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Username: zackdnelson
Zachary Nelson
Housestaff/Resi - Center for Advanced Dental Education (CADE)
5477 Genesta Walk
St. Louis, MO 63123

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Notes:
The risk of orthodontic treatment for producing temporomandibular mandibular disorders: A literature overview

Cyril Sadowsky, BDS, MS*
Chicago, Ill.

The benefits of orthodontic treatment in the management of temporomandibular disorders (TMD) is questionable, since the occlusion is considered as having a limited role in the cause of TMD as recently stated by Seligman and Pullinger1 after an extensive review of the literature. However, the potential detrimental effects of orthodontic treatment has captured the attention of the orthodontic community over the last decade.

Several studies have been published previously addressing the question of a possible functional risk or benefit of orthodontic treatment on the temporomandibular joint (TMJ) and masticatory musculature. The purpose of this paper is to provide a somewhat detailed review of those studies in which samples of orthodontically treated patients have been evaluated. In addition to the six studies referenced by Reynolds2 in a recent review of the literature from 1966 to 1988, eight more studies will be reviewed to provide the reader with specific information as background with which to compare future studies (Table 1).

STUDIES FROM 1966-1988

Two studies were done as part of a National Institutes of Dental Research (NIDR) research contract on the long-term effects of orthodontic treatment. Sadowsky and BeGole3 reported on the findings from the Illinois study of 75 adult subjects who were treated with full fixed appliances as adolescents approximately 20 years previously and compared them with a similar group of 75 adults with untreated malocclusions. In a subsequent article by Sadowsky and Polsen,4 the findings from the total sample of 96 orthodontically treated subjects as compared with 103 controls from the Illinois study was contrasted to the findings from an independent study, also part of the NIDR research contract, performed at the Eastman Dental Center on 111 subjects who received orthodontic treatment a minimum of 10 years previously and were compared with 111 adults with untreated malocclusions. Nonextraction and extraction cases were well represented in both the above studies. The findings were very similar in both studies with the prevalence of symptoms varying between 15% to 21% and 29% to 42% for signs (joint sounds), there being no statistically significant differences between treated and untreated subjects in either of the studies. The conclusion from the above two studies was that orthodontic treatment performed during adolescence did not generally increase or decrease the risk of developing TMD in later life.

Larsson and Ronnerman5 studied 23 Swedish adolescent patients who were treated orthodontically 10 years previously, 18 of whom had fixed appliances and 5 of whom had a functional appliance (activator). In 31% of the subjects mild dysfunction was recorded clinically and only one subject (4%) had severe dysfunction according to the Helkimo index. In comparing their results with other published epidemiologic studies, they concluded that extensive orthodontic treatment can be performed without fear of creating complications of TM dysfunction. They suggested that orthodontic therapy may possibly prevent TMD. Janson and Hasund6 in Norway studied 60 patients with Class II, Division 1 malocclusions who were treated as adolescents an average of 5 years out of retention, 30 of whom were treated with a four premolar extraction strategy; the 30 nonextraction patients received a combination of headgear and activator initially, followed by fixed appliances. A sample of 30 untreated patients were used as a control. Anamnestic symptoms were found in 42% of subjects overall (treated and untreated), with similar findings for the clinical dysfunction index, which were mostly of a mild-to-moderate degree (Helkimo index). The findings supported the conclusion that there was not a significant risk of developing TM dysfunction when treating orthodontic patients with relatively severe malocclusions. It was also suggested that early orthodontic treatment without extraction may be beneficial to functional disorders. Pancherz7 evaluated the effects of the Herbst fixed functional appliance in the treatment of 22 growing patients with Class II, Division 1 mal-

*Professor of Clinical Orthodontics
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Table I. Sample studies on the relationship between orthodontics and temporomandibular disorders*

