Temperomandibular Joint Disorders and Orthodontic Treatment: A Review

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ABSTRACT

The association between orthodontic treatment and temperomandibular disorders has always been of great interest to oral health professionals. Temperomandibular disorders have been quite prevalent in children and adolescents. Moreover, about 30 per cent of the population receive orthodontic treatment during this period. In this context, the issue of orthodontic treatment may be a predisposing factor for the occurrence of temperomandibular disorders has been raised. Lack of obvious evidence to the assumption that orthodontic treatment is associated with the occurrence of temperomandibular disorders promotes the need for extensive follow-up studies representing broader population sample and more rigorous methodology encompassing all confounding factors in relation to temperomandibular disorders.

KEYWORDS: Temperomandibular Joint Disorders, Orthodontic Treatment, Orthodontics, Mandibular Condyle

INTRODUCTION

The issue of relationship of temperomandibular disorders (TMD) and orthodontic treatment has been explored for many years by researchers; this association has always been of great interest to the oral professionals. TMD has been quite a common condition, which is being prevalent in children and adolescents. Moreover, about 30 per cent of the population receive orthodontic treatment during this period. In this context, the issue of orthodontic treatment may be risk factor for occurrence of TMD has aroused. The findings in relation to TMD may have clinical implications and can have a profound effect on health and quality of life of patients. The present literature review was undertaken with the purpose to confirm about whether the association exists between TMD and orthodontic treatment.

MATERIALS FOR REVIEW

For this systematic review, the literature search was done in Pub med, Medline and Google databases using the keywords as ‘Temperomandibular joint disorders and orthodontic treatment, Temperomandibular joint disorders or orthodontics’ for the period 1980 to 2015. 91 articles could be retrieved. However only 38 were relevant to the theme chosen. Out of this, were 27 original articles, 9 were review and 2 were case reports. The study subjects were in the age range of 9-19 years including both the genders. (Table 1, Table 2, Table 3) Previously, many reviews were conducted to estimate the possible association between TMD and orthodontic treatment which had variable interpretations about the literature.

