Occlusal Parameters and Temporomandibular Disorders: A Literature Review

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Abstract: ***Temporomandibular disorders (TMD) have major impact on the quality of life. The identification of an unambiguous universal cause of TMD is, as yet, lacking. Controversy exists because of the limited knowledge regarding the etiology and natural history or course of TMD. Disorders of temporomandibular joint have been suspected and shown to be influenced by certain occlusal parameters. To date, controlled studies have failed to prove a clear association between dental wear, malocclusion as well as orthopaedic instability of occlusion and TMD. Occlusal features such as Angle's malocclusions, cross bites, occlusal interferences and extensive overjet have been commonly identified as predisposing, initiating and perpetuating factors. In this paper presentation, there is an attempt to review the current literature regarding the interaction of occlusal factors relative to TMD.***

Keywords: temporomandibular disorders, craniomandibular disorders, occlusal parameters, occlusion interferences, occlusal factors

1. Introduction

Temporomandibular disorders is defined as a group of musculoskeletal conditions that involve the temporomandibular joints (TMJs), the masticatory muscles and all associated tissues [1]. Over the years, they have been identified by a variety of terms. In 1934, James Costen [2] described a group of symptoms centering around the ear and temporomandibular joint (TMJ) and hence the term *Costen syndrome* developed. Then in 1959, Shore [3] introduced the term *TMJ dysfunction syndrome*. Later came the term *functional TMJ disturbances*, coined by Ramfjord and Ash [4]. Other terms used were *occlusomandibular disturbances* [5], *pain-dysfunction syndrome* [6], *myofascial pain-dysfunction syndrome* [7] and *TM pain-dysfunction syndrome* [8]. Since the symptoms are not always limited to the TMJ, a broader more collective term was used by Bell [9] as *TM disorders* which gained popularity. The American Dental Association [10] adopted the term *temporomandibular (TM) disorders* in order to coordinate efforts and avoid lack of communication of research efforts due to differences in terminology.

The signs of TMD include muscle and joint tenderness, joint sounds, limitation and incoordination of mandibular movement, parafunction, occlusal wear, attrition, and headache. It is now generally accepted that headache should be included as an additional sign [11] especially since common muscle contraction headaches (CMCH) have been reported to account for up to 90% of all headache pain [12]. Epidemiologic and clinical studies indicate that some signs of dysfunction may be present without producing pain. However, pain is the main complaint and the principle reason why patients seek treatment [13].

The etiology of TMD has been considered to be multifactorial [14-16], but generally caused by an untoward interplay between neuromuscular, TMJ, occlusal and psychological factors [15]. According to McNeill [14], the etiologic factors of TMD include: genetic, physiologic, traumatic, pathologic, environmental, and behavioral factors. Others reason that because there is no consistent pattern of presentation, the etiology is probably multifactorial [17]. Nonetheless, there is general agreement that external trauma is often a predisposing factor [13] [17-19].

2. Statement of problem

Although there are many etiological factors of TMD yet to be fully understood, disorders of temporomandibular joint have been suspected and shown to be influenced by certain occlusal parameters. Occlusal features such as Angle's malocclusions, cross bites, occlusal interferences in retruded contact position (RCP) & balancing sides interferences; slide between RCP and intercuspal position (ICP), presence of crown and bridge with premature contact; and extensive overjet have been commonly identified as predisposing, initiating, and perpetuating factors.

3. Aim

The aim of this meta-analytic literature review study was:
1) The identification of population-based studies that examined the associations between malocclusion and/or functional occlusion and TMD and its signs and symptoms in adults (age > 20 years).
2) To determine whether or not associations exist between malocclusion or functional occlusion and TMD.

4. Methodology

4.1 Inclusion criteria and search strategy

Included/excluded study types: The following types of studies were taken into consideration:
1) Population-based epidemiologic association studies that examined the relationship between morphologic and functional occlusion and TMD in adults, based on a randomized selection of the study population from the complete target population in order to guarantee an equal distribution of known and unknown risk factors in the groups compared [20-21].
2) Epidemiologic research with nonrandomized study populations but suitable substitute methods that at least partially fulfill the criterion of randomization, were also included, such as "systematic selection" (e.g., every 20th subject).

