed a high variability as far as the occlusal features under evaluation and the TMD diagnosis (i.e., muscle, joint, or combined disorders) are concerned.

Anterior vertical (i.e., overbite) and horizontal overlap (i.e., overjet), and slide from centric relation (CR) to maximum intercuspation (MI) were the most frequently investigated occlusal features. Methodological features and main findings concerning the possible association between dental occlusion and temporomandibular disorders in patients and non-patient populations are summarized in **tables 1 and 2.**

In summary, the pattern of described association is quite consistent across studies toward a lack of clinically-relevant association between TMD and dental occlusion. Only two (i.e, CR-MI slide and mediotrusive interferences) of the almost forty dental occlusion features that have been evaluated in the different studies are associated with TMD in the majority (i.e., at least 50%) of single variable analyses in patient populations, and only mediotrusive interferences are associated with TMD in the majority of multiple variable analyses, with an OR of 2.45 for myofascial pain [57] and 2.14 for disc displacement.[64] Other potential clinically-relevant odds ratio (OR) for TMD (i.e., higher than 2) in multiple variable analysis are reported occasionally. **Table 3**

Of the 25 papers included in the review, only two received an 8-star score. The majority of papers felt within the 4-to-6-star range.

Table 1: **The characteristics of the included studies**

Study first author, year	Population (P)	Intervention (I)	Comparison (C)	Outcomes (O)
Pullinger, 1993[48]	N=147 asymptomatics	11 occlusal features Anterior open bite; unilateral maxillary lingual crossbite; RCP-ICP slide length; RCP-ICP slide; unilateral RCP contact; overbite; overjet; dental midline discrepancy; number of missing teeth; the greater of the mesio-distal intermaxillary relationship discrepancies at the first molar location; first molar intermaxillary relationship (right vs. left asymmetry)	Disc Displacement with Reduction (n= 81), Disc Displacement without Reduction (n = 48), Osteoarthrosis with Disc Displacement History (n = 75), Primary Osteoarthrosis (n = 85), and Myalgia Only (n =124).	Significant associations (per disease) (p<0.05) Disc Displacement with Reduction: Unilateral lingual crossbite; Overbite; Dental midline discrepancy; Missing posterior teeth; RCP-ICP slide length Disc Displacement without Reduction: Unilateral lingual crossbite; First molar relationship Osteoarthrosis with Disc Displacement History: Anterior open bite; Unilateral lingual crossbite; Overjet; Missing posterior teeth Primary Osteoarthrosis: Anterior open bite; Overjet; Missing posterior teeth; RCP-ICP slide length Myalgia Only: Anterior open bite; Unilateral lingual crossbite; Overjet; RCP-ICP slide length Clinically relevant associations (per occlusal factor) (OR>2) Anterior open bite: Osteoarthrosis with disc displacement history OR=7.39 Primary osteoarthrosis OR=7.27 Myalgia only OR=7.55 Unilateral lingual crossbite: Disc displacement with reduction OR=3.33 Disc displacement without reduction OR=2.64
Kahn, 1998[50]	N=82 asymptomatics (55 with normal TMJ disc position, 27 with DD)	2 occlusal features Overbite; overjet	N=263 symptomatics (i.e., TMJ pain) - 221 with DD, 42 with normal TMJ disc position	Single variable (p<0.05): Overjet >4mm
Kahn, 1999[51]	N=82 asymptomatics (55 with normal TMJ disc position, 27 with DD)	3 occlusal features Molar relationship; occlusal guidance; Non-working side contacts	N=263 symptomatics (i.e., TMJ pain) - 221 with DD, 42 with normal TMJ disc position	Single variable (p<0.05): Canine guidance (Symptomatic DD); Absence of one or more non-working contacts (Symptomatic normal; symptomatic DD)
McFarlane, 2001[52]	N=196 healthy subjects aged 18-65 years	1 occlusal feature Missing posterior teeth	N=131 subjects with "Pain dysfunction syndrome"	Multiple variable: no association