Initially, Greene CS, 1981, in his review work inferred that occasional clicking may be seen in orthodontically treated patients. The two assumptions that the orthodontic correction of malocclusion may reduce the likelihood of development of TMD or may be therapeutic for those who have developed TMD, were discussed in his review work. Later, Tallents RH et al., 1990 in his review dealt with etiology of the temperomandibular joint (TMJ) problems and found it quite debatable. He postulated that orthodontic therapy neither accelerates nor hinders the development of mandibular dysfunction, in turn, the TMD. McNamara JA et al, 1995, has reviewed the literature on the interaction of functional and morphologic occlusal factors and orthodontic treatment in relation to TMD. It was concluded that the prevalence of TMJ signs and symptoms increases with age, and they occur in a population otherwise. Hence the TMD that originates during orthodontic treatment may not be associated with treatment. It was also mentioned that extractions of teeth or type of mechanics used for treatment do not elevate the risk of TMD. However, the author advised that the future research may be targeted at the complete understanding of occlusal factors to manage TMDs as although minor it needs to be explored. The systematic review of the randomized controlled trials on the role of occlusal adjustment in the temperomandibular disorders in adults inferred that the occlusal adjustments do not have the role in prevention or treatment of TMD. Luther F reviewed the literature relating TMD with orthodontic treatment as well as malocclusion. It appeared to him that the treatment or malocclusion had little role in worsening or precipitating TMD. Contrarily, some longitudinal studies showed the reduction in TMJ signs in orthodontically treated subjects. They mentioned about the inadequacy of literature on long-term studies investigating a functional occlusion.
<table>
<thead>
<tr>
<th>Study Year</th>
<th>Type of study/ Sample</th>
<th>Objective of study</th>
<th>Parameters</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larsson and Ronnerman, 1981</td>
<td>Retrospective, 23-28 yrs</td>
<td>Analyze mandibular dysfunction symptoms in treated patients</td>
<td>10 year follow-up</td>
<td>No association between extensive tooth movement &amp; occurrence of symptoms, higher prevalence of symptoms in patients treated with fixed appliances in both jaws than only in 1 jaw</td>
</tr>
<tr>
<td>Tadej et al, 1989</td>
<td>Prospective, 100, Adolescent</td>
<td>Study the TMJ changes due to forces applied using functional appliance</td>
<td>Radiographic</td>
<td>Major changes in condyle size during growth occurred in mediolateral dimension than anteroposterior. Condylar size in males was greater than in females</td>
</tr>
<tr>
<td>Kundinger KK, 1991</td>
<td>Prospective, 29, Adolescent 13-19y</td>
<td>Evaluate TMJ and jaw muscles after orthodontic treatment in extraction cases</td>
<td>Premolar, Extractions, Electromyography-phen</td>
<td>There were no significant differences between the control and experimental subjects</td>
</tr>
<tr>
<td>Artun et al, 1992</td>
<td>Prospective 29/F---CI II, 34/F---CI I, 16.6y</td>
<td>Study the relationship between condylar position &amp; internal derangement of TMJ in treated patients</td>
<td>Radiographic &amp; clinical follow-up, Extraction &amp; non-extraction</td>
<td>% Few patients developed clicking. Condyles were located more posteriorly in patients with clicking. No difference in extraction &amp; non-extraction cases</td>
</tr>
<tr>
<td>Rendell-JK et al, 1992</td>
<td>Longitudinal, 451, 18-months</td>
<td>Investigate relationship between orthodontic treatment &amp; TMD</td>
<td>TMD pain &amp; dysfunction in symptomatic patients</td>
<td>No clear or consistent changes in levels of pain and dysfunction occurred longitudinally during the treatment period</td>
</tr>
<tr>
<td>Dibbets &amp; Weele, 1996</td>
<td>Prospective, 161, Children, 8-15</td>
<td>To study relationship between orthodontic treatment and TMD</td>
<td>20 year follow up</td>
<td>Although signs and symptoms of TMD increased with age. After 20 years neither orthodontic treatment showed a causal relationship with TMD</td>
</tr>
<tr>
<td>Peltola et al, 1993</td>
<td>Prospective 355/M, 613/F, 19-25</td>
<td>Assess of condylar variations TMD</td>
<td>Radiographic</td>
<td>Treated students had condylar variations of 21.1% in males and 16.5% per cent in females. No age correlation in frequency of variations, Condylar flattening &amp; subcortical sclerosis were common in treated subjects</td>
</tr>
<tr>
<td>Pullinger et al, 1993</td>
<td>Logistic regression, 44 young</td>
<td>Analysis of 11 common occlusal features in controls in 5 TMD groups</td>
<td>---</td>
<td>The features as intercuspal position, occlusal slide asymmetry, retruded contacts, overbite, overjet, midline discrepancies, missing teeth, molar relationship did not develop TMD</td>
</tr>
<tr>
<td>Peltola 1995</td>
<td>Longitudinal, 625, 4-15.9</td>
<td>Examined panoramic radiographic characteristics in mandibular condyles in treated patients</td>
<td>12-year follow-up</td>
<td>Osseous changes of the condyle were only detected in 2.2% and associated with Class II malocclusion. Condylar findings varied greatly during follow-ups. The findings had become more severe in 49% of the subjects, F&gt;M. Condylar findings disappeared in 28%</td>
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</tbody>
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**Table 1: Archiving of features of studies conducted in 1981-1995**