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Journal</th>
<th>Year</th>
<th>Relationship orthodontics and TMD</th>
<th>Number of cases</th>
<th>Appliance</th>
<th>Control</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larson and Ronnerman</td>
<td>Eur J Orthod</td>
<td>1981</td>
<td>+</td>
<td>23 Experimental</td>
<td>Fixed Functional</td>
<td>No</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Janson and Hasund</td>
<td>Eur J Orthod</td>
<td>1981</td>
<td>+</td>
<td>60 Experimental</td>
<td>Fixed Functional</td>
<td>Yes</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Sadowsky and BeGole</td>
<td>Am J Orthod</td>
<td>1980</td>
<td>0</td>
<td>75 Experimental</td>
<td>Fixed</td>
<td>Yes</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>Sadowsky and Polsen</td>
<td>Am J Orthod</td>
<td>1984</td>
<td>0</td>
<td>297 Experimental</td>
<td>Fixed</td>
<td>Yes</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>Pancherz</td>
<td>Am J Orthod</td>
<td>1985</td>
<td>0</td>
<td>20 Experimental</td>
<td>Herbst</td>
<td>Yes</td>
<td>Before-after</td>
</tr>
<tr>
<td>Dibbets and van der Weele</td>
<td>Am J Orthod Dentofac Orthop</td>
<td>1987</td>
<td>0</td>
<td>63 Functional</td>
<td>Fixed</td>
<td>Yes</td>
<td>Longitudinal</td>
</tr>
<tr>
<td>Lieberman et al.</td>
<td>J Oral Rehab</td>
<td>1985</td>
<td>0</td>
<td>&lt;369</td>
<td>Unspecified</td>
<td>No</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Smith and Freer</td>
<td>Aust Dent J</td>
<td>1989</td>
<td>0</td>
<td>87 Experimental</td>
<td>Fixed</td>
<td>Yes</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Nielsen et al.</td>
<td>Eur J Orthod</td>
<td>1990</td>
<td>0</td>
<td>219 Experimental</td>
<td>Unspecified</td>
<td>No</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Egermark-Eriksson et al.</td>
<td>Eur J Orthod</td>
<td>1990</td>
<td>0</td>
<td>295 Experimental</td>
<td>Fixed</td>
<td>Yes</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Dibbets and van der Weele</td>
<td>Am J Orthod Dentofac Orthop</td>
<td>1991</td>
<td>0</td>
<td>388 Control</td>
<td>Functional</td>
<td>Yes</td>
<td>Longitudinal</td>
</tr>
</tbody>
</table>

Terminology: -- , orthodontics causes TMD; + , orthodontics cures TMD; 0, orthodontics does not influence TMD.


occlusions and reported that the number of subjects with tenderness to palpation doubled during the initial 3 months of treatment. However, after appliance removal, most muscle symptoms disappeared and 12 months posttreatment the number of subjects with symptoms was the same as before treatment. In a survey of 369 Israeli school children 10 to 18 years of age, Lieberman et al.8 found no association between previous orthodontic treatment and increased symptoms of mandibular dysfunction (Table I).

In a prospective longitudinal study, Dibbets and van der Weele9 in the Netherlands studied 63 orthodontic patients who were treated with a modified functional activator and 72 patients who were treated with fixed appliances (Begg technique) mostly with an extraction treatment strategy during childhood and adolescence. The patients were followed over a 10-year period. A subsample of patients at the pretreatment stage served as an internal control group. Objective signs increased from 21% to 41% overall; however, the authors attributed the increase to age rather than orthodontic treatment on the basis of an internal control group. The findings for subjective symptoms, objective signs and radiographic changes in the condyles supported the conclusion that orthodontic treatment does not induce TM dysfunction. Even though the fixed appliance group as compared with the functional appliance group had higher percentages of objective symptoms after retention, no differences existed at the 10-year follow-up.

STUDIES SINCE 1988

Dahl et al.10 conducted a retrospective study of 51 Norwegian subjects who were 19 years of age and an average of 5 years after orthodontic treatment. According to the authors, the treated group was representative of young people receiving treatment in that country. Signs and symptoms of craniomandibular disorders (CMD) were compared with 47 untreated 19-year-old persons. The clinical dysfunction index showed mild symptoms in 43% and moderate symptoms in 28% of the treated group and 40% and 13% in the untreated group. They concluded that there were no substantial differences between these two groups. The most striking finding was that none of the subjects really had CMD. Smith and Freer11 in Australia examined 87 patients who received full fixed appliances during ado-
lescence, approximately two-thirds involving extractions, and who were an average of 52 months after retention and compared them with an untreated control group of 28 subjects. Symptoms were found in 21% of the treated subjects and 14% of the controls, which was not statistically significant; similarly for hard clicks which occurred in 16% of orthodontic and 4% of control subjects. Their results rejected the hypothesis of a significant association between orthodontic treatment and occlusal or TMJ dysfunction. The one exception was the finding of a higher rate of soft clicks in the post-orthodontic group (64% compared with 36%).