Tallents, 2002[54]	N=82 asymptomatics (55 with normal TMJ disc position, 27 with DD)	1 occlusal feature Missing posterior teeth	N=263 symptomatics (i.e., TMJ pain) - 221 with DD, 42 with normal TMJ disc position	Single variable (p<0.05): missing posterior teeth (Symptomatic DD)
Landi, 2004[57]	N=49 healthy females (m.a. 34.8, range 20-61 years)	8 occlusal features RCP-MI slide length, vertical overlap, horizontal overlap, unilateral posterior reverse articulation, anterior open occlusal relationship, incisor dental midline discrepancy, mediotrusive interferences, laterotrusive interferences,	N=81 females with myofascial pain (m.a. 37.2, range 20-71 years)	Single variable (p<0.05): RCP-MI >2mm; mediotrusive interferences; laterotrusive interferences Multiple variable (p<0.05 and OR): RCP-MI (OR=2.57); mediotrusive interferences (OR=2.45)
Hirsch, 2005[58]	N=573 adults (age 35-44) and 1225 seniors (age 65-74) without TMD	2 occlusal features Overbite, overjet	N=82 adults (age 35-44) and 112 seniors (age 65-74) with joint noise (click or crepitus)	Single variable: no association Multiple variable: no association
Seligman, 2006[59]	N=47 asymptomatic females (m.a. 41.2 ± 15.48, range 21-74 years)	9 occlusal features RCP-ICP slide length; overbite; overjet; unilateral posterior crossbite; anterior open bite; incisor dental midline discrepancy; number of unreplaced missing posterior teeth; first molar mesiodistal relationship; right and left first molar position asymmetry	N=124 female patients with intracapsular TMD - 51 DD, 73 OA (m.a. 35.4 ± 11.89, range 13-72 years)	Single variable (p<0.05): RCP-MI slide length; unilateral posterior crossbite Multiple variable (p<0.05 and OR): RCP-MI (OR=1.33); unilateral posterior crossbite (OR=11.67)
Selaimen, 2007[61]	N=30 pain-free females (15-60 years)	8 occlusal features Overbite, overjet, number of anterior teeth, number of posterior teeth, Angle class, bilateral canine guidance on lateral excursion, bilateral canine guidance of protrusion, anterior CR-CO slide	N=72 myofascial pain females (15-60 years)	Single variable (p<0.05): Absence of canine guidance; Angle class II
Takayama, 2008[63]	N=970 dental patients aged >25 years	1 occlusal feature Occlusal support (Eichner index)	N=504 TMD patients aged>25 years	Single variable (p<0.05): More occlusal support in TMD than dental patients
Chiappe, 2009[64]	N=145 healthy subjects (65 males; m.a. 31.0 yrs)	12 occlusal features Cross bite, open bite, overbite, scissor bite, overjet, incisor midline, canine Angle class, molar Angle class, slide RCP-ICP, occlusal guidance, mediotrusive interferences, laterotrusive interferences	N=165 subjects with disc displacement alone (65 males; m.a. 32.5 yrs)	Single variable (p<0.05): slide RCP-ICP, mediotrusive interferences, absence of bilateral canine guidance Multiple variable (p<0.05 and OR): absence of bilateral canine guidance (OR=2.84); mediotrusive interferences (OR=2.14); slide RCP-ICP (OR=1.75)
He, 2010[65]	N=70 students (20-30 years)	1 occlusal feature CR-MI slide	N=107 pre-treated orthodontic TMD patients (18-32 years)	Single variable (p<0.05): CR-MI slide
Manfredini, 2010[66]	N=166 pain-free subjects	8 occlusal features RCP-MI slide length; vertical overlap; horizontal overlap; posterior reverse articulation; anterior open bite; mediotrusive and laterotrusive interferences	N=110 TMJ pain subjects	Single variable (p<0.05): Overjet >4mm Multiple variable (p<0.05 and OR): Overjet >4mm (OR=2.83); laterotrusive interferences (OR=2.67)
Wang, 2012[67]	N=31 TMD-free subjects (19-31 years) with normal occlusion	1 occlusal feature Premature contact in ICP	N=31 TMD subjects (19-31 years) with normal occlusion	Single variable (p<0.05): Premature contact in ICP
Halalur, 2013[68]	N=50 healthy subjects (18-35 years)	6 occlusal features Type of occlusion; CR-CO Slide; Balancing Interferences; Working interferences; Protrusive Interferences; Loss of Vertical height	N=50 subjects (18-35 years) with at least one TMD signs or symptoms	Single variable (p<0.05): group function; CR-CO slide; balancing interferences
De Sousa, 2015[70]	N=58 TMD-free subjects aged>15 years	5 occlusal features Anterior open bite; Posterior crossbite; Overbite ≥4mm; Overjet≥5 mm; more than 5 posterior teeth lost	N=42 TMD subjects aged>15	Single variable: no association Multiple variable: no association
Manfredini, 2017[72]	N=58 TMD-free subjects (aged 20-40 years) without history of orthodontics	3 occlusal features Canine class; molar class; asymmetry	N=96 TMD patients (aged 20-40 years) without history of orthodontics	Single variable: no association