Included study participants. Participants should not exhibit trauma in the cranial area and inflammatory systemic arthropathy (e.g., chronic polyarthritis). The tooth-loss rate or the number of natural or prosthetically restored teeth had to be adequate to permit a determination of malocclusions and functional occlusion. General population studies that included wide age ranges as well as stratified studies with representative age groups of a certain age population were also taken into consideration.

Outcome variables of interest were relationships between the following factors:
1) Clinical signs and subjective symptoms of TMD, such as tenderness or pain upon palpation of the temporomandibular joints (TMJ) or the masticatory muscles, joint sounds, and mandibular mobility disorders.
2) 2, Morphologic occlusion: Normal dental conditions, as well as malocclusions, (e.g., enlarged sagittal overbite, anterior and posterior crossbite, open and deep bite, distal bite, mesial bite).
3) Functional occlusion: Occlusal tooth contacts with functional mandibular movement, as well as occlusal interferences (e.g., balancing and hyperbalancing occlusal contacts in laterotrusion or protrusion, deviations of centric and habitual occlusion).
4) Attritions (wear facets) of the natural teeth or that of dental restorations.

Articles from various journals and search engines were searched for finding correlation or association of temporomandibular disorders (TMD) and various occlusal factors. Defined criteria employed in search of articles from search engines like pubmed, google scholar, embase, cocharane library, google search (from year 1961-2017). The keywords like '*tempormandibular disorders*', '*temporomandibular joint tenderness*, '*functional disturbances of masticatory system*', '*craniomandibular disorders*', '*occlusal parameters*', '*occlusion'*, '*occlusal interferences'*, '*occlusal factors*', etc were used for the search. For finding specific articles, topic were selected as '*association*', '*relationship*', '*influence*', etc.

4.2 Review method

One of the authors undertook the study identification, data extraction, and manual searching. Data were extracted from each report without being blinded as to the authorship of the study or results obtained.

A second author assisted with the evaluation of the studies whenever doubt existed as to whether or not one should be included in the review.

5. Results

56 references were searched using the above criteria, the title and abstracts of which were reviewed thoroughly. Out of those references, 4 articles were excluded on the grounds of being literature review articles and another 30 articles due to lack of or unclear description of sample method, randomization etc., and different outcome of interest (e.g., tooth loss, dentures). In the end, 22 relevant articles were selected for further meta-analytic review.

In 1972, Solberg et al [22] stated that all patients had deflective or interceptive contacts on terminal hinge closure, and nearly all had a mandibular shift from centric relation. The magnitude and direction of this shift were not markedly different in both symptomatic and control groups, and therefore, it must be assumed that one of the factors presumed to cause the symptoms, namely, the mandibular displacement from centric relation, was equally present in both groups. This study adds its evidence (I) that the TMJ disorder is a highly complex phenomenon, which has intricate interactions all within the normal range, and (2) that its interrelation with other stomatognathic disturbances is incompletely delineated. Probably no one variable can be pinpointed as the key to the etiology. Rather, a combination of factors seems more likely. A survey of 123 subjects (dental students) was performed by Graham et al [23] to evaluate quantitative data that may be of value in the incidence and treatment of myofacial pain. The results showed that most subjects demonstrated, both subjectively and clinically, symptoms of neuromuscular dysfunction without occlusal interferences.

Another study by Mohlin [24] of 205 Swedish women between age 20 and 45 years (mean 31.4 years) showed no association between any single malocclusion and the severity of clinical signs. A positive correlation existed between the number of rotated lateral teeth and the subjective symptoms of dysfunction, but the strength of the correlation was not stated. No association was described between functional occlusion and TMD.

In 1985, under the supervision of Bush [25], The Angle classification of occlusion, as well as occlusal contacts determined at retrusion, mediotrusion, laterotrusion, and protrusion were recorded from 298 dental students. Various masticatory muscles and the TM joints were palpated simultaneously for tenderness. The greatest frequency of muscular tenderness occurred in students with the Class I relationship - 11%, then Class II - 1%, and Class III - <1%. No significant relationships were observed between (1) tenderness and Angle class or (2) tenderness and any occlusal contact. 93% of the students had a slide between RCP-IP positions. In relation to a slide between retruded contact position and intercuspal position: measurements for (a) vertical and (b) horizontal displacements, but not (c) lateral deflection, were greater in Class I students without tenderness than in Class I students with tenderness. 37% of the Class I students had mediotrusive contacts and associated tenderness. Another 38% had these contacts and no tenderness. These contacts were most common among Class II and Class III students (70%), which occurred mostly on the second molar.

