# Orthodontics and Temporomandibular Joint Disorders (TMD): A Systematic Review

## Introduction and Background:

Evidence based practice can be defined as 'An approach to decision making in which the clinician uses the best evidence available, in consultation with the patient, to decide upon the option which suits the patient best' [1]. Evidence based practice is not restricted to randomized controlled trials and the hierarchy of evidence depends on the type of research question.

There is great variation in the nomenclature and description of Temporomandibular Joint Disorders (TMD) in the literature. In order to simplify the matter and decrease confusion a broader term for description will be used here; pain of the temporomandibular joint (TMJ) and/or its associated musculature. According to Le Resche [2], 10% of the population over the age of 18 years have pain in the temporomandibular region with a female to male ratio of 2:1. There is a multifactorial aetiology including psychosocial factors, trauma, and occlusal factors, which has led to a large number of treatment and management protocols. Treatment may include pharmacological agents, occlusal splints, physiotherapy or surgery.

Orthodontics is the branch of dentistry concerned with facial growth, with the development of the dentition and occlusion, and with diagnosis, interception, and treatment of occlusal anomalies [3]. Conventional orthodontic treatment is achieved by the use of different forms of intra-oral and extra-oral appliances to enhance dental and jaw function and dentofacial aesthetics.

Orthodontic treatment has been linked to both causing TMD, and also to treating them. Historically, it has been a controversial issue whether or not orthodontics caused or treated TMD, and this controversy was heightened in 1987 when the famous Michigan lawsuit was won which was filed against an orthodontist complaining that temporomandibular joint problems were caused as a result of orthodontic care [4]. The theory behind this is that extraction of teeth related to orthodontic treatment leads to locking and limitation of movement of the lower jaw and therefore impairs the function of the associated temporomandibular joint.

The aim of this study is to systematically review the literature to answer the following questions:

Question (1) What types of malocclusion traits are associated with TMD?
Question (2) Does orthodontic treatment lead to TMD?
Question (3) Can TMD be treated by orthodontics and are certain orthodontic appliances superior to others in managing TMD?

## Methods:

***Databases and search terms used:***

The following databases within Ovid were searched; Medline from 1966 to April Week 2 2004, Embase from 1980 to 2004 week 18, the Cochrane Controlled Trial Registry (CCTR), the Database of Abstracts of Reviews of Effects (DARE), the Cochrane Database of Systematic Reviews (CDSR), and the American College of Physicians (ACP) Journal club.

Search terms used were "temporomandibular", "temperomandibular", "malocclusion" and "orthodontics". Initially, Medline was searched, in which the terms were mapped to the MESH headings. MESH terms, free text, and truncated forms were used to form a search strategy.

The same search strategy was then run separately on Embase, and again it was run on the remaining databases collectively, CCTR, DARE, CDSR, ACP Journal club.

As a result of this initial search, there were 1475 citations from Medline from which I kept 203 by going through the titles and eliminating citations that were obviously irrelevant. From Embase there were 218 citations from which I kept 13. Finally, I kept 6 citations from the remaining databases. This gives a total of 232 citations as a starting point from the electronic search.

Furthermore, the SIGLE (System for Information on Grey Literature) and NRR (National Research Register) websites were searched to look for unpublished reports, yielding no relevant results.

A hand search of two journals was also performed, the Journal of Orthodontics and the Journal of Oral and Maxillofacial surgery in an attempt to represent both orthodontic and surgical aspects of TMD. These journals were searched from 1999 to October 2004. There were no reports that had not already been found in the initial electronic search.

***Types of Studies:***

Randomised controlled trials, cohort, case-control and cross-sectional studies were used according to the study question.

