Orthodontics for treating temporomandibular joint (TMJ) disorders (Review)

Luther F, Layton S, McDonald F

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2010, Issue 7

http://www.thecochranelibrary.com

TABLE OF CONTENTS

[Intervention Review]

Orthodontics for treating temporomandibular joint (TMJ) disorders

Friedy Luther[2], Stephen Layton[3], Fraser McDonald[1]

[1]Department of Orthodontics, King's College London Dental Institute, King's College London, London, UK. [2]Department of Orthodontics, Division of Child Dental Health, Leeds, UK. [3]United Lincolnshire Hospitals NHS Trust, Lincoln Nuffield Hospital, Lincoln, UK

Contact address: Fraser McDonald, Department of Orthodontics, King's College London Dental Institute, King's College London, Floor 22, Guy's Tower, St Thomas Street, London, SE1 9RT, UK. fraser.mcdonald@kcl.ac.uk.

Editorial group: Cochrane Oral Health Group.
Publication status and date: New, published in Issue 7, 2010.
Review content assessed as up-to-date: 3 June 2010.

Citation: Luther F, Layton S, McDonald F. Orthodontics for treating temporomandibular joint (TMJ) disorders. *Cochrane Database of Systematic Reviews* 2010, Issue 7. Art. No.: CD006541. DOI: 10.1002/14651858.CD006541.pub2.

ABSTRACT

Background

Temporomandibular disorders (TMD) relate to discomfort of the temporomandibular joint (TMJ). The disorder is multifactorial with a degree of psychogenic influence varying throughout an individual's life with phases of symptoms affecting the quality of life. In an attempt to treat this complex group of disorders many treatment modalities have been identified some of which are also considered in other Cochrane reviews. The disorder also has a normal cycle of events appearing to spontaneously improve without treatment.

Objectives

To establish the effectiveness of orthodontic intervention in reducing symptoms in patients with TMD (compared with any control group receiving no treatment, placebo treatment or reassurance) and to establish if active orthodontic intervention leads to TMD.

Search methods

The Cochrane Oral Health Group's Trials Register, CENTRAL, MEDLINE and EMBASE were searched. Handsearching of orthodontic journals and other related journals was undertaken in keeping with the Cochrane Collaboration handsearching programme. No language restrictions were applied.

Authors of any studies were identified, as were experts offering legal advice, and contacted to identify unpublished trials. Most recent search: 13th April 2010.

Selection criteria

All randomised controlled trials (RCTs) including quasi-randomised trials assessing orthodontic treatment for TMD were included. Studies with adults aged equal to or above 18 years old with clinically diagnosed TMD were included. There were no age restrictions for prevention trials provided the follow-up period extended into adulthood. The inclusion criteria required reports to state their diagnostic criteria for TMD at the start of treatment and for participants to exhibit two or more of the signs and/or symptoms. The treatment group included treatment with appliances that could induce stable orthodontic tooth movement. Patients receiving splints for 8 to 12 weeks and studies involving surgical intervention (direct exploration/surgery of the joint and/or orthognathic surgery to correct an abnormality of the underlying skeletal pattern) were excluded. The outcomes were: how well were the symptoms reduced, adverse effects on oral health and quality of life.

Data collection and analysis

Screening of eligible studies, assessment of the methodological quality of the trials and data extraction were conducted in triplicate and independently by three review authors. As no two studies compared the same treatment strategies (interventions) it was not possible to combine the results of any studies.

Main results

The searches identified 284 records from all databases. Initial screening of the abstracts and titles by all review authors identified 55 articles which related to orthodontic treatment and TMD. The full articles were then retrieved and of these articles only four demonstrated any data that might be of value with respect to TMD and orthodontics. After further analysis of the full texts of the four studies identified, none of the retrieved studies met the inclusion criteria and all were excluded from this review.

Authors' conclusions

There are insufficient research data on which to base our clinical practice on the relationship of active orthodontic intervention and TMD. There is an urgent need for high quality randomised controlled trials in this area of orthodontic practice.

When considering consent for patients it is essential to reflect the seemingly random development/alleviation of TMD signs and symptoms.

PLAIN LANGUAGE SUMMARY

Orthodontics for treating temporomandibular joint (TMJ) disorders

There is no evidence about the effects of different types of orthodontic braces for problems associated with the joint between the lower jaw and skull. When the joint between the lower jaw and the base of the skull is not working well (temporomandibular disorders (TMD)), it can lead to abnormal jaw movement or locking, noises (clicking or grating), muscle spasms, tenderness or pain. TMD is very common, and it is believed by some that it may be caused by the occlusion (the way the teeth bite), trauma or psychological stress. There is also a belief that the pain associated with TMD is similar, in that respect, to low back pain and may be related to variations of a person's individual pain perception. Changes in the way the teeth meet can be produced by the use of active orthodontic appliances. This review found that there is no evidence from trials to show that active orthodontic treatment can prevent or relieve temporomandibular disorders adding support to teeth not being part of its cause. It is suspected that we do not know the real cause of TMD at present.

BACKGROUND

The temporomandibular joint (TMJ) is the joint between the lower jaw and the base of the skull. TMJ disorders (TMD) refer to a group of disorders with symptoms that include pain, clicking, grating in the jaw joint and/or problems with chewing or opening the jaw. This condition can be known by a variety of conditions including craniomandibular disorders (CMD) and is a frequent cause of facial pain problems (Dworkin 1992). A positive relationship between occlusal factors (the way the teeth bite together) and TMD has been suggested (Ramfjord 1961). However, the term TMD may eventually be discarded as we come to understand the underlying pathophysiology of this disorder especially with respect to chronic musculoskeletal pain. Prevalence studies have reported approximately 75% of the population having at least one sign of joint dysfunction (abnormal jaw movement, joint noises, tenderness on palpation, etc) and approximately 33% having at least one symptom (facial pain, joint pain, etc) (Rugh 1985; Schiffman 1988). It is a significant finding that in all studies except one (Talaat 1986), females are affected more than males. There are many suggested causes of TMD although it is generally accepted that this covers a significant number of conditions that have common symptoms. Various theories have been put forward that relate the occlusion (bite of teeth), trauma, and stress with TMD (Bell 1986).The common signs and symptoms of TMD include pain, joint sounds (clicking, grating), and limited or asymmetrical jaw movement. It is suggested that these symptoms may have an effect on health and quality of life which in turn can lead to further

anxiety.