Droukas et al [26] found that about one third of the patients had a distance between RCP and IP that was 1 mm or more in sagittal and vertical direction, while the same distance was recorded in lateral direction for only two patients. 13 patients were free of occlusal interferences, 17 had one, 19 had two, and one had five. Dentinal attrition was recorded on the incisors in 30% of the patients, on canines in 24%, on premolars in 8%, and on molars in 4%.

The study by Jenni et al [27] tested for differences in the frequency of clinically and anamnestically determined craniomandibular dysfunction between populations with and without occlusal interferences. No statistically significant difference in the frequency of occlusal interferences was found. There was also a lack of a significant relationship between occlusal interferences and the degree of clinical dysfunction.

Bivariate correlations between signs or symptoms of mandibular dysfunction and morphologic/functional occlusion as well as other parameters were studied by Szentpetery et al [28]. For the variables of morphologic occlusion, there were no significant correlations with the clinical or anamnestic Helkimo's dysfunction index, except for the angle Class II. Division 2 malocclusion {= distal bite with retrusion of the front teeth) and the deep bite. However, both correlations are negative, ie, they were associated with relatively less TMD. The variables of functional occlusion did not show any significant correlations with the clinical or anamnestic dysfunction index either, except for excessive abrasions, which correlated positively with the clinical dysfunction index. The strength of correlation was not stated, but it was significant ($P < .05$).

Seligman et al [29] found in his study of two complete classes of freshman dental and dental hygiene students, 120 men and 102 women (mean age 23.9 years), that the only significant associations found were in highly selective categories. Class II, division 2 malocclusion was associated with more muscle tenderness than class II, division 1 malocclusions ($p < .05$) when muscle pain was defined as four ‘or more sites of moderate or severe tenderness. Second, generalized muscle tenderness (≥ 4 sites, $n = 16$) was more common in subjects (17%) with deep vertical overlap of the incisors (15 mm) than in those with less vertical overlap (7%) ($p < .05$). Third, localized muscle tenderness (only one site) was found more often with coincident ICP and RCP ($p < .05$) but there was no association with any specific muscle group. Experiments by Kirveskeri et al [30] suggested a significant association between the number of interferences and the signs of craniomandibular disorders.

Another study by Kirveskeri [31] studied the association between occlusal interferences and signs of TMD over a period of 6 years in two cohorts of children, half of whom underwent occlusal adjustment annually. They concluded that occlusal adjustment resulted in a modest decrease in the number of occlusal interferences, sufficient to disclose a significant association between the number of occlusal interferences and clinical sings of TMD in the two nonpatient child populations. Another result [32] showed high dependence between the frequency of temporomandibular disorders and class II division 1, class III patients, group function occlusion, and a high horizontal overlap value. When the non-working side contacts were increased, a higher association of temporomandibular disorders was observed. In relation to the type of occlusion, Manns [33] suggested that the stomatognathic system is more effectively protected against unphysiologic muscle tension in canine guidance than in group function occlusion. This study confirms the findings of Al-Hadi [32] who observed low incidence of TMD in canine guided occlusion.

Pullinger et al [34] found that significant increases in risk occurred selectively with anterior open bite ($p < 0.01$), unilateral maxillary lingual crossbite ($p < 0.05$ to $p < 0.01$), overjets > 6-7 mm ($p < 0.05$ to $p < 0.01$), > 5- 6 missing posterior teeth ($p < 0.05$ to $p < 0.01$), and RCP-ICP slides > 2 mm ($p < 0.05$ to $p < 0.01$). He thus concluded that occlusion cannot be considered the unique or dominant factor in defining TMD populations. According to Kirveskari [35], controlled clinical studies results are difficult to understand unless occlusion is taken as an etiologic factor of TMD. Besides, a lot of studies have failed on proving that occlusion has nothing to do with TMD. Jarabak [36] affirms that occlusal instability with loss of posterior support might cause some subclassifications of TMD including muscle spasm.

