

Alterations of Temporomandibular Disorders before and after Orthognathic Surgery

A Systematic Review

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ABSTRACT

Objective: To answer the question whether orthognathic surgery does affect the prevalence of signs and symptoms of temporomandibular disorders (TMDs).

Materials and Methods: A literature survey in the PubMed and Cochrane Library electronic databases was performed and covered the period from January 1966 to April 2006. The inclusion criteria were controlled, prospective or retrospective studies comparing TMDs before and after orthognathic surgery in patients with malocclusion. There were no language restrictions, and three reviewers selected and extracted the data independently. The quality of the retrieved articles was evaluated by four reviewers.

Results: The search strategy resulted in 467 articles, of which 3 met the inclusion criteria. Because of few studies with unambiguous results and heterogeneity in study design, the scientific evidence was insufficient to evaluate the effects that orthognathic surgery had on TMD. Moreover, the studies had problems with inadequate selection description, confounding factors, and lack of method error analysis.

Conclusion: To obtain reliable scientific evidence, additional well-controlled and well-designed studies are needed to determine how and if orthognathic surgery alters signs and symptoms of TMD.

KEY WORDS: Temporomandibular disorders; Malocclusion; Orthognathic surgery; Systematic review

INTRODUCTION

Temporomandibular disorders (TMDs) embrace different signs and symptoms of the temporomandibular joint (TMJ), masticatory muscles, and related structures.¹ These include orofacial pain, joint sounds, reduced or asymmetric mandibular movement, and pain

on palpation of the TMJ and related muscles.² Different kinds of occlusal factors are sometimes claimed to be associated with TMD; however, the opinion as to whether this association has been proven differs between different studies.³⁻⁹ It has been indicated that orthodontic treatment does not, except for mild signs, increase prevalence of TMD¹⁰ and that orthodontic treatment, of some kinds of malocclusion, in children and adolescents may even reduce prevalence of signs and symptoms of TMD.^{11,12}

In severe malocclusions with major skeletal discrepancies, orthodontic treatment in combination with orthognathic surgery is sometimes needed. Orthognathic surgery and its effect on TMD have been examined in several studies during the past decades, and a systematic review of the present knowledge is motivated. In view of this and because evidence-based medicine has grown in importance,¹³ a systematic review of the present knowledge seems desirable. Systematic reviews try to locate, appraise, and synthesize evidence from scientific studies to provide informative answers

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to scientific questions by including a comprehensive summary of the available evidence.

The aim of this systematic review was to answer the question of whether orthognathic surgery affects the prevalence of signs and symptoms of TMDs.

MATERIALS AND METHODS

Search Strategy

To identify all studies that examined orthognathic surgery and its effect on TMD in patients with severe malocclusion, a literature survey was performed using the PubMed (www.ncbi.nlm.nih.gov) and the Cochrane Library electronic databases (www.cochrane.org). The search covered the period from January 1966 to April 2006. The terms used in the search were *malocclusion*, *retrognathia*, *prognathia*, *open bite*, and *deep bite* in various combinations with *craniomandibular disorders*, *temporomandibular disorders*, *temporomandibular dysfunction*, *temporomandibular joint dysfunction*, *temporomandibular joint pain* and *orthognathic surgery*, *surgical-orthodontic treatment*, and *surgery*.

Selection Criteria

Inclusion Criteria

- Studies comparing symptoms and signs of TMDs before and after orthognathic surgery in patients with malocclusion
- Randomized clinical trials (RCT) or prospective, retrospective, controlled human studies.

Exclusion Criteria

- Animal studies
- Case reports, case series, and preliminary reports
- Reviews, discussions, interviews
- Treatment of patients with syndromes; cleft lip or palate treatment (or both)

Three reviewers independently assessed all the article abstracts that appeared to meet the inclusion criteria. The article abstracts were collected irrespectively of the language in which they were published, and the retrieved articles were read in their entirety. The reference lists of the retrieved articles were also checked for relevant studies not found in the database search. Any interexaminer conflicts were resolved by discussion to reach a consensus.