<table>
<thead>
<tr>
<th>Study Year</th>
<th>Type of study/ Sample</th>
<th>Theme/objective</th>
<th>Variables/ parameters</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kallberg RW et al, 1996</td>
<td>Prospective, 102 treated 76 control</td>
<td>To compare prevalence of internal derangement of TMJ</td>
<td>MRI</td>
<td>Prevalence of disk displacement in 33% &amp; 77% patients. No link between a history of prior treatment &amp; internal derangement of TMJ</td>
</tr>
<tr>
<td>Owen AH, 1998</td>
<td>Retrospective 600 Adolescent</td>
<td>Assess female patients during fixed appliance therapy, those female Class II malocclusion</td>
<td>---</td>
<td>Patients demonstrating a severe initial overjet, overbite and moderate to severe crowding of the lower arch were most predisposed to developing TMD. Stated the importance of routine X-ray follow-up</td>
</tr>
<tr>
<td>Langerström L, et al, 1999</td>
<td>Prospective 860 19yrs</td>
<td>Study the prevalence of signs and symptoms of TMD</td>
<td>Questionnaire and clinical examination</td>
<td>Severe signs and symptoms of TMD were rare, the prevalence did not differ between 2 study groups, more common in females than in males</td>
</tr>
<tr>
<td>Henrikson T, et al, 1999</td>
<td>Prospective 65 females with Class II Adolescent</td>
<td>Investigate the relationship between orthodontic treatment and symptoms and signs of TMD</td>
<td>Fixed appliance treatment with straight-wire technique, with or without extractions</td>
<td>Both symptoms and signs of TMD showed considerable fluctuations over 3-year period, with general tendency towards decreasing. TMJ clicking increased slightly over 3 year period.</td>
</tr>
<tr>
<td>Yamada K et al, 1999</td>
<td>Prospective 23 F 6 M, 18.8-6y</td>
<td>To explore condylar bony changes related to craniofacial morphology radiographically</td>
<td>Radiographic MRI, CT</td>
<td>Bilateral condylar-change group showed osteophyte formation and erosion commonly. Unilateral condylar change group showed flattening of condyles. Erosion only subjects aged below 19 years. Condylar resorption may be related to a lateral mandibular shift and a retrognathic mandible</td>
</tr>
<tr>
<td>Henrikson T, Nilner M, Kuroi J, 2000</td>
<td>Longitudinal females 65-Class II, 58-unit 60 normal Adolescent</td>
<td>Examine signs of TMD and occlusal changes in Class II malocclusion receiving orthodontic treatment &amp; compare with untreated</td>
<td>---</td>
<td>Temporomandibular joint clicking increased in all study groups over the 2 years, but was less common in the Normal group. The Normal group had a lower prevalence of signs of TMD than orthodontic &amp; untreated Class II groups</td>
</tr>
<tr>
<td>Tahina K et al, 2000</td>
<td>56 Adol</td>
<td>The purpose of this study was to estimate the morphologic features of the craniofacial skeleton in treated adolescent patients with Class III malocclusion</td>
<td>Radiographic-cephalograms, chin-up therapy for duration of 3.9 months</td>
<td>Upward-and-forward rotation of mandible, with the forward growth and displacement, is highly associated with unsatisfactory treatment outcomes after pubertal growth in growing Class III patients.</td>
</tr>
</tbody>
</table>

**Table 2: Archiving of features of studies conducted in 1996-2000**
following orthodontic treatment. The literature reviews mentioned that the assumption of orthodontic treatment leads to or prevents TMD appears to be ill-founded. Kim MR et al, 2002, explained the relationship between orthodontic treatment and TMD out of the meta-analysis of the 31 articles. The variables as study designs, symptoms, signs, or indexes, a specific type of appliance used, extractions performed, and the prevalence of temporomandibular disorders were included in the study. It appeared that TMD symptoms are most prevalent among patients between 15 and 25 years old; people receive orthodontic treatment in this age group, orthodontists may encounter patients who complain about TMD during or after treatment. Also, it was recommended that the future research should be undertaken on the evaluation of TMD using the standardized diagnostic criteria and outcome measures. Owing to the considerable data variability among the studies, it is not possible to come to any definite inference. There is urgent need of quality randomized controlled trials in this area of orthodontic practice.

Conti AC et al, 2007, presented a detailed clinical guide for examination of an orthodontic patient in regards to facial pain and dysfunction. The existing TMD needs to be ruled out before the beginning of orthodontic therapy that needs the careful examination of the stomatognathic system. Available evidence-based data demonstrated that orthodontic treatment has little to do with TMD signs and symptoms.