Another study by Pullinger and Seligman [37] showed that patients with disk displacement were mainly characterized by unilateral posterior crossbite and longer RCP-ICP slides. Significant relative risk for disease (odds ratio > 2:1) was mainly associated with infrequent, more extreme ranges of occlusion measurements, thereby stating that occlusal factors may be cofactors in the identification of patients with TMD, but their role should not be overstated. Some occlusal variation may be a consequence of rather than a cause for TMD. Single variables had more limited value and it takes sets of adverse variables to model TMD.

John et al [38] found that an odds ratio of 0.76 (95% confidence interval: 0.51 to 1.15) indicated that after adjusting for gender and age, the odds in favor of TMD decreased an estimated 24% for each additional unit of the mean tooth wear score. This result was not significant ($P = 0.20$). Based on these findings, a clinically relevant risk for TMD from incisal tooth wear can be excluded. Multivariate logistic regression analysis performed by Celic et al [39] showed several weak but statistically significant correlations between the occlusal factors, parafunctional habits, and TMD in this nonpatient population. Thus it concluded that some association does exist between occlusal factors and TMD signs. However, this association cannot be considered unique or dominant in defining subjects with TMD in the population. Moreover, a study by Pergamalian et al [40] showed that tooth wear factors did not differentiate patients with bruxism from those without. Also, the amount of bruxism activity was not associated with more severe muscle pain and was associated with less pain in the TMJ on palpation. Further, Schierz et al [41] found that using anterior tooth wear as an indicator for long-term bruxing behavior, a clinically relevant dose-response relationship between bruxism and TMD pain does not appear to exist.

In 2011, Troeltzsch et al [42] concluded in a study that parafunction (P=.001), TMD (P=.001) and gross differences between centric occlusion and maximum intercuspation of more than a 3 mm visible track marked with 8 µm articulation foil (P=.001) significantly influenced the presence of headache. In a study conducted by Costa et al [43], one hundred patients from the Department of Operative Dentistry, Federal University of Sergipe, were evaluated. Fifty patients had TMD and the control group was composed by 50 volunteers with no TMD symptoms. In the TMD group, 32% had posterior crossbite (20% unilateral and 12% bilateral), 8% open bite, 18% overbite and 10% overjet greater than 5 mm. The number of teeth with dental wear found was 20% for 1 to 4 teeth, 12% for 5 to 10 teeth and 18% with more than 10 worn teeth. Considering the sagittal relation, 42% were Class I, 26% Class II and 32% Class III. The discrepancy between centric relation (CR) and maximum intercuspation (MHI) was 68% for 0 to 2 mm, 30% for 2 to 4 mm and 2% for greater than 4 mm. Balancing side interferences were found in 78% of TMD patients (34% unilateral and 44% bilateral).

6. Discussion

This review attempted to analyze the published population-based adult studies on the relationship of malocclusion and functional occlusion to TMD and its signs and symptoms. Only few valid and relevant studies (n = 22) dealing with this subject fulfilled the inclusion criteria and permitted an approximately population-based result. Thirty four studies dealing with this subject but did not fulfill the inclusion criteria were excluded.

13 of these 22 studies found positive relationship between occlusal factors and TMD symptoms, whereas 9 studies did not find such relationship. This proves that no simple-cause and-effect relationship exists, as confirmed by Okeson [44]. Amongst the studies which found positive relationship, the most common occlusal parameters found were:

1) Interference in retruded contact position
2) Retruded contact postion-Intercuspal position slide > 3 mm
3) Balancing (non-working) side interferences
4) Posterior crossbite
5) Overjet > 5 mm

Despite of finding positive correlations in some of the studies, no consistent occlusal conditions were reported. This is in confirmation with earlier reports [45-48], making it even more difficult to understand the relationship between occlusion and TMD.

7. Conclusion

This review of the current literature specifies that the etiology of TMD is multifactorial, which seems to be related to genetic, physiologic, traumatic, pathologic, environmental, and behavioral factors. Occlusal factors seem to be only a piece of the mosaic in the multifactorial process of TMD. But despite this fact, completely discounting the role of occlusion may be an inappropriate interpretation of published data. Future research should be directed toward developing a complete understanding of these occlusal factors so that reliable criteria can be developed to assist dental practitioner in deciding when dental therapy plays a role in the management of TMD. Further population-based studies of adequate methodologic quality, based on a random sample with sufficient sample size (power) and response rate that are multivariately analyzed and adjusted to confounders-are recommended. In addition, systematic reviews on clinical patient population studies, which were not taken into account in this study, are necessary.

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