Data Collection and Analysis

Data were extracted on the following items: author, year of publication, study design, sample size, gender and age, surgical treatment methods, follow-up time, methods to determine TMD, outcomes, and authors' conclusions. In addition, to document the methodolog-

Table 1. Distribution of Excluded Articles

| Exclusion Criteria | No. of Excluded Articles |
|--|--------------------------|
| Studies not concerning the objectives of this review (analysis of surgery techniques or of electromyographic activity in temporomandibular joint-related muscles, management of mandibular condyle fractures, treatment of arthritis and arthros, treatment of syndromes as cleft, lip, or palate treatment) | 386 |
| Animal studies | 5 |
| Case reports, case series, preliminary reports | 64 |
| Review articles, discussions, interviews | 9 |
| Total | 464 |

ical soundness of each article, a quality evaluation modified by the methods described by Antczak et al¹⁴ and Jadad et al¹⁵ was performed with respect to pre-established characteristics. The following seven variables were evaluated: study design (RCT = 3 points, prospective study = 2 points, retrospective study = 1 point), adequate sample size = 1 point, adequate selection description = 1 point, valid measurement methods = 1 point, use of method error analysis = 1 point, adequate statistics provided = 1 point, and consequences of confounders discussed in analysis = 1 point. By summing the seven variables, a study could score a maximum of 9 points in quality. A study's quality was categorized as low (0 to 4 points), medium (5 to 7 points), or high (8 or 9 points). The data extraction and quality scoring from each article were assessed independently by four evaluators. Interexaminer conflicts were resolved by discussion of each article to reach a consensus.

RESULTS

The search strategy resulted in 467 articles. After analysis according to the inclusion/exclusion criteria, three articles¹⁶⁻¹⁸ remained to be qualified for the analysis. The reasons for exclusion and the number of excluded articles are listed in Table 1. An agreement of more than 90% was found between the reviewers in assessing the data extraction and quality scores of the included articles.

Study Design and Treatment Methods

Summarized data of the three articles are shown in Table 2. All of the studies were longitudinal, prospective, and controlled clinical trials. In two of the studies,^{17,18} the test and control samples were age and gender matched, whereas in the study by Onizawa et al,¹⁶ the control sample was only age matched. The control group in Onizawa et al¹⁶ consisted of dental students and was without any description of dental deformities

Table 2. Summarized Data of the Three Studies Included in This Review

| Article | Study Design | Material: Size, Gender, and Age (y) | Treatment Methods | Follow-up | Methods of Determining TMD | Outcome/Authors' Conclusion |
|-----------------------------------|---------------------------------------|--|---|-----------|--|--|
| Onizawa et al, 1995 ¹⁶ | Prospective controlled clinical trial | T: 30 (20 women, 10 men) Age: mean 24.0 (17–34) C: 30 (11 women, 19 men) Age: mean 26.3 (22–39) | Bilateral sagittal split and/or Le Fort I osteotomy; rigid fixation with miniplates | 6 mo | Questionnaire, clinical examination | After surgical correction changes in the TMJ, symptoms did not always show improvement, and some patients showed changes for the worse |
| Panula et al, 2000 ¹⁷ | Prospective controlled clinical trial | T: 60 (49 women, 11 men) Age: mean 33.2 (16–56) C: 20 (16 women, 4 men) Age: mean 31.5 (15–44) | Bilateral sagittal split and/or Le Fort I osteotomy; rigid fixation with miniplates | 4 y | Questionnaire; clinical examination (Helkimos index) | Functional status and headache can be improved with orthognathic surgery; no direct relationship between TMJ dysfunction and dentofacial deformities |
| Dervis et al, 2002 ¹⁸ | Prospective controlled clinical trial | T: 50 (29 women, 21 men) Age: median 29.3 (19–42) C: 50 (28 women, 22 men) Age: mean 29.8 (20–36) | Surgery method not described; non-rigid fixation; 6 wk of intermaxillary fixation | 2 y | Questionnaire; clinical examination (Helkimos index) | Surgical correction has a beneficial effect on TMJ pain and dysfunction; TMD signs and symptoms do not always show improvement after surgical correction |

T indicates patient group; C, control group; TMD, temporomandibular disorder; and TMJ, temporomandibular joint.

and examined at only one time. In the study by Panula et al,¹⁷ the control sample was composed of patients that had refused orthognathic treatment after the first information, and in the study by Dervis et al,¹⁸ the control group was composed of individuals without dentofacial deformities. In all of the studies,^{16–18} there were few or no dropouts. Panula et al¹⁷ reported five dropouts who were deleted from the study. Dervis et al¹⁸ and Onizawa et al¹⁶ did not report dropouts. However, in the study by Onizawa et al,¹⁶ there was a decrease in the number of class III patients from the initial to the final examination, on which the authors only partly commented.