A developing view of TMD is linked to that of low back pain. The use of the word 'psychogenic' suggests there is no known physical cause. However, a biopsychosocial model is developing as the most heuristic approach to chronic pain (Gatchel 2007). This has been related to TMD (Suvinen 2005) whereby the interaction of basic neuroscience processes of pain (the bio of biopsychosocial) with psychosocial factors or how psychological and social factors interact with the processing of information in the central nervous system to influence health. The causation related to the gender predisposition may be associated with genetic variations of pain perception although this is yet to be defined (Tegeder 2009). There are some data that link pain to the circulating hormones. One study in particular, although with a limited sample size, considered low levels of oestrogen relating to highest levels of pain (although increased levels of pain may also be associated with the most rapid periods of change of oestrogen levels) (LeResche 2003).

Treatment options for TMD include reassurance (patient education, self care and behaviour therapy), physiotherapy (such as ultrasound, megapulse, acupuncture, short wave diathermy laser, heat exercises, and biofeedback), splint therapy, drug therapy, occlusal adjustment, surgical intervention and combined treatment. Acupuncture has been a particular treatment modality favoured by List (List 1993) and there are numerous articles in the literature in relation to this topic. It is, however, outside the remit of this review. Certain authors actually consider conservative, 'low tech' treatment as success rates from invasive treatment do not produce a better result (Stohler 1999). Furthermore, some authors actually debate the need for treatment: LeResche (LeResche 2001) suggested only 10% of the population aged over 18 are likely to have symptoms that require treatment whilst others (McNeill 1997; Okeson 1996), using other authors' data, estimated that 3.6% to 7% of the population are actually needing treatment.

Occlusal adjustment (OA) is the selective adjustment of the biting surface of the teeth by grinding the enamel (outer layer of the tooth) so that the upper and lower teeth fit together (the intercuspal position) harmoniously and is the subject of another Cochrane review (Koh 2003). The summary finding, however, is that there is no consistent data to support this permanent change in the shape of the occlusal surface of the teeth to treat TMD. Cochrane reviews of other treatments (e.g. splint therapy or surgery) are also underway or published (Al-Ani 2004; Guo 2009). It is not clear if malocclusion has a causal role in TMD. However, orthodontic treatment has been used in studies to prevent TMD. There are ethical and clinical implications if orthodontic treatment is found to be ineffective in preventing or initiating TMD.

As all the muscles associated with chewing may be affected by the disorder, the pain is often felt away from the joint so the term CMD has also been described (Dworkin 1990). Okeson (Okeson 1997) described TMD as a collective term including a number of clinical problems that involve the chewing muscles, the TMJ and associated structures or both. However, psychosocial factors play a major part in the causes of TMD and by treating/managing the factors associated with stress and anxiety of the patient, the symptoms and signs of TMD can often be reduced or stopped (Greene 1995).

There is a distinct profile of the types of people affected by TMD and the number of people affected by the condition increases with age. It is far more common in females to the point that only females are reported in some studies with no record of the incidence or prevalence in males affected (Landi 2004; Miller 2005). In another report (Lipton 1993) TMJ pain was reported by 5.5% of the population in a survey of 45,711 American households. Previous studies have indicated that approximately 75% of people have at least one sign of joint dysfunction (abnormal jaw movement, joint noises, tenderness on palpation, etc) and approximately 33% have at least one symptom of TMD (facial pain, joint pain, etc).

There is a significant degree of controversy regarding the relationship of TMD and orthodontic treatment (Luther 1998a; Luther 1998b). The use of orthodontic appliances to correct the alignment and vertical relationships of teeth has small yet significant risks: an increase in plaque build up, leading to an increase in oral and dental disease, and a reduction of bone support to the teeth and possible root resorption (Ireland 2003). Included in the possible risks of orthodontic treatment is the concern related to the development of TMD. There are many studies that have examined the inter-relationships of the occlusion (malocclusion) and the development of TMD. The reports appear to relate to specific issues: (i) Is the malocclusion, without treatment, related to the development of TMD? (ii) Is orthodontic treatment capable of improving the signs of symptoms of TMD? (iii) Does orthodontic treatment predispose to the development of TMD in later life?

(i) The nature of the psychosocial profile of the population studied can vary and as a consequence the studies of two groups from differing areas in the same country may prevent direct comparisons. In the study by Sadowsky and Polson (Sadowsky 1984) groups in both Illinois and Eastman are examined. Within the paper, whilst there is a comparison between the treated and untreated groups of the socioeconomic background and ethnicity within each study, it is not reported if the two studies were compared in this respect. A 20-year follow-up using questionnaires to self report the signs and symptoms has demonstrated that whilst several malocclusion traits were consistent with patients with TMD there was no strong correlations between them and as such screening of malocclusion, on the basis of identifying those at risk of TMD, was not worthwhile (Helm 1989).

(ii) A study examining adolescent girls undergoing treatment, showed that in the group that was treated there was a significantly reduced prevalence of muscular signs post-treatment, but that clicking, a symptom often identified, increased in both the

treated, untreated and normal groups over the 2 years of observation (Henrikson 1999; Henrikson 2000).

(iii) Long term follow-up studies are clearly difficult but have been undertaken with some robust data acquisition. One group have followed patients until 30 years of age (Mohlin 2004). They identified no link between orthodontic treatment acting as either a preventative measure or a significant cause of TMD. They did, however, identify significant associations with TMD and general health and psychosocial well being as well as neuroticism and self esteem measures. Another group has reported, in several papers, on the longitudinal follow-up of patients for 20 years. The overall conclusion initially was that whilst the patients who had undergone orthodontic treatment and had a reduced dysfunction index (Egermark 1992), further follow-up indicated that orthodontic care did not predispose to the development of TMD in later life (Egermark 2003; Egermark 2005).

Many of the studies, whilst identifying small associations, fail to isolate a single unique aspect that can either refute or support the association of orthodontic treatment to TMD, presumably because of the diffuse nature of TMD. Thus, it appears that to date the ideal study has not yet been undertaken to assess this and whilst there are small but significant risks involved in the use of orthodontic appliances, especially the more complex appliances, the use of a technique without data to support it, is not considered appropriate in contemporary health care. This can be especially so if the clinicians are poorly trained in the use of such appliances. Furthermore, the use of any treatment may inappropriately raise patient expectations as well as wasting valuable healthcare resources (in as much as no patient benefit will be predictably and reliably achieved).