In a report of a survey of 568 dental students ages 20 to 43 years at the Medical College of Georgia, Loft et al. found a significant association between facial discomfort and pain as reported by the female subjects only, who had received orthodontic treatment. Nielsen et al. evaluated 706 Danish children of whom 295 (37%) had completed orthodontic treatment and were between 14 and 16 years of age. The 388 untreated subjects served as controls. Approximately one-third of the subjects had signs of TMJ dysfunction. It was found that the functional status was not related to the type of orthodontic treatment or the use of removable or fixed appliances, including extraction therapy. However, they did feel that there may be a functional risk to treat the small percentage of patients with minor occlusal discrepancies.

A prospective longitudinal study of 238 subjects in three different age groups (7, 11, and 15 years) was conducted over a 4 to 5-year period by Egermark-Eriksson et al. in Sweden. Corrective orthodontic treatment had been done on 35 subjects. Approximately 20% of subjects in the older age group had clinical signs of CMD. No differences were found in the prevalence of signs or symptoms of CMD between orthodontically treated and untreated subjects. In a recent article Dibbets and van der Weele reported the findings from their prospective longitudinal study in the Netherlands over a 15-year period for 111 of the original 172 orthodontically treated patients of the average age of 12.5 years who were enrolled in the study. Removable appliances (functional) were used in 39%, fixed appliances (Begg) in 44%, and chin cups in 17% of cases. A nonextraction approach was used in 34% of cases, four premolars were extracted in 29%, and other extractions in 37%. They evaluated subjectively perceived symptoms, which increased from 20% to 62%; objectively identified clicking/crepitation, which increased from 23% to 36% after 4 years and then stabilized; and the radiographic appearance of the condyle, which increased slightly during the first 4 years and then stabilized at around 25%. It was found that during the first years of the study, age probably accounted for the statistical differences in percentages between the three types of treatment; the influence of age disappeared after 10 years. For the first 10 years there was no difference between the three treatment groups with regard to subjective clicking. However, after 15 years it was greater for the four premolar extraction group. Objective clicking was always more frequent in the four-premolar extraction group at all time points, but the frequency paralleled the other two groups. Clicking frequency, subjective or objective, was always higher in the four premolar extraction group even before treatment was started. They concluded that the original growth pattern, rather than an extraction treatment strategy, was the most likely factor responsible for the frequency of CMD reported many years posttreatment.

As part of the American Association of Orthodontists funded grants for studies on orthodontics and TMD, Sadowsky et al. reported on their prospective longitudinal study of 160 patients of average age of 14 years 6 months (range 9 to 41 years), treated with full fixed appliances for an average of 35 months (range 14 to 53 months). Of the 160 patients, 54% were treated with an extraction treatment strategy and 42.5% were treated with nonextraction (3.1% had missing data). In addition to recording symptoms, joint sounds were objectively recorded with an audiovisual videotape system. Before treatment 25% of patients had joint sounds, whereas 16.2% had sounds after treatment. In 27 patients the sounds were not evident after treatment, in 13 patients there was no change in occurrence, and sounds developed in 13 patients by the end of treatment. Before treatment 14% of the patients had reciprocal clicking, whereas only 8% had reciprocal clicking after treatment. The findings did not indicate a progression of signs/symptoms to more serious problems. The conclusions were that orthodontic treatment did not pose an increased risk for the development of TM joint sounds irrespective of whether extraction or nonextraction treatment strategies were used.

**CONDYLAR POSITION AND ORTHODONTIC TREATMENT**

Orthodontic treatment, particularly involving premolar extractions, has also been implicated in producing a posteriorly positioned condyle. It has been reported anecdotally that an internal derangement may therefore result. In a cross-sectional study, Gianelly et al. evaluated condylar position with corrected tomograms before orthodontic treatment in 37 consecutive patients ages 10 to 18 years and compared them with 30 consecutively treated four premolar extraction cases at the completion of treatment. All patients were treated with fixed appliances, 23 with the edgewise technique and 7 with the Begg technique. They could find no
difference in condylar positions between the extraction and the untreated groups. It was concluded that extraction therapy did not appear to be an iatrogenic cause of distally positioned condyles. Condylar position tended to be centered on average; however, a wide variation in position was noted. Similar wide variations in normal condylar position has been reported by several authors as discussed by Tallents et al. in a critical review of the literature.