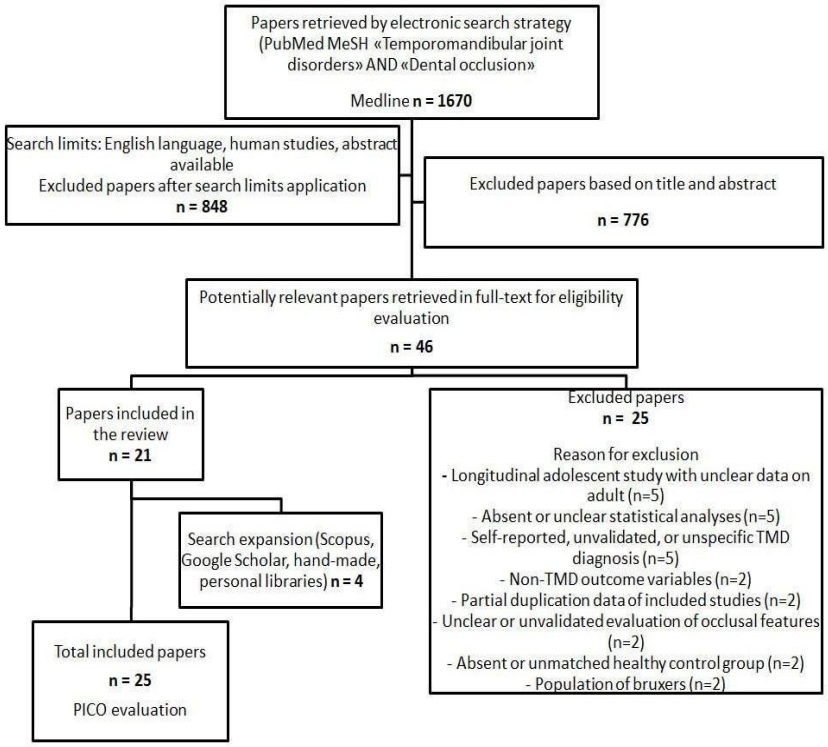
Table 2: charecteristics of the cohorts of the nonpatients with and without TMD

Study first author, year	Population (P)	Intervention (I)	Comparison (C)	Outcomes (O)
Hiltunen, 1997[49]	N=301 subjects with normal or mild Helkimo dysfunction index (age 76-86 years)*	1 occlusal feature Occlusal support with and without dentures (Eichner index)	N=63 subjects with moderate or severe Helkimo dysfunction index (age 76-86 years)	Single variable: no association
Celic, 2002[53]	N=151 non-patients without TMD (19-28 years)*	2 occlusal features Overbite; overjet	Muscle pain non-patients (N=13), DDR non-patients (n=21), muscle pain + DDR non-patients (n=45)	Single variable (p<0.05): Overjet>4mm (muscle pain; muscle pain + DDR); Overbite >4mm (DDR; muscle pain + DDR)
Ciancaglini, 2003[55]	N=15 subjects without TMD (19-26 years)	1 occlusal feature Number of occlusal contacts	N=15 Subjects with at least 2 TMD signs or symptoms	Single variable: No association
Gesch, 2004[56]	N=2997 general population (20-79 years)	27 occlusal features Upper incisors crowding; lower incisors crowding; labial/lingual position of one or more canines; posterior teeth crowding; spacing; Overjet; Retroclined maxillary incisors; Edge-to-edge bite; Crossbite anterior; Negative overjet; Distoclusion; Mesioclusion; Mixed occlusion (no specific type); Open bite anterior; Open bite posterior; Deep bite; Buccolingually cusp-to-cusp relation (unilateral or bilateral); Crossbite posterior (unilateral or bilateral); Scissors-bite (unilateral or bilateral); Normal occlusion; Attrition; Non-working side interferences (unilateral or bilateral); Protrusion interferences (unilateral or bilateral); Non-working side contacts (unilateral or bilateral); Protrusion contacts (unilateral or bilateral); Non-working side contacts + wear; lateral contacts on protrusion + wear	N=1292 general population with two or more TMD signs (20-79 years)	Single variable (p<0.05): Posterior crowding; Edge-to-edge bite; negative overjet; distocclusion (1premolar width); bilateral open bite up to 3 mm; Unilateral posterior crossbite Multiple variable (p<0.05 and OR): edge-to-edge bite (OR=1.5); negative overjet (OR=2.4); bilateral posterior open bite up to 3mm (OR=4.0); unilateral posterior crossbite (OR=1.2)
Schmitter, 2007[60]	N=136 asymptomatic females (m.a. 31.05,	6 occlusal features Overjet, open bite, overbite, missing posterior	N=15 age- and sex-matched females with myofascial pain	Multiple variable (p<0.05 and OR): Non-occlusion, at least one side (OR=4.2); open bite (OR=3.6)