**TMD AND CLINICAL**

The prevalence studies on TMDs have reported that approximately 75% of the population has, at least, one sign of joint dysfunction; the signs included joint noises, abnormal jaw movement, or tenderness on palpation. While approximately 33% has, at least, one symptom such as joint pain or facial pain, etc. The commonly observed signs and symptoms of TMD include joint sounds as clicking, pain, spasm of the muscles of mastication and the restricted jaw movements.

It was also observed that the patients occasionally developed TMD or clicking in TMJ during orthodontic treatment which is seen more in an adult population. This was attributed to effects of exceeding adaptive capacity of muscles and joints. The orthodontically treated patients with clicking had more posteriorly placed condyles suggesting the internal arrangements of TMJ. Cacho and Martinb, 2007, evaluated a case-series of 27 symptom-free patients treated using activator. The sonographic study showed no differences in temporomandibular joint sounds before and after treatment.

Table 3: Archiving of features of studies conducted in 2001-2010

<table>
<thead>
<tr>
<th>Study Year</th>
<th>Type of study</th>
<th>Theme</th>
<th>Variables/parameters</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conti A et al, 2003</td>
<td>200</td>
<td>evaluated prevalence of TMD (TMJ &amp; muscle palpation, mandibular motion, &amp; joint noise) before and after orthodontic treatment</td>
<td>Questionnaire, Subjects classified as per TMDs.</td>
<td>The 34% of sample had mild TMD, whereas 3.5% had moderate TMD, higher in females. Joint noises (15.3%) followed by headache (13%) were frequent. TMDs have not shown any relationship with orthodontic mechanics or extraction. Positive association between TMD and parafunctional habits and emotional tension was found.</td>
</tr>
<tr>
<td>Shen YH et al, 2005</td>
<td>Case-control 28/F</td>
<td>28-year-old female who underwent orthodontic treatment for 22 months</td>
<td>Radiographic Splint therapy</td>
<td>Clicking commenced 5 months prior to treatment completion along with neck-muscle and right shoulder muscle pain and condylar resorption in later stages. Splint therapy for 1 month has subsided TMD with new bone growth in right condyle.</td>
</tr>
<tr>
<td>Kinzinger G et al, 2006</td>
<td>Prospective 20-CII</td>
<td>Study effects of orthodontic treatment with fixed functional orthopaedic appliances on the disc-condyle relationship in TMJ</td>
<td>Radiographic-MRI</td>
<td>The treatment does not have adverse effects on initial physiological disc-condyle relationships.</td>
</tr>
<tr>
<td>Cacho and Martinb, 2007</td>
<td>Prospective 27-cases-series, 11y</td>
<td>To analyze effect of orthodontic treatment by means of activator appliance on disc-condyle complex</td>
<td>Kinesiographic &amp; sonographic records</td>
<td>No differences in temporomandibular joint sounds before and after treatment, orthodontic treatment with an activator in a child is not a risk factor for the development of TMD or mandibular dysfunction.</td>
</tr>
<tr>
<td>Egermark &amp; Ronnerman 2007</td>
<td>Prospective 50 12.9</td>
<td>investigate development of TMD in active phase of orthodontic treatment.</td>
<td>TMJ, headache, bruxism and occlusal interferences examined</td>
<td>The prevalence of TMD was high before treatment. Except for TMJ sounds, signs and symptoms of TMD and headache decreased during the treatment.</td>
</tr>
<tr>
<td>Rey et al, 2008</td>
<td>Cohort Adolescent &amp; Young</td>
<td>compare class III patients treated with headgear, class I (treated &amp; untreated)</td>
<td>No difference in TMD prevalence was found between the 3 groups after 2-3 years.</td>
<td></td>
</tr>
<tr>
<td>MacFarlane &amp; Young 2009</td>
<td>Prospective Cohort 1981 n=1018 (11-12y), 1984 n=792, 1989 n=456, 2000 n=337</td>
<td>Explore relationship between orthodontic treatment and TMD</td>
<td>Orthodontic treatment neither causes nor prevents TMD, participants with a history of treatment did not have higher risk of new or persistent TMD.</td>
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</tr>
</tbody>
</table>
during and post-treatment for TMD, except for TMJ clicking which has increased over a period, there was great fluctuation in symptoms and signs of TMD over the three-year period. The studies evaluated orthodontically treated patients and observed that 34% had mild TMD, and 3.5% had moderate TMD, the joint noises and headache were the most frequent complaints and had female predilection. Egermark and Ronnerman11, 2007 investigated the presence of muscle tenderness, headache, bruxism and occlusal interferences in 50 patients (mean age 12.9 years) before, during and immediately after orthodontic treatment. Except for TMJ sounds, other signs, and symptoms of TMD decreased during the treatment. Although there was a high prevalence of occlusal interferences during treatment, they seemed to have little importance for the development of TMD. Shen YH et al20, 2005 mentioned regarding the case of 28-year-old female who developed clicking sound 5 months prior to completion of 22 months orthodontic treatment. Additionally, she had neck-muscle and right shoulder muscle pain; radiograph revealed right mandibular condylar resorption. The orthodontic treatment was terminated, and the patient was treated with splint therapy, one month subsequent to which the symptoms were subsided, and new bone growth in the right condyle was observed. Accordingly, it is recommended to closely monitor the patient when TMD is noted during active orthodontic treatment. Also, splint therapy may be utilized to treat TMD and any associated bone remodelling.