**TMJ SOUNDS AND ORTHODONTIC TREATMENT**

Temporomandibular joint sounds are a common finding and occur in approximately 20% to 30% of the population, including patients before orthodontic treatment. As discussed by Wabeke et al. in a literature overview of TMJ clicking in 1989, joint sounds are the most frequent sign of TMD and are often present in the absence of symptoms. Treatment to eliminate joint sounds is usually unsuccessful. In the absence of pain or significant discomfort, patients with joint sounds should be reassured and monitored over time. Approximately half of the patients with joint sounds have a reciprocal click, which is often associated with disk displacement with reduction. However, in many patients the reciprocal clicking may be explained by condylar dislocation anterior to the disk or the articular eminence. Joint sounds or other symptoms may change in character or disappear over time and do not usually progress to joint degeneration.

**PROGRESSION OF SIGNS/SYMPTOMS OF TMD**

Wanman and Agerberg studied 258 subjects from 17 to 19 years of age and found no change in symptoms in 60%, whereas 20% improved, and 20% got worse. In a study of 70 patients with reciprocal clicking whose mean age was 30 years (range 10 to 69 years), Lundh et al. found that over 3 years 71% showed no change, 29% decreased, and 9% progressed to locking. Magnusson et al., in following 119 subjects longitudinally from age 15 to 20 years, found no change in clinical signs in almost half the subjects, with almost equal rates of improvement and impairment. Greene and Laskin submitted a questionnaire to 190 former patients who were treated conservatively for TMJ problems 1 to 11 years previously and found that in 38% the clicking had gone away, 35% improved, 26% were the same, and 1% was worse. They concluded that clicking is generally benign and does not progress to more serious clinical dysfunction or disease, even in subjects who previously had symptoms. Furthermore, subjects with symptomatic clicking can be successfully treated without addressing the position of the disk. Heikinheimo et al. followed 167 subjects from ages 12 to 15 years and found that symptoms of CMD did not change in 38% of subjects, increased in 32%, and decreased in 31%. Half of those exhibiting clicking at the age of 12 years lost the clicking by the age of 15 years.

In a review of the literature, Widmer reported that joint sounds alone are not pathognomonic of disease and may be present for up to 10 years without progression. Tallents et al. concluded from their recent literature review that joint sounds do not necessarily indicate a "problem" but may represent a "risk" factor; however, no treatment should be considered in the absence of symptoms.

**GENERAL COMMENTS**

A thought-provoking article by Greene presented an historic overview of TMD concepts in orthodontics and challenged or refuted a number of myths on the basis of scientific evidence. It was pointed out that a high probability existed that the emergence of symptoms often associated with a TMD, had little or nothing to do with the orthodontic therapy.

In an extensive review of the literature, Seligman and Pullinger concluded that published research suggests a limited role for intercuspal occlusal factors in the cause of TMD. Similarly, in their recent evaluation of the literature, Tallents et al. determined that there may not be a strong association between incisal relationships, condylar position, and TMD. However, as pointed out by Greene and others, a prudent orthodontist should identify and document findings related to the TMJ and mandibular function. If painful symptoms arise during orthodontics, therapy may have to be modified, gross occlusal interferences relieved, and forces tending to distalize the mandible eliminated. Patients with TMD need our skill and knowledge to provide them with rational and appropriate care.

The 14 studies summarized in Table I represent the findings for approximately 1300 previously treated orthodontic patients from different regions of the world, treated with varying strategies including nonextration and extraction approaches, and various appliance systems both fixed and removable. While most are cross-sectional studies, some notable prospective longitudinal studies exist. The overwhelming evidence supports the conclusion that orthodontic treatment performed on children and adolescents is generally not a risk for the development of TMD years later. This conclusion should not be surprising for two obvious reasons: first, the multiplicity of factors that may be responsible for producing or exacerbating a TMD in general, and second, that orthodontic mechanotherapy produces gradual changes in an environment that is generally quite adaptive.
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REFERENCES


Reprint requests to:
Dr. Cyril Sadowsky
Department of Orthodontics
College of Dentistry
University of Illinois at Chicago
801 S. Paulina St.
Chicago, IL 60680