The prognosis of TMD, due to the multi-factorial nature of the condition, is difficult to establish. A long term follow-up of over 30 years (de Leeuw 1994) established the chronic nature of such a condition.

The working hypothesis appears to be that if the teeth bite incorrectly in the form of a malocclusion, this can then apply a restriction to the function of the TMJ or worse still, predispose it to future pathological deterioration. By correcting the alignment and arrangement of the teeth the TMJ will remodel to the overriding new functional needs thus treating any disease processes/malfunction of joint integrity and allowing normal function to continue unabated for the life of the patient (Moss 1969). The subject can be further subdivided into two further aspects or questions: 1) Does orthodontic treatment predispose to later development or worsening of TMD? 2) Does orthodontic treatment permanently and consistently improve the immediate signs and symptoms of TMD?

OBJECTIVES

To establish the effectiveness of orthodontic intervention in reducing symptoms in people with temporomandibular disorders (TMD) (compared with any control group receiving no treatment, placebo treatment or reassurance) and to establish if active orthodontic intervention leads to TMD.

The following primary null hypotheses were tested:

Orthodontic treatment does not treat or prevent symptoms of TMD.

Specifically, the review addressed the hypotheses of no difference between orthodontic treatment and control for TMD for the following outcomes where data were available:

- overall symptoms;
- relief of headache;
- patient quality of life.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled trials (RCTs), including quasi-randomised trials, assessing orthodontic treatment and TMD.

Types of participants

Adults, aged equal to or above 18 years old, with clinically diagnosed TMD. There were no age restrictions for prevention trials provided the follow-up period extended into adulthood. The inclusion criteria required reports to state their diagnostic criteria for TMD at the start of treatment and for participants to exhibit two or more of the signs and/or symptoms listed below. This technique is well established in clinical diagnosis and epidemiology.
The list of symptoms (Austin 1995) included the following.

- The occurrence of recurrent headache (equal or more than two episodes a month).
- Pain in the jaws, face, throat, neck, shoulders or back.
- Ear symptoms (includes tinnitus, stuffiness, diminished hearing, or pain).
- Pain in the temporomandibular joint (TMJ) at rest and during chewing.
- Day and night time grinding or clenching.
- Vertigo.
- Stiffness in jaws.
- Difficulties in swallowing.

- Globus symptoms (associated with choking sensations or soreness of the throat).
- Joint sounds (including clicking and grating).
- Spontaneous luxation or locking of the jaws.

The list of signs included the following.

- Palpatory tenderness on either side of the masticatory muscles.
- Joint sounds during jaw movements, elicited by auscultation. Distinction is made between opening and closing clicks, crepitations and reciprocal clicking (as with previous Cochrane studies of this disorder).
- Tenderness during jaw movements.
- Deviation of the mandible on opening and closing.
- Reduced mandibular range of motion.
- Presence of occlusal interference in retruded, protruded and medio- and latero-trusion positions of the mandible.
- Wear facets.

TMD was required to be clinically absent at baseline in studies on prevention.

Any signs or symptoms associated with pain of dental origin were excluded.

Types of interventions

The treatment group received appliances that could induce stable orthodontic tooth movement for a significant period to induce permanent orthodontic change in tooth position. Therefore, patients receiving splints for 8 to 12 weeks, whilst moving teeth during the short term, would not be considered. Whilst this time interval appears somewhat arbitrary it was felt that, from an orthodontic perspective, this would represent a realistic time interval. This form of tooth movement, if present, would not be stable from an orthodontic perspective and the design of such splints would allow relapse to pre-treatment positions. The control groups received no treatment, placebo or reassurance.

Studies where splints had been used prior to placement of orthodontic appliances were excluded.

Types of outcome measures

Primary outcomes

The main outcomes considered were overall symptoms, pain and headache.

Relief from symptoms was assessed using global measures of symptoms.

Data on pain were recorded according to frequency, severity or duration. Where possible, data for the frequency, severity and duration of pain would have been aggregated.

Similarly, data on headache were recorded according to frequency, severity or duration. Where possible, data for the frequency, severity and duration of pain would have been also aggregated.

The interval required for outcome measurement was at least 6 months after the intervention.

Secondary outcomes

Limitation of movement. Other signs were ignored because they are neither unique to the disease nor associated with the progression or outcomes of TMD.

Search methods for identification of studies

The subject search used a combination of controlled vocabulary and free text terms based on the search strategy developed for MEDLINE. The search was combined with the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised controlled trials in MEDLINE: sensitivity maximising version (2009 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of the *Cochrane Handbook for Systematic Reviews of Interventions* version 5.0.2 (updated September 2009) (Higgins 2009).

Databases to be searched

The following databases were searched:

- The Cochrane Oral Health Group's Trials Register (to 13th April 2010) (Appendix 1)
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2010, Issue 3) (Appendix 2)
- MEDLINE via OVID (1950 to 13th April 2010) (Appendix 3)
- EMBASE via OVID (1980 to 13th April 2010) (Appendix 4).

Language

The search identified all relevant studies irrespective of language. Every attempt was made for non-English papers to be translated.

Checking reference lists

The reference lists of all relevant trials obtained were checked, along with the reference lists of relevant review articles. In addition, reference lists from prosthetic dentistry textbooks on temporomandibular disorders and splint therapy were also checked.

Handsearching

The following journals were identified as being important to be handsearched for this review:

Acta Odontologica Scandinavica (1939 to October 2009)

Journal of the American Dental Association (1966 to October 2009)
Journal of Oral Rehabilitation (1974 to October 2009)
Journal of Craniomandibular Practice (1986 to October 2009)
Journal of Oral and Maxillofacial Surgery (1982 to October 2009).
The review authors examined these journals following the guidance of the Cochrane Oral Health Group's Journal Handsearchers' Manual.

Personal contact

A comprehensive list of relevant articles, along with inclusion criteria for the review, were included in a letter which was sent to the first author of each paper asking for any unpublished, relevant studies not included in the list. Copies of the same letter were also sent to other experts in the field of TMD, or others with an interest in the area. In addition, evidence in the form of scientific articles offered in support of legal cases was also examined both in the form of material previously submitted and by contacting the legal experts who support such protocols. The British Orthodontic Society was contacted for any unpublished data on this subject together with the authors of information leaflets of the British Orthodontic Society where TMD was discussed.

Unpublished studies

Conference proceedings and abstracts were examined but none provided data appropriate for consideration.