Peltola et al5,18 investigated the hypothesis that radiographic condylar findings in treated patients are associated with clinical TMD. The frequency of temporomandibular joint crepitation was higher in treated (27%) subjects than controls (8%). It was suggested that crepitation may be due to osteoarthrosis in the present subjects. Further, 12-year follow-up study showed that although radiographic findings worsen with duration, the subjective symptoms and signs did not seem to cause any significant clinical problems to the patients. Rendell JK et al16, 1992, had 2 observations as the asymptomatic patients who underwent orthodontic treatment showed no evidence of signs and symptoms of TMD during treatment. The patients who had signs and symptoms of TMD at the time of their entry showed no consistent and reliable clinical parameters of pain and dysfunction during the treatment. Twenty-year follow-up studies for orthodontically treated patients showed no causal relationship with signs and symptoms of TMD.17,31

The observations by Katzberg RW et al30, 1996 could not show the significant correlation between the internal derangement of the TMJ and the orthodontic treatment. It was inferred in a study that orthodontic treatment performed during adolescence has no significant effect on the initiation and precipitation of TMD later in the patient’s life.33 However, the patients having severe initial overjet, overbite and moderate to severe crowding of the lower arch showed the higher predilection towards developing TMD subsequent to orthodontic treatment; it was observed more in female patients.21 Additionally, the majority participants who had undergone orthodontic treatment had well-functioning masticatory systems after long-term follow-ups, the severe signs, and symptoms of TMD were rare.22 Winocur and Emodi-Perlman37, 2012, in their extensive literature search mentioned regarding the occurrence of TMD signs and symptoms in healthy individuals otherwise; it may increase with age; hence, TMDs that originate during orthodontic treatment can be a coincidence and may not be related to the treatment itself.

**TMD AND APPLIANCE**

Larsson and Ronnerman12, 1981, studied the Mandibular dysfunction symptoms in 23 orthodontically treated patients by fixed appliances aged between 24 and 28 years with 10-year follow-up. The patients with fixed appliances in both jaws had a tendency towards higher prevalence of symptoms than having appliance only in the upper jaw. In general, there was no evidence of increased occurrence of mandibular dysfunction symptoms; however, it is advocated to be cautious dealing with the patients given the torque on the molars to avoid mediotrusive interferences. Dibbets and Van der Weele17, 1992, compared TMD in children treated with different orthodontic procedures. Patients were monitored for a 20 year period after the start of orthodontic treatment. Although signs and symptoms of TMD increased with age, after 20 years neither orthodontic treatment showed a causal relationship with signs and symptoms of TMD.