***Selection criteria and initial assessment:***

All publications in which there was an association between orthodontics or malocclusion and TMD as generally defined in the introduction were included. Publications were excluded and considered unsuitable in the following circumstances:

1. if participants needed surgery, had specific syndromes or anomalies,
2. if the temporomandibular joint dysfunction was measured by clicking or sounds only (since this does not comprise TMD),
3. if the temporomandibular joint dysfunction was measured by position in condylar fossa by imaging (since this does not fit any definition of TMD).
4. if they failed to address any of the three questions.

Each publication was initially assessed for relevance to each study question, and the type of study using the information presented in the abstract. Two independent assessors, TM and SJ, and in instances where there was disagreement, it was resolved by open discussion.

***Quality assessment:***

Quality assessment forms were produced for each type of study. Thus, there was an assessment form for RCT's, case-control , cohort and cross-sectional studies. These assessment forms were based mainly on forms available through the NHS Centre for Reviews and Dissemination website, and were amended and finalised by the authors.

Quality assessment via the standardised forms was performed by two independent assessors, DB and SJ, after which agreements and disagreements were openly discussed. Each study was scored according to the number of criteria it fulfilled on its respective assessment form. If a study scored 50% or more, it was considered to have sound research methodology, and therefore was included for data extraction.

***Data extraction:***

Data extraction forms were produced based on the different characteristics of malocclusion we were considering (Angles Cl I, II, III, overjet, overbite, anterior open bite, posterior crossbite), and signs and diagnostic indices of TMD. There was a form for Question 1, and a second form for both Questions 2 and 3 due to the similarity of the data to be extracted for these questions. Data extraction was performed by two assessors, DB and SJ, in collaboration.

***Statistical analysis:***

Data from question 1 was not amenable to statistical analysis due to the lack of standardised reporting.

Post treatment data for the four most commonly reported outcome measures (joint sounds, joint limitation, joint pain and muscle pain) from questions 2 and 3 was entered into Review Manager version 4.2 for windows [5]. The option used was a fixed effect meta-analyses using the Mantel-Haenszel odds ratios for dichotomous data.

**Results:**

The following forest plots were generated by RevMan with regards to question 2 and question 3 in relation to the outcomes of TMJ sounds, TMJ limitation, TMJ pain and TMJ muscle pain:

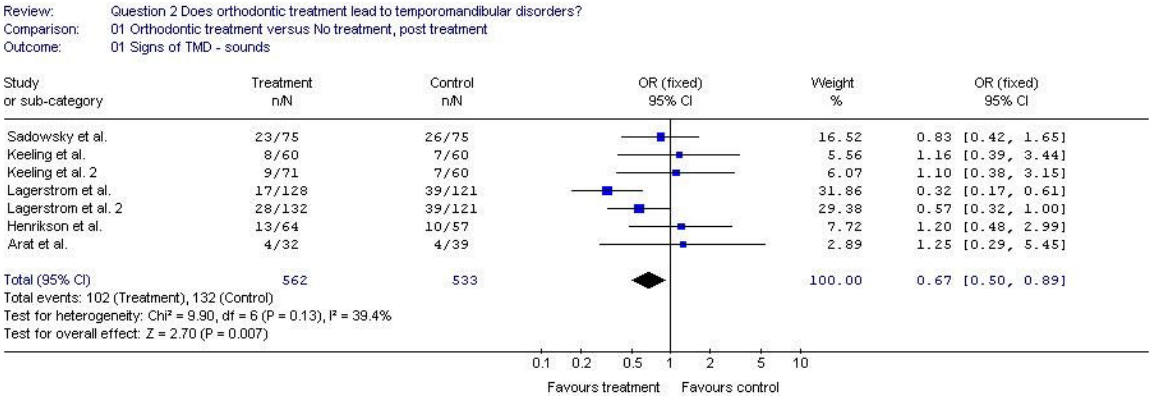


**Figure 1: Meta-analysis demonstrating the effect of orthodontic treatment on the prevalence of joint sounds.**

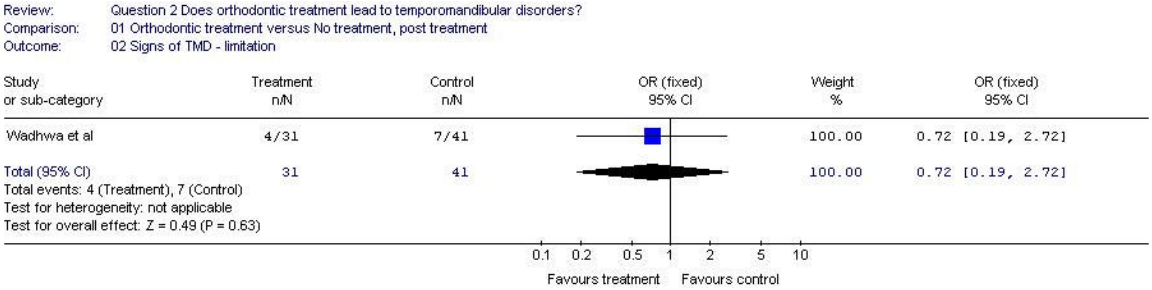


**Figure 2: Meta-analysis demonstrating the effect of orthodontic treatment on the prevalence of limitation of movement of the TMJ.**