Data collection and analysis

Study selection

The title, abstract, and keywords of identified studies were screened independently by all review authors for relevance to the systematic review. Studies meeting the inclusion criteria were retrieved as complete articles. Those with randomised and quasi-randomised controlled design, participants with TMD confirmed clinically, occlusal adjustment and control specified and the required outcome variables were to be included. The term quasi-randomised studies followed the definition in the Cochrane Oral Health Group's Journal Handsearchers' Manual and are studies where the method of allocation was known but was not considered strictly random.

Data extraction

All review authors independently extracted data, if appropriate, to a pre-designed data collection form. No studies were identified but if they had, the data would have been extracted considering: bibliographic details, details of the study setting, characteristics of study population, frequency and course of the interventions, baseline and outcome measures, etc. The different requirements and techniques for adjustment would be recorded as covariates and assessed as possible sources of heterogeneity. Where available, data on psychosocial factors would be included as a covariate and assessed as a possible source of heterogeneity. If new studies are identified in the future this protocol and data extraction forms will be used.
There were no uncertainties on data extraction. Authors of the original studies were consulted by mail to obtain more information about any of the published studies to determine if there were data that could be extracted.

Assessment of the risks of bias in included studies

An assessment of the risk of bias would have been undertaken following the recommendations in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* 5.0.2 (Higgins 2009). As no studies were identified this was not possible.
A specific tool would have been used for assessing risk of bias in each included study if identified. This would have consisted of a description and a judgement for each entry in a risk of bias table, where each entry addressed a specific feature of the study:

- Sequence generation
- Allocation concealment
- Blinding
- Incomplete outcome data addressed
- Free of selective outcome reporting
- Free of other bias.

The judgement for each entry would involve answering a question, with answers 'Yes' indicating low risk of bias, 'No' indicating high risk of bias, and 'Unclear' indicating either lack of information or uncertainty over the potential for bias.
Overall risk of bias: studies would have been categorised according to the following:

- Low risk of bias (plausible bias unlikely to seriously alter the results) if all criteria were met
- Unclear risk of bias (plausible bias that raises some doubt about the results) if one or more criteria were assessed as unclear
- High risk of bias (plausible bias that seriously weakens confidence in the results) if one or more criteria were not met.

Data synthesis

The Cochrane Collaboration's statistical guidelines would have been followed. Unfortunately, there were no data to consolidate and so it was not possible to consider any statistical evaluations. If future publications demonstrate suitable data we will evaluate as follows: Clinical heterogeneity will be assessed by examining the types of participants, interventions and outcomes in each study. Meta-analysis will only be used when studies are of similar comparisons reporting comparable outcome measures. The significance of discrepancies in the estimates of treatment effects from the different trials will be assessed by inspection of a graphical display and

by means of Cochran's test for heterogeneity, and any heterogeneity investigated. Random-effects models will be used for all meta-analyses provided there are more than three studies in the meta-analysis. Risk ratio values will be calculated along with 95% confidence intervals for binary data. Mean differences and 95% confidence intervals will be used for continuous data. Categorical data will be converted to binary outcomes e.g. cured/not cured, improved/not improved with sensitivity analyses of the 'same' group to give best and worse case scenarios. The studies will be grouped according to treatment type and duration of follow-up.

In addition, a sensitivity analysis will be carried out to see how the quality of the studies affects the findings (a small change in the parameter of a study may have a profound change of the outcomes), if studies incorporating sufficient data allow for this analysis.

Although unpublished data will be sought, the difficulty in identifying all unpublished material is acknowledged. Publication bias will be assessed using funnel plots.

RESULTS

Description of studies

See: Characteristics of excluded studies.

The searches identified 284 records from all databases. Initial screening of the abstracts and titles by all review authors identified 55 articles which related to orthodontic treatment and TMD. The full articles were then retrieved and of these articles only four demonstrated any data that might be of value with respect to TMD and orthodontics. The majority of trials were not eligible as they did not include subject matter relevant to the topic; the remainder included splints, no control groups for comparison, only assessed symptoms and signs but did not include orthodontic care, and surgical intervention. The remaining studies, whilst not achieving the correct level for inclusion of data, identified some noteworthy findings. After further analysis of the full texts of the four studies identified, none of the retrieved studies met the inclusion criteria and all were excluded from this review (Gianelly 1988; Keeling 1995; Piancino 2008; Sonnesen 2008). Three articles (Gianelly 1988; Keeling 1995; Sonnesen 2008) considered a tenuous link with the level of overbite; two studies examined joint function with imaging although one did not include orthodontics (Piancino 2008), and the other examined the findings of children with clinical symptoms (Keeling 1995).

Risk of bias in included studies

No studies were found eligible for inclusion and therefore no methodological quality assessment was conducted.

Effects of interventions

No studies were identified for inclusion.

DISCUSSION

There is an absence of evidence that orthodontic treatment can treat or prevent temporomandibular disorders (TMD). There are no trials or studies that reach the threshold required to support the concepts of orthodontic treatment relating to TMD. It is important to distinguish between absence of evidence and evidence of absence. There may not be evidence of an effect because there are no data regarding the effectiveness of orthodontic treatment for TMD.

Some data from a number of studies did lead to a degree of understanding that could assist in delivering care for patients. One of the more robust studies (Conti 2003) assessed 200 participants divided into four groups dependent on the malocclusion type. Whilst the data lacked a control group there was an association identified which linked parafunctional habits such as grinding and not orthodontic treatment to TMD.

In a further study (Franco 2002) Class II Division 1 malocclusions were evaluated with a control group and a Frankel II therapy group (Frankel appliances are a group of appliances that work by changing the environment of the lips and the cheeks and in so doing apply forces to move the teeth). The issue that negates the value of this study as one to be considered, is that the control group were the participants observed over an 18-month period before treatment was commenced; this does not provide a robust control group. The disc position was assessed using magnetic resonance imaging (MRI) and the outcome was that orthodontic therapy did not affect disc position. A significant omission, however, was that symptoms of TMD were not assessed; only disc position. The recommendations of this study, therefore, are that ethical approval is required, a true and absolute control group needs to be considered alongside the study group and that symptoms and signs be incorporated with the MRI views.