Table 3: Summary of findings of studies adopting multiple variable analysis

Occlusal features	Non-patient studies	Patient studies
Overjet	Association: N=0 No association: N=2	Association N=1 (OR 2.83 for TMJ pain) No association N=8
Overbite	Association: N=0 No association: N=2	Association: N=0 No association: N=10
Open Bite	Association: N=2 (anterior open bite OR 3.6 for myofascial pain; posterior open bite OR 4.0 for TMD) No association: N=1	Association: N=1 (OR 7.27 for osteoarthrosis) No association: N=8
Unilateral Cross Bite	Association: N=0 No association: N=1	Association: N=3 (OR 3.33 for DDR, OR 2.64 for DDNR, OR 11.67 for intracapsular TMD) No association: N=6
CR-MI Slide	Association: N=0 No association: N=1	Association: N=1 (OR 2.57 for myofascial pain) No association: N=8
Midline Discrepancy	Association: N=0 No association: N=4	Association: N=0 No association: N=8
Posterior Missing Teeth	Association: N=1 (OR 4.2 for myofascial pain) No association: N=1	Association: N=0 No association: N=8
Molar Class	Association: N=0 No association: N=1	Association: N=0 No association: N=5
Molar Asymmetry	-	Association: N=0 No association: N=5
Mediotrusive Interferences	Association: N=0 No association: N=1	Association: N=2 (OR 2.45 for myofascial pain; OR 2.14 for disc displacement) No association: N=1
Laterotrusive Interferences	Association: N=0 No association: N=1	Association: N=1 (OR 2.67 for TMJ pain) No association: N=2

Figure 1: Flow chart describing systematic research search



DISCUSSION

We systematically reviewed the literature on the topic, by including all papers that may be pertinent for the assessment of the association between dental occlusion features and TMD, with a focus on the orthodontia.

We found that absence of consistent, clinically-relevant associations between TMD and the various features of dental occlusion. Reported associations were scarce, weak, and mainly drawn from studies with a single-variable design. Multiple variable analyses described associations that reached strength for possible clinical relevance only in a few papers on patient or non-patient populations.[1-15] Each of those papers identified no more than two occlusal variables in association with TMD among the full spectrum of features under investigation (i.e., ranging from six to thirty-three). Contrariwise, each of those variables was not associated with TMD in more than a single paper. In short, patterns of association are not consistent across studies, and may even be due to chance. Therefore, the absence of the fundamental pre-requisite of association between the two phenomena leads to conclude that a causal role for dental occlusion in temporomandibular disorders should not be hypothesized.[16-20]

The association among unilateral cross bite and TMJ disorders, which was described in three studies, has been recently shown to be independent on the correction of cross bite.[47] This means that in patients with TMJ disorders, the presence of cross bite is not causative of the joint pathology, but it could be even viewed as the consequence of a certain skeletal morphology. A similar conclusion can be reached in the case of sagittal skeletal profiles that are associated with an increased risk for disc displacement.[25] Such suggestion is in line with recent observations that orthodontics is neutral as far as the temporomandibular disorders are concerned.[3] Similar suggestions have been proposed also for the purported relationship between anterior open bite and TMJ osteoarthrosis, with the former being the consequence, rather than the cause, of the latter.[20-25] Moreover, the findings of a higher prevalence of CR-MI slide and functional interferences in TMD patients, as reported by a few papers, can be explained with the pain-related adaptation of motor functioning, rather than considered the cause of pain.

In conclusion, it can be concluded that some significant associations between occlusal variables and TMD have been occasionally described, but they are not consistent across studies. Alternative explanations for the presence of such features in TMD patients with respect to their purported causal role tended to be ignored by the dental communities over the past few decades.[3,7] In addition, epidemiologic studies of dental occlusion have demonstrated that purported malocclusions and occlusal dysharmonies should be viewed as ancillary findings that are also present with the same frequency in non-TMD patients.[82] Thus, even the pre-requisite to hypothesize a causal role for dental occlusion in TMD patients, viz., the presence of a strong and consistent association between the two phenomena (i.e., occlusal feature and TMD), is lacking. On the contrary, the literature is strong and consistent to support the role of other factors, such as psychosocial and genetic issues as well as muscle-related overload, in the pathophysiology of temporomandibular disorders.[1,2,83]

CONCLUSIONS

From our study we can conclude that the absence of a disease-specific association, there is no ground to hypothesize a major role for dental occlusion in the pathophysiology of TMDs ith regard to the orthodontia. Dental clinicians are thus encouraged to move forward and abandon the old-fashioned gnathological paradigm.

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