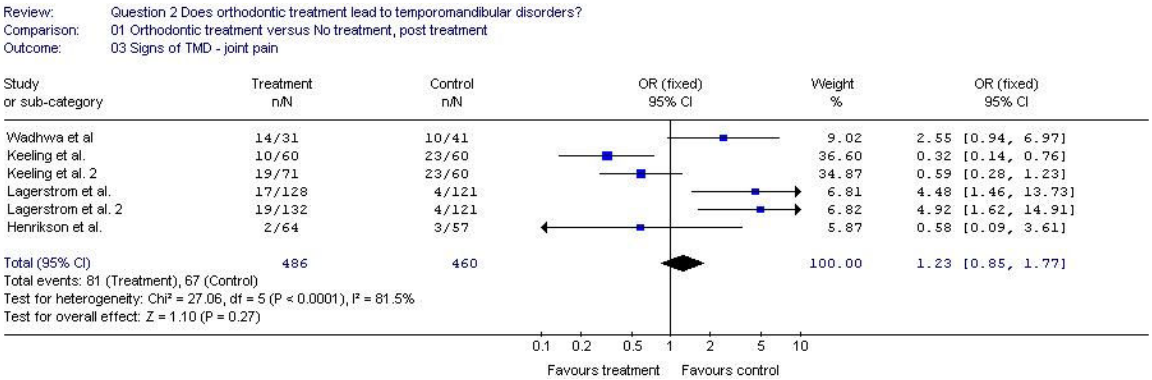


**Figure 3: Meta-analysis demonstrating the effect of orthodontic treatment on the prevalence of joint pain.**

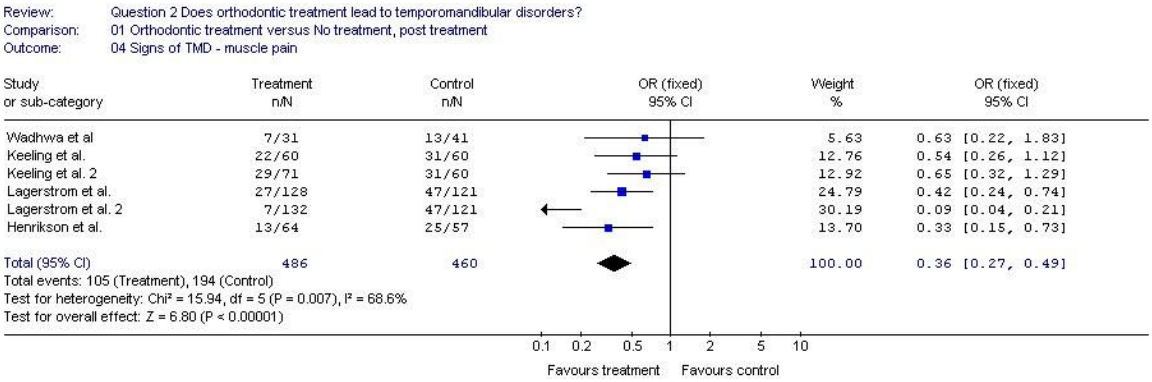


**Figure 4: Mete-analysis demonstrating the effect of orthodontic treatment on the prevalence of muscle pain.**

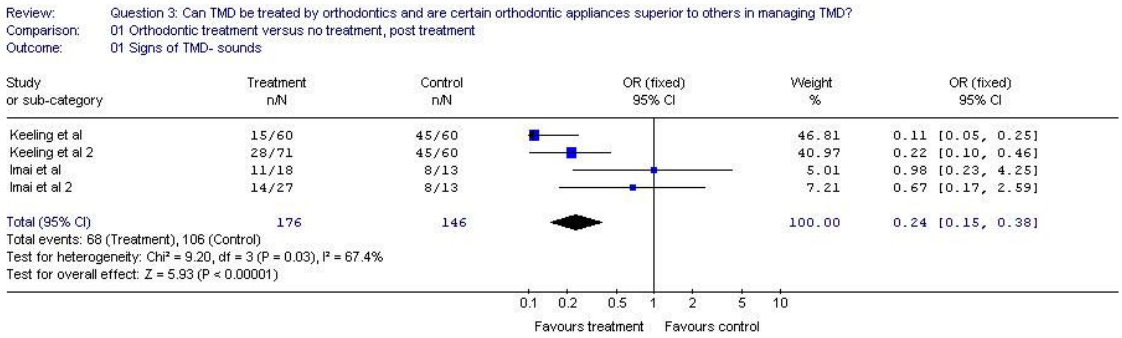


**Figure 5: The effect of orthodontic treatment on joint sounds.**

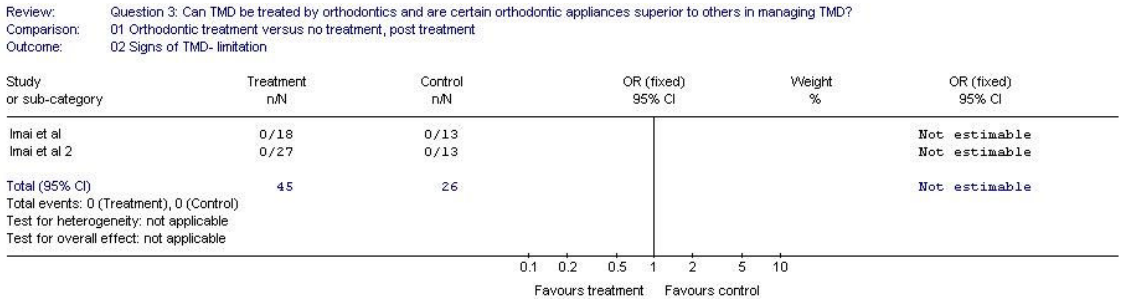


**Figure 6: The effect of orthodontic treatment on limitation of movement of the TMJ.**

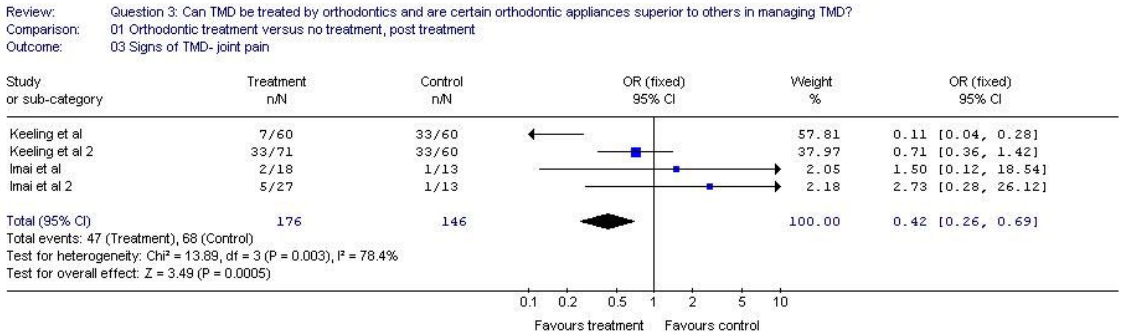


**Figure 7: The effect of orthodontic treatment on joint pain.**

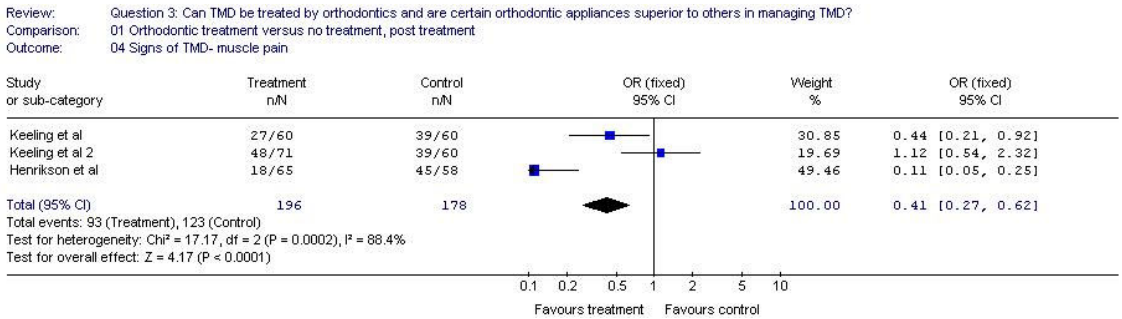


**Figure 8: The effect of orthodontic treatment on muscle pain.**

## Discussion:

### *Question 1*

Question 1 is concerned with the association of malocclusion and TMD, therefore a meta-analysis is not a valid method of analyzing its data. Furthermore, it would have been misleading to combine the data mainly because of lack of standardization of measuring TMD. There was a general trend for a higher association

of TMD with anterior open bite, posterior crossbites, reverse overjet/class III malocclusion, and to a lesser extent with Class II malocclusions.

***Question 2***

**Joint sounds (Figure 1)**

There was a total of 7 treatment modalities reported in 5 studies with regards to joint sounds [6-10]. Two of these studies reported two different types of orthodontic treatment and therefore were entered as two sets of data. Pooling of the data from the studies revealed an overall effect of decreased joint sounds associated with orthodontic treatment, which was statistically significant (P = 0.007). The heterogeneity was reasonably low at 39.4%.

**Joint limitation (Figure 2)**

There was only one study reporting limitation of the TMJ [11]. It is not recommended to use a forest plot where the outcome was demonstrated by only one study, but it was included in the analysis to illustrate the lack of available data for this outcome. Conclusions cannot be drawn for this outcome.

**Joint pain (Figure 3)**

There were 6 treatment modalities reported in 4 studies [7-9, 11]. The meta-analyses showed no effect of orthodontic treatment on TMD. There was poor heterogeneity at a level of 81.5%. It is interesting to note the distribution of the different studies in the forest plot. Two of the studies indicate a possible beneficial effect of orthodontic treatment on joint pain, while the remaining two favour the control group that had no orthodontic treatment. Although the study with the highest weighting (Keeling et al bionator group) showed a beneficial effect of treatment, when all the data was pooled, the overall effect showed a tendancy for the non-orthodontically treated group to have less joint pain, but this was not statistically significant.

**Muscle Pain (Figure 5)**

There were 6 treatment modalities reported in 4 different studies [7-9, 11]. The meta-analyses showed an overall effect of less muscle pain associated with orthodontic treatment that was statistically significant (p = 0.0001). However, this must be interpreted with caution as the heterogeneity was at a level of 68.6%.