Keeling 1995 assessed a robust number of participants (although there was no evaluation at the outset as to how many should be considered). In this study 60 participants were treated with a functional appliance, 60 were observed and 60 were treated with headgear and a bite plane. The participants were evaluated for TMD prior to treatment and then assessed by examiners who were blinded to the type of treatment provided to the patient. The initial study began in 1990 when ethical approval was not as stringent as in 2010; the obtaining of informed consent is detailed. The data appeared to indicate that age was the most significant factor relating to developing TMD; in addition, participants who began the study with TMD were seven times more likely to have

these symptoms at follow-up. Within the study there was no reporting of intention-to-treat or indication of any drop outs from the original cohort over and above those excluded on the basis of the protocol of the study. However, this study did not provide any data relevant to this review.

Class III malocclusions were evaluated in one study (Gavakos 1991) when different treatment modalities were identified for assessing a type of jaw relationship it was thought could lead to TMD. There were several types of appliance systems with treatment commencing in the mixed dentition phase and continuing until growth was complete. These treatment techniques included: a functional appliance, 27 patients further treated with fixed appliances, and three patients treated with a reverse headgear. There was a clear description of the gender and age of the patients at the assessment of the study. However, there was no assessment of the symptoms of TMD prior to commencement of the orthodontic treatment although the patients were assessed using the Helkimo index and the clinical dysfunction index. A third evaluation, using the occlusal state determined by clinical investigation of the number of teeth, the number of teeth in occlusion, occlusal interferences during movement from retruded contact position to the intercuspal position, and articulation interferences during protrusion and lateral movements was evaluated. This was not correlated to symptoms of TMD. Surgical patients were also included. There were no reported differences in the groups evaluated but the study was retrospective.

Egermark followed a cohort of patients who had orthodontic care between 1981 and 1983 and laudably followed up the patients 20 years later (Egermark 2003; Egermark 2005). The studies used a questionnaire and calculated the Helkimo index for evaluation of TMD. One of the conclusions was that there was no statistically significant difference in the prevalence of TMD with patients who had received orthodontic treatment when compared with those who had not received active orthodontic intervention. The numbers in the 35-year old group were significantly reduced. Whilst 102 patients had been identified the actual types of orthodontic treatment were only recorded from the patient history (i.e. they gave an affirmative answer that they had received some kind of orthodontic treatment in childhood, Egermark 2003). Clearly the varied nature of the treatment mechanics could not be recorded precisely on the basis of the patients' recollection. The groups were further subdivided as the level of the care provided differed varying between specialist level care and that provided by general dental practitioners; it was also unclear as to the number of individuals delivering the care. In the latter study (Egermark 2005) a total of 50 subjects (27 males and 23 males) were identified but were further subdivided due to the varied nature of the malocclusions that had been treated. The overall incidence of manifest TMD, that required treatment, was 1% and the study did not identify a significant increase in those patients who had undergone orthodontic treatment.

A major study has been published from Groningen (Dibbetts 1987; Dibbets 1989; Dibbets 1992). This has produced a significant amount of data examining orthodontic treatment and TMD. The final report (Dibbets 1992) examined participants 20 years after treatment; the treatment was divided into functional appliances, Begg treatment and chin cap treatment. There was no control group. In addition, the cases were analysed with regard to extractions; the three groups were non-extraction, extraction of four premolars and all other types of extractions. By evaluation of the participants using frequencies and the Chi^2 statistic it was apparent that neither the type of treatment, nor whether extractions were undertaken, predisposed to the development of TMD after 20 years of observation (Dibbets 1992).

The study by Minakuchi (Minakuchi 2001), whilst not utilising orthodontics as one of the treatment modalities, was noteworthy in terms of principle within the remit of TMD treatment. In this study the authors identified anterior disc displacement without reduction. The patients were recruited to the study presented during 1997 and 1998 and the study had institutional review and approval of the appropriate committee. The 69 patients were allocated to one of three groups of patients: no treatment, self care and non-specific anti-inflammatory agents and an occlusal appliance and observed over an 8-week period. The 8-week period of assessment was deemed, by the authors of this Cochrane review, to be insufficient to produce stable orthodontic tooth movement. There were robust inclusion criteria reported and the initial group of patients consisted of 269 patients eventually leading to a recruitment of the 69 participants. There was clear and precise recording of the reasons for non-inclusion. The final group of participants had clear reporting of the male/female allocation (reflecting the female preponderance for the condition: 7 males and 62 females) and the age of the cohort together with the standard deviation of the patients (34.0 ± 15.4). All patients had MRI images and had an initial observation period following a full explanation of the condition and diagnosis. Standardised visual analogue scales were used to assess the symptoms at the start of treatment and throughout the observation period. The conclusions from this study were that the treatment required for TMD was minimal intervention and that there was no difference between the different treatment approaches and the control group.

One issue that was apparent relates to the recommendation that in some instances patients should not have any active treatment as this will not alleviate the signs and symptoms.

There are concerns of the validity and reliability of the criteria used in all the trials. Inaccurate and inconsistent diagnosis of TMD causes misleading reporting of TMD and incomparability of results with other trials. There were limitations of the methods used in the trials considered in this review from not assessing TMD appropriately to the inconsistent use of indices for assessment of TMD. These limitations should be considered in their historical context.

Recommendations for future research include:

(1) ethical approval and consent have to be undertaken;

(2) reporting the odds ratio, risk ratio, risk ratio reduction, absolute risk reduction or mean difference and associated 95% confidence intervals where appropriate;

(3) the studies must be well controlled with respect to bias and blinding is essential;

(4) reporting data on psychosocial outcomes, costs and quality of life;

(5) the use of standardised diagnostic criteria for TMD;

(6) the use of standardised outcome measures for evaluating treatments of TMD;

(7) reporting of any side effects, especially if they were directly related to the intervention;

(8) providing intra- or extra-examiner variability where appropriate;

(9) future research should use samples of adequate size based on power calculations. The existing trials can be used as the basis of such power calculations.

To date there has never been a satisfactory evaluation of orthodontics with respect to TMD. It is believed that the most robust study would require the recruitment of participants with TMD diagnosed, allocation to groups relating to the malocclusion (or not) and then treatment with either active orthodontic intervention or splints.

AUTHORS' CONCLUSIONS

Implications for practice

There is no evidence to support or refute the use of orthodontic treatment for the treatment of temporomandibular disorders (TMD). In addition, there are no data which identify a link between active orthodontic intervention and the causation of TMD. Based on the lack of data, orthodontic treatment cannot be recommended for the treatment or prevention of TMD. Patients attending with symptoms of TMD prior to orthodontic treatment should be counselled appropriately with regard to the possibilities of the progression of the disorder (i.e. it may worsen, stay the same or improve). The apparent random nature of the progression of such a disease process demonstrates the need for clear, unambiguous informed consent. The views of Stohler (Stohler 1999), aiming for the simpler solutions, seem the most sensible in light of current data.