The orthognathic surgical method was described in two of the studies.^{16,17} Both studies used bilateral split osteotomy only or in combination with Le Fort I osteotomy. In the study by Dervis et al,¹⁸ no description of the surgical method was given.

In the study by Onizawa et al,¹⁶ evaluation of TMD was assessed before and 6 months after surgery, whereas Dervis et al¹⁸ and Panula et al¹⁷ evaluated signs and symptoms 2 and 4 years, respectively, from the initial preoperative examination.

All studies^{16–18} used a questionnaire and performed a clinical examination before and after surgery when assessing the patients' signs and symptoms of TMD. Controls were examined with the same methods at two different occasions except in the study by Onizawa et

al,¹⁶ in which the control group was examined on only one occasion. In addition, Panula et al¹⁷ and Dervis et al¹⁸ also evaluated the frequency of headache.

Orthognathic Surgery and Its Effect on TMD

When comparing signs and symptoms of TMD before treatment, neither study found any significant differences between patients and control group or type of malocclusion. After treatment, two of the studies^{17,18} concluded that both signs and symptoms related to TMD could be significantly improved (Table 2). On the other hand, Onizawa et al¹⁶ declared that TMD symptoms did not always show improvement after surgical correction, and for some patients, the symptoms changed for the worse (Table 2). When considering specific signs of TMD, Panula et al¹⁷ and Dervis et al¹⁸ found a statistically significant decrease in muscle palpation tenderness after surgery, whereas in the study by Onizawa et al,¹⁶ there was no such change found. Furthermore, Panula et al¹⁷ also reported a significant decrease in joint palpation tenderness. Onizawa et al¹⁶ reported a significant decrease in maximal mouth opening capacity, which was not observed by the other studies.^{17,18}

Quality Analysis

A quality analysis of the three involved studies is presented in Table 3. The research quality and meth-

Table 3. Quality Evaluation of the Three Retrieved Studies^a

| Authors | Study Design | Sample Size | Selection Description | Valid Measurement Methods | Method Error Analysis | Adequate Statistics Provided | Consequences of Confounders Discussed | Judged Quality Standard |
|-----------------------------------|--|----------------------------------|-----------------------|---------------------------|-----------------------|------------------------------|---------------------------------------|-------------------------|
| Onizawa et al, 1995 ¹⁶ | Prospective, longitudinal, controlled clinical trial | Adequate | Inadequate | Yes | No | Yes | No | Medium (5 points) |
| Panula et al, 2000 ¹⁷ | Prospective, longitudinal, controlled clinical trial | Inadequate, small control sample | Inadequate | Yes | No | Yes | No | Low (4 points) |
| Dervis et al, 2002 ¹⁸ | Prospective, longitudinal, controlled clinical trial | Adequate | Inadequate | Yes | No | Yes | No | Medium (5 points) |

^a Maximum nine points were possible to reach.

odological standard was low in one study¹⁷ and medium in two studies.^{16,18} The reasons for the low quality standard were mainly inadequate sample selection or description and no method error analysis. In addition, the authors had not discussed the influence of confounding factors on the results. Moreover, Panula et al¹⁷ had an inadequate control sample size.

DISCUSSION

The aim of this systematic review was to answer the question of whether orthognathic surgery affects the prevalence of signs and symptoms of TMDs in patients with malocclusion. However, no conclusion could be drawn because of the few studies located and their unambiguous results. Moreover, the included studies had problems with insufficient or lack of sample selection description, no discussion of confounding factors, and no method error analysis.