The female patients having Class II malocclusion with significant crowding, overbite and severe overjet at entry showed more susceptibility to develop TMD on fixed orthodontic treatment.15 Henrikson T et al22, 1999 treated 65 adolescent girls with Class II malocclusion with fixed appliance using the straight-wire technique. The subjects with pre-treatment signs of TMD of muscular origin were benefited functionally from orthodontic treatment over 3 year period.23 The 65 patients treated using fixed straight wire appliances were evaluated for the period of 2 years and it was showed that orthodontic treatment does not increase the risk of TMD.23 In a study conducted for 200 patients previously, the extraction protocols and the mechanics used for orthodontic treatment did not show any relationship with occurrence of TMD.27

In a study conducted in wistar rats to show the change in the calcified tissues of mandibular condyle caused by abnormal muscle function. To achieve the lateral shift of mandible, the maxillary occlusal splint was fabricated. The study showed that both the mandible and the condyle modified their shape and size as well as the trabecular pattern, during shifting of the mandible to one side as it closed.38

The studies verified 11 common occlusal features in 5 temporomandibular disorder groups using different orthodontic techniques (functional appliances class I/II elastics, chin-cup, headgear, activator, fixed or removable appliances), the assumptions that these can be etiological
orders and growth are highly susceptible to unsatisfactory outcomes and TMD.\textsuperscript{26} Tadej G et al\textsuperscript{13}, 1989, evaluated 100 cases for TMJ changes due to forces applied using functional appliance. The major changes in condyle size during growth occurred in mediolateral than the anteroposterior dimension.\textsuperscript{13} Kinzinger G et al\textsuperscript{29}, 2006 and Cacho and Martin\textsuperscript{10}, 2007 studied the effects on the disc-condyle relationship of TMJ using fixed myofunctional mechanotherapy in patients with class II malocclusion and observed that the treatment does not have adverse effects on TMJs, rather in patients with anterior disc displacement, the disc position was improved. While Rey et al\textsuperscript{10}, 2008 studied effects in class III patients treated with cervical headgear, class I orthodontically treated and untreated subjects. No difference in TMD prevalence was found between the 3 groups after 2-3 years.

**TMD AND EXTRACTION**

An evaluation of 29 orthodontically treated patients with maxillary and mandibular premolar extractions showed no significant differences in TMD signs and symptoms.\textsuperscript{14} In a study by Artun J et al\textsuperscript{15} 1992, on 29 female patients treated for Class II, Division 1 malocclusion it was observed that the mean condylar position was more posterior at right central and medial tomographic sections in patients treated with maxillary first premolar extraction.

In a study involving 65 females, it was inferred that the orthodontic treatment with or without tooth extractions did not increase the risk for TMD or worsen pre-treatment signs of TMD.\textsuperscript{23}

**CONCLUSION**

Overall, the literature review suggests the lack of clear evidence about the association of orthodontic intervention and TMD. The prevalence of symptoms and signs are shown to be varied according to the criteria used and the methods of data collection. Longitudinal studies showed the increased in occurrence of prevalence of the signs of TMD with age as compared to the symptoms. Owing to the greater prevalence of TMD in children and adolescents, also the higher number of patient in this age group undergo orthodontic treatment, it may appear that orthodontic intervention may be a risk factor for TMD. The various studies have mentioned about the development of signs and symptoms of TMD during and after treatment in the patients who were asymptomatic at the entry. In addition, there is no reliable data to correlate TMD with the type of mechanics used, associated tooth extraction and type of malocclusion in treated patients or whether the severity and prevalence of TMD are influenced by orthodontic treatment. The lack of universal diagnostic criteria for TMD, methodologic shortcomings and variability hampers that any conclusion can be drawn about this association.

On the whole, orthodontic intervention has been cited either detrimental or beneficial factor in regards to the occurrence of TMD. Lack of obvious evidence to the assumption that orthodontic treatment is associated with the occurrence of TMD promotes the need for longitudinal studies with broader representation and more rigorous methodology encompassing all relevant variables or confounding factors in relation to TMD.

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