An issue which developed during this study was during the screening of papers and identification of the data. In many instances this reflected poorly on the quality of editorial stringency with abstracts (structured or unstructured) failing to ensure that the abstract reflected the body of the text of the article.

Implications for research

(1) More research is needed to elucidate whether there is any benefit from treating TMD with orthodontic treatment.

(2) Consideration needs to be given to developing valid and standardised diagnostic criteria for TMD.

(3) Consideration needs to be given to standardised outcome measurements for evaluating interventions for TMD.

(4) Guidelines, produced by the CONSORT Group, have been published for reporting of randomised controlled trials in the medical literature (www.consort-statement.org/). The use of such guidelines would improve the quality of trials and reports of the management of TMD.

ACKNOWLEDGEMENTS

Thanks go to Emma Tavender and Luisa Fernandez Mauleffinch (past and current Managing Editors respectively for the Cochrane Oral Health Group) for their help with the administration and support of the review, Jayne Harrison for her help in the editorial process, and Sylvia Bickley and Anne Littlewood (past and current Trials Search Co-ordinators respectively) for carrying out the searches for the review.

We would also like to thank those who have provided comments and editorial input into this review.

REFERENCES

References to studies excluded from this review

Gianelly 1988 *{published data only}*

Giannelly AA, Hughes HM, Wohlgemuth P, Gildea G. Condylar position and extraction treatment. *American Journal of Orthodontics and Dentofacial Orthopedics* 1988;**93**(3):201–5.

Keeling 1995 *{published data only}*

Keeling SD, Garvan CW, King GJ, Wheeler TT, McGorray S. Temporomandibular disorders after early Class II treatment with bionators and headgears: results from a randomized controlled trial. *Seminars in Orthodontics* 1995;**1**(3):149–64.

Piancino 2008 *{published data only}*

Piancino MG, Roberi L, Frongia G, Reverdito M, Slavicek R, Bracco P. Computerized axiography in TMD patients before and after therapy with 'function generating bites'. *Journal of Oral Rehabilitation* 2008;**35**(2):88–94.

Sonnesen 2008 *{published data only}*

Sonnesen L, Svensson P. Temporomandibular disorders and psychological status in adult patients with a deep bite. *European Journal of Orthodontics* 2008;**30**(6):621–9.

Additional references

Al-Ani 2004

Al-Ani MZ, Davies SJ, Gray RJM, Sloan P, Glenny AM. Stabilisation splint therapy for temporomandibular pain dysfunction syndrome. *Cochrane Database of Systematic Reviews* 2004, Issue 1. [DOI: 10.1002/14651858.CD002778.pub2]

Austin 1995

Austin DG, Pertes RA. Clinical management of temporomandibular disorders and orofacial pain. In: Pertes RA, Gross SG editor(s). *Examination of the TMD Patient*. 1st Edition. Illinois: Quintessence Publishing Co, 1995:123.

Bell 1986

Bell WE. Classification of temporomandibular disorders. In: Bell WE editor(s). *Temporomandibular Disorders. Classification, Diagnosis, Management*. Chicago: Year Book Medical Publishers Inc, 1986:172–214.

Conti 2003

Conti A, Freitas M, Conti P, Henriques J, Janson G. Relationship between signs and symptoms of temporomandibular disorders and orthodontic treatment: a cross-sectional study. *The Angle Orthodontist* 2003;**73**(4):411–7.

de Leeuw 1994

de Leeuw R, Boering G, Stegenga B, de Bont LG. Clinical signs of TMJ osteoarthrosis and internal derangement 30 years after nonsurgical treatment. *Journal of Orofacial Pain* 1994;**8**(1):18–24.

Dibbets 1989

Dibbets JM, van der Weele LT. Prevalence of TMJ symptoms and X-ray findings. *European Journal of Orthodontics* 1989;**11**:31–6.

Dibbets 1992

Dibbets JM, van der Weele TL. Long-term effects of orthodontic treatment, including extraction, on signs and symptoms attributed to CMD. *European Journal of Orthodontics* 1992;**14**(1):16–20.

Dibbetts 1987

Dibbetts JM, van der Weele LT. Orthodontic treatment in relation to symptoms attributed to dysfunction of the temporomandibular joint: A 10-year report of the University of Groningen study. *American Journal of Orthodontics and Dentofacial Orthopedics* 1987;**91**(3):193–9.

Dworkin 1990

Dworkin SF, LeResche L, DeRouen T, Von Korff M. Assessing clinical signs of temporomandibular disorders: reliability of clinical examiners. *The Journal of Prosthetic Dentistry* 1990;**63**(5):574–9.

Dworkin 1992

Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *Journal of Craniomandibular Disorders* 1992;**6**(4):301–55.

Egermark 1992

Egermark I, Thilander B. Craniomandibular disorders with special reference to orthodontic treatment: an evaluation from childhood to adulthood. *American Journal of Orthodontics and Dentofacial Orthopedics* 1992;**101**(1):28–34.

Egermark 2003

Egermark I, Magnusson T, Carlsson GE. A 20-year follow-up of signs and symptoms of temporomandibular disorders and malocclusions in subjects with and without orthodontic treatment in childhood. *The Angle Orthodontist* 2003;**73**(2):109–15.

Egermark 2005

Egermark I, Carlsson GE, Magnusson T. A prospective long-term study of signs and symptoms of temporomandibular disorders in patients who received orthodontic treatment in childhood. *The Angle Orthodontist* 2003;**75**(4):645–50.

Franco 2002

Franco AA, Yamashita HK, Lederman HM, Cevidanes LH, Proffit WR, Vigorito JW. Fränkel appliance therapy and the temporomandibular disc: a prospective magnetic resonance imaging study. *American Journal of Orthodontics and Dentofacial Orthopedics* 2002;**121**(5):447–57.

Gatchel 2007

Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychological Bulletin* 2007;**133**(4):581–624.

Gavakos 1991
Gavakos K, Witt E. The functional status of orthodontically treated prognathic patients. *European Journal of Orthodontics* 1991;**13**(2):124–8.

Greene 1995
Greene CS. Etiology of temporomandibular disorders. *Seminars in Orthodontics* 1995;**1**(4):222–8.