The outcome or authors' conclusion differed between the articles. One of the reasons could be the disparity of follow-up time between the study of Onizawa et al¹⁶ and the other two studies.^{17,18} The short follow-up time (6 months) used by Onizawa et al¹⁶ may not be enough for the patients to fully recover from the surgery. Orthognathic surgery is usually combined with presurgery and postsurgery orthodontic treatment. However, the description of the orthodontic treatment and its length of application was sparse¹⁷ or lacking.^{16,18} In Onizawa et al,¹⁶ there may have been a potential risk that the occlusion had not yet settled in some of the patients since the postsurgery orthodontic treatment may have been ongoing or recently completed. When comparing the treatment outcome between these three studies, one should also be aware of the heterogeneity in surgical methods and fixation,

which could have influenced the outcome. Stomatognathic treatment before surgery could have been a confounding factor in the study by Panula et al¹⁷ and might also have affected the results of this study and thereby affected the treatment outcome.

It is well known that uncontrolled studies and case reports imply low scientific evidence, and this was the reason why such studies were excluded. As signs and symptoms of TMD have been proven to fluctuate over time¹⁹ and because symptom frequencies appear to be age dependent,²⁰ it is important to include an age- and gender-matched²¹ nonpatient control group as comparison to diminish the risk that the results after treatment show only the normal fluctuation in prevalence of TMD. The study by Panula et al¹⁷ was the only study in which efforts were made to use an appropriate control group (ie, a control group consisting of patients with severe malocclusions and who refuse orthognathic surgery treatment). However, the control sample size was judged to be too small and thereby inadequate. Furthermore, no sample size calculation was presented to prove that the control sample size was sufficient. Nevertheless, in all of the studies, it seems it was difficult for the researchers to enroll appropriate control groups. However, in this kind of clinical controlled trial, it might be very difficult to find a control group with severe skeletal jaw discrepancy. It would be unethical not to offer treatment to those kinds of controls either conservatively, orthodontically, or by surgical-orthodontic treatment.

In all of the studies,¹⁶⁻¹⁸ the methods of assessing signs and symptoms of TMD were valid and well known. However, in two studies,^{17,18} the Helkimos index²² was used, and it remains to be determined whether the Helkimos index is an appropriate method

to determine TMD patients. Broad-based symptom scales (eg, the Helkimos indices) have often been used in the past. However, advances in classification mandate that future epidemiological studies use working definitions that include patterns of signs and symptoms of TMD and focus on more narrowly defined disease groups.²³ Furthermore, Storey²⁴ stated that although TMD was viewed as one syndrome, current research supports the view that TMDs are a cluster of related disorders in the masticatory system that have many common symptoms. Today, it is more suitable to use the research diagnostic criteria for TMD, which is a valid instrument with good reliability among adults to subdiagnose TMD.^{25,26}

From a methodological point of view, it was notable that none of the articles declared the use of blinding in measurements. However, the explanation for this may be that even if the extraoral stomatognathic examination is performed before the intraoral one, the blinding concerning test and control fails because the test individuals often are exteriorly affected by their skeletal malocclusion.

Today, the systematic literature search, data extraction, and subsequent quality assessment of included articles are well-established measures in evidence-based medicine/dentistry. However, the precise methods for the process can differ between various systematic reviews. The methodology used in this review was adopted from and based on the criteria for assessing study quality from the Centre for Reviews and Disseminations in York, United Kingdom.²⁷ Many articles were excluded: the main reason was the lack of a control group. Other excluded articles were those based on evaluation after the intervention without any registrations or analyses before the intervention started.

Several methods and scales to incorporate quality into systematic reviews have been proposed.^{14,15,27,28} However, many items were clearly not applicable, for example, placebo appearance/taste or patient or observer blinded to treatment. Instead, the quality of the articles was judged as low, medium, or high according to the scoring system based on the characteristics given in Table 3.

The restrictions on the number of databases used when searching the literature might imply that some articles were not identified. However, studies that are difficult to find are often of lower quality. The strength of the evidence in a systematic review is probably more dependent on assessing the quality of the included studies than on the degree of comprehensiveness.²⁹

CONCLUSIONS

- No conclusions could be drawn because of the few studies identified, heterogeneity in study design, and

unambiguous results. To obtain reliable scientific evidence, additional well-controlled and well-designed studies are needed to determine if and how orthognathic surgery alters signs and symptoms of TMD and headache.

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