It is interesting to note here that each study had a different type of orthodontic treatment. Three reports studied fixed orthodontic treatment, and the remaining 3 studied bionator, headgear and biteplane, and removable appliances. All of these studies had point means that favoured orthodontic treatment (ie less TMD in patients who had undergone orthodontic treatment), but with varying confidence intervals. An important question is raised here as to whether or not it is valid to combine the data from different orthodontic treatment modalities into one meta-analysis. If this is performed, then it must be kept in mind while interpreting the results. Perhaps it is the occlusal manipulation, not the particular orthodontic treatment modality that has a beneficial effect on the TMD. On the other hand, if the results of the studies are not combined, it will not be possible to analyse the effect of individual treatment modalities due to the small amount of data available for each type. Perhaps in the future when more studies are available, a meta-analysis can be performed on specific types of orthodontic treatment.

***Question 3***

**Joint sounds (Figure 6)**

Two studies reporting 4 treatment modalities were included in the meta-analyses [7, 12]. The overall effect was a decrease in joint sounds with orthodontic treatment at a statistically significant level (p = 0.00001). Heterogeneity was poor at a level of 67.4%.

**Limitation (Figure 7)**

There was only one study with 2 different treatment modalities reporting limitation of the TMJ [12]. The results were inconclusive due to the fact that post-treatment data indicated that no patients at the end of treatment had any limitation of the TMJ. The original paper presents no explanation as to why limitation was not present at the end of treatment although there were a number of patients who had it pre-treatment.

**Joint Pain (Figure 8)**

Four treatment modalities were reported in 2 studies [7, 12]. The meta-analyses showed a statistically significant decrease in joint pain with orthodontic treatment (p = 0.0005). However, this must be interpreted with caution as heterogeneity was poor at a level of 78.4%.

This effect is mainly based on one leg of the Keeling et al study which had more than 50% of the weighting. The experimental group in this leg of the study were treated with bionators. It might be expected that with this type of treatment which repositions the mandible anteriorly may act as an anterior repositioning splint, thereby reducing joint pain. The headgear/ bite plane group (Keeling et al 2) also had a heavy weighting and showed a beneficial effect. This may be due to the bite plane freeing the occlusion and decreasing pressure on the TMJ.

**Muscle pain (Figure 8)**

Three treatment modalities were represented from 2 studies [7, 9]. The meta-analyses showed a statistically significant decrease in muscle pain with orthodontic treatment($p = 0.0001$). However, the heterogeneity was poor at a level of 88.4%.

The Henrikson et al study had a heavy weighting of just under 50%. The experimental group in this study had orthodontic treatment with straight wire appliances. This may be in line with the theory that orthodontic treatment leads to soreness of the teeth, therefore reducing masticatory muscle activity as a protective response. However, in this study the TMD status was examined 1-2 years after completion of treatment, when the effect of sore teeth is no longer an issue.

In general, these results were quite surprising, but very interesting and exciting. It has been shown that orthodontic treatment is associated with a decreased prevalence of TMD signs and that orthodontic treatment can treat joint and muscle pain. So there is an overall beneficial effect of orthodontic treatment on TMD signs.

**Conclusions:**

Statistical analysis for Question 1 was not possible due to lack of standardised reporting. However, there was a general trend for TMD to be associated with posterior crossbite, reverse overjet and anterior open bite. Meta-analysis for Question 2 revealed that orthodontic treatment is associated with a decrease in prevalence of joint sounds and muscle pain, and has no effect on joint pain. Therefore orthodontics is not a risk factor for these signs of TMD. Meta-analysis for Question 2 showed that orthodontic treatment has a beneficial effect on joint sounds, joint pain and muscle pain. Any relationship between limitation of movement of the TMJ and orthodontic treatment cannot be determined due to insufficient data.

**References:**

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