Guo 2009
Guo C, Shi Z, Revington P. Arthrocentesis and lavage for treating temporomandibular joint disorders. *Cochrane Database of Systematic Reviews* 2009, Issue 4. [DOI: 10.1002/14651858.CD004973.pub2]

Helm 1989
Helm S, Petersen PE. Mandibular dysfunction in adulthood in relation to morphologic malocclusion at adolescence. *Acta Odontologica Scandinavica* 1989;**47**(5):307–14.

Henrikson 1999
Henrikson T, Nilner M, Kurol J. Symptoms and signs of temporomandibular disorders before, during and after orthodontic treatment. *Swedish Dental Journal* 1999;**23**(5-6):193–207.

Henrikson 2000
Henrikson T, Nilner M, Kurol J. Signs of temporomandibular disorders in girls receiving orthodontic treatment. A prospective and longitudinal comparison with untreated Class II malocclusions and normal occlusion subjects. *European Journal of Orthodontics* 2000;**22**(3):271–81.

Higgins 2009
Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions version 5.0.2 (updated September 2009). The Cochrane Collaboration, 2009. Available from www.cochrane-handbook.org.

Ireland 2003
Ireland AJ, McDonald F. *The Orthodontic Patient: Treatment and Biomechanics*. Oxford: Oxford University Press, 2003.

Koh 2003
Koh H, Robinson PG. Occlusal adjustment for treating and preventing temporomandibular joint disorders. *Cochrane Database of Systematic Reviews* 2003, Issue 1. [Art. No.: CD003812. DOI: 10.1002/14651858.CD003812]

Landi 2004
Landi N, Manfredini D, Tognini F, Romagnoli M, Bosco M. Quantification of the relative risk of multiple occlusal variables for muscle disorders of the stomatognathic system. *The Journal of Prosthetic Dentistry* 2004;**92**(2):190–5.

LeResche 2001
LeResche L. Epidemiology of orofacial pain, Section I. The clinical problem and epidemiology. In: Lund JP, Lavigne GJ, Dubner R, Sessle E editor(s). *Orofacial Pain: From Basic Science to Clinical Management. The Transfer of Knowledge in Pain Research to Education*. Chicago: Quintessence Publishing Co Inc, 2001:15–25.

LeResche 2003
LeResche I, Mancl L, Sherman JJ, Gandara B, Dworkin SF. Changes in temporomandibular pain and other symptoms across the menstrual cycle. *Pain* 2003;**106**(3):253–61.

Lipton 1993
Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. *Journal of the American Dental Association* 1993;**124**(10):115–21.

List 1993
List T, Helkimo M, Karlsson R. Pressure pain thresholds in patients with craniomandibular disorders before and after treatment with acupuncture and occlusal splint therapy: a controlled clinical study. *Journal of Orofacial Pain* 1993;**7**(3):275–82.

Luther 1998a
Luther F. Orthodontics and the temporomandibular joint: where are we now? Part 1. Orthodontic treatment and temporomandibular disorders. *The Angle Orthodontist* 1998;**68**(4):295–304.

Luther 1998b
Luther F. Orthodontics and the temporomandibular joint: where are we now? Part 2. Functional occlusion, malocclusion, and TMD. *The Angle Orthodontist* 1998;**68**(4):305–18.

McNeill 1997
McNeill C. History and evolution of TMD concepts. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 1997;**83**(1):51–60.

Miller 2005
Miller JR, Mancl L, Critchlow C. Severe retrognathia as a risk factor for recent onset painful TMJ disorders among adult females. *Journal of Orthodontics* 2005;**32**(4):249–56.

Minakuchi 2001
Minakuchi H, Kuboki T, Matsuka Y, Maekawa K, Yatani H, Yamashita A. Randomized controlled evaluation of non-surgical treatments for temporomandibular joint anterior disk displacement without reduction. *Journal of Dental Research* 2001;**80**(3):924–8.

Mohlin 2004
Mohlin BO, Derweduwen K, Pilley R, Kingdon A, Shaw WC, Kenealy P. Malocclusion and temporomandibular disorder: a comparison of adolescents with moderate to severe dysfunction with those without signs and symptoms of temporomandibular disorder and their further development to 30 years of age. *The Angle Orthodontist* 2004;**74**(3):319–27.

Moss 1969
Moss ML, Salentijn L. The primary role of functional matrices in facial growth. *American Journal of Orthodontics* 1969;**55**(6):566–77.

Okeson 1996
Okeson JP. Differential diagnosis and management considerations of temporomandibular disorders. In: Okeson JP editor(s). *Orofacial Pain: Guidelines for*

Assessment, Diagnosis and Management. Chicago: Quintessence Publishing Co Inc, 1996:113–84.

Okeson 1997
Okeson JP. Current terminology and diagnostic classification schemes. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 1997;**83**(1):61–4.

Ramfjord 1961
Ramfjord SP. Dysfunctional temporomandibular joint and muscle pain. *The Journal of Prosthetic Dentistry* 1961;**11**(2): 353–74.

Rugh 1985
Rugh JD, Solberg WK. Oral health status in the United States: temporomandibular disorders. *Journal of Dental Education* 1985;**49**(6):398–406.

Sadowsky 1984
Sadowsky C, Polson AM. Temporomandibular disorders and functional occlusion after orthodontic treatment: results of two long-term studies. *American Journal of Orthodontics* 1984;**86**(5):386–90.

Schiffman 1988
Schiffman E, Fricton JR. Epidemiology of TMJ and craniofacial pain. In: Fricton JR, Kroening RJ, Hathaway KM editor(s). *TMJ and Craniofacial Pain: Diagnosis and Management*. St Louis: IEA Publications, 1988:1–10.

Stohler 1999
Stohler CS, Zarb GA. On the management of temporomandibular disorders: a plea for a low-tech, high prudence therapeutic approach. *Journal of Orofacial Pain* 1999;**13**(4):255–61.

Suvinen 2005
Suvinen TI, Reade PC, Kemppainen P, Könönen M, Dworkin SF. Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *European Journal of Pain* 2005;**9**(6):613–33.

Talaat 1986
Talaat AM, el-Dibany MM, el-Garf A. Physical therapy in the management of myofacial pain dysfunction syndrome. *The Annals of Otology, Rhinology, and Laryngology* 1986;**95** (3 Pt 1):225–8.

Tegeder 2009
Tegeder I. Current evidence for a modulation of low back pain by human genetic variants. *Journal of Cellular and Molecular Medicine* 2009;**13**(8B):1605–19.

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Gianelly 1988	A retrospective evaluation of position of condyle but with no symptoms identified
Keeling 1995	A very robust study but considering children; potentially a study capable of delivering data for this review in the future
Piancino 2008	Orthodontic care was not part of the study considerations.
Sonnesen 2008	There was no randomisation into groups to allow evaluation of treatment

DATA AND ANALYSES

This review has no analyses.

APPENDICES

Appendix 1. Cochrane Oral Health Group's Trials Register search strategy

((temporomandibular or "myofascial pain syndrome*" or craniomandibular or "joint diseases" or "temporo mandibular" or temporomandibular or "orofacial pain" or "facial pain" or "costen* syndrome*" or "articular disorder*" or headache* or bruxism or bruxist or "cranio mandibular" or "cranio-mandibular" or "disk derangement" or "disc derangement" or "disc displacement" or "disk displacement") AND (orthodontic* or malocclusion*))

Appendix 2. CENTRAL search strategy

#1 exp TEMPOROMANDIBULAR JOINT/
#2 exp TEMPOROMANDIBULAR JOINT DISORDERS/
#3 exp MYOFASCIAL PAIN SYNDROMES/
#4 exp CRANIOMANDIBULAR DISORDERS/
#5 (temporomandibular* or craniomandibular* or "myofascial pain syndrome*")
#6 TMJ or CMD or TMD [ti]
#7 TMJ or CMD or TMD [ab]
#8 exp JOINT DISEASES/
#9 "temporo mandibular" or temporo-mandibular or "orofacial pain" or "facial pain" or "costen* syndrome*" or "articular disorder*" or headache* or bruxism or bruxist or "cranio mandibular" or "cranio-mandibular" or "disk derangement" or "disc derangement" or "disc displacement" or "disk displacement"
#10 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9
#11 exp ORTHODONTICS/
#12 MANDIBULAR ADVANCEMENT/
#13 #11 NOT #12
#14 orthodontic* or malocclusion*
#15 exp MALOCCLUSION
#16 #13 or #14 or #15
#17 #10 AND #16

Appendix 3. MEDLINE via OVID search strategy

1. exp Temporomandibular Joint/
2. exp Temporomandibular Joint Disorders/
3. exp Myofascial Pain Syndromes/
4. exp Craniomandibular Disorders/
5. (temporomandibular$ or craniomandibular$ or myofascial pain syndrome$).mp. [mp=ti, ot, ab, nm, hw]
6. TMJ.ti. or TMJ.ab. or CMD.ti. or CMD.ab.
7. ((temporo adj mandibular) or temporo-mandibular or (orofacial adj pain) or (facial adj pain) or Costen$ syndrome$ or articular disorder$ or headache$ or bruxism or bruxist).mp. [mp=ti, ot, ab, nm, hw]
8. ((cranio adj mandibular) or cranio-mandibular or (disk adj derangement) or (disc adj derangement) or (disc adj displacement) or disk adjdisplacement).mp. [mp=ti, ot, ab, nm, hw]
9. TMD.ti. or TMD.ab.

10. exp Joint Diseases/
11. or/1-10
12. exp ORTHODONTICS/
13. Mandibular Advancement/
14. 12 not 13
15. malocclusion.mp. or orthodontic$.ab,ti. [mp=ti, ot, ab, nm, hw]
16. exp MALOCCLUSION/
17. or/14-16
18. 11 and 17

Cochrane search filter for MEDLINE via OVID

Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised trials in MEDLINE: sensitivity maximising version (2009 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of the *Cochrane Handbook for Systematic Reviews of Interventions v*ersion 5.0.2 (updated September 2009).
1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. or/1-8
10. animals.sh. not (humans.sh. and animals.sh.)
11. 9 not 10

Appendix 4. EMBASE via OVID search strategy

1. exp Temporomandibular Joint/
2. exp Temporomandibular Joint Disorder/
3. exp Myofascial Pain Syndromes/
4. exp Craniomandibular Disorders/
5. (temporomandibular$ or craniomandibular$ or myofascial pain syndrome$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
6. TMJ.ti. or TMJ.ab. or CMD.ti. or CMD.ab.
7. ((temporo adj mandibular) or temporo-mandibular or (orofacial adj pain) or (facial adj pain) or Costen$ syndrome$ or articular disorder$ or headache$ or bruxism or bruxist).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
8. ((cranio adj mandibular) or cranio-mandibular or (disk adj derangement) or (disc adj derangement) or (disc adj displacement) or disk adjdisplacement).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
9. TMD.ti. or TMD.ab.
10. "joint diseases".mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
11. or/1-10
12. ORTHODONTICS/
13. "Mandibular Advancement".mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
14. 12 not 13
15. malocclusion.mp. or orthodontic$.ab,ti. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]

16. MALOCCLUSION/
17. or/14-16
18. 11 and 17

Filter for EMBASE via OVID

1. random$.ti,ab.
2. factorial$.ti,ab.
3. (crossover$ or cross over$ or cross-over$).ti,ab.
4. placebo$.ti,ab.
5. (doubl$ adj blind$).ti,ab.
6. (singl$ adj blind$).ti,ab.
7. assign$.ti,ab.
8. allocat$.ti,ab.
9. volunteer$.ti,ab.
10. CROSSOVER PROCEDURE.sh.
11. DOUBLE-BLIND PROCEDURE.sh.
12. RANDOMIZED CONTROLLED TRIAL.sh.
13. SINGLE BLIND PROCEDURE.sh.
14. or/1-13
15. ANIMAL/ or NONHUMAN/ or ANIMAL EXPERIMENT/
16. HUMAN/
17. 16 and 15
18. 15 not 17
19. 14 not 18

HISTORY

Protocol first published: Issue 2, 2007

Review first published: Issue 7, 2010

CONTRIBUTIONS OF AUTHORS

Fraser McDonald (FM) and Friedy Luther (FL) wrote the protocol and the review. FM co-ordinated the review, handsearched the appropriate journals and wrote the letters to trial authors. FL, Stephen Layton (SL) and FM independently and in triplicate assessed the eligibility of trials, extracted data and assessed the quality of trials. FM would have conducted the statistical analysis.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- University of Leeds, UK.
- United Lincolnshire Hospitals NHS Trust, UK.
- King's College London, UK.

External sources

- No sources of support supplied

INDEX TERMS

Medical Subject Headings (MeSH)

Orthodontics, Corrective [*methods]; Temporomandibular Joint Disorders [*therapy]

MeSH check words

Adult; Humans; Young Adult