

Effects of orthodontic therapy on periodontal health; a systematic review of controlled evidence.

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ABSTRACT

Background: Orthodontic therapy has been suggested to lead to an improved periodontal status through mechanisms such as increased ease of plaque removal and reduced occlusal trauma.

Objective: To systematically evaluate human studies comparing orthodontic intervention to no intervention and evaluating a periodontal outcome measured at least one month after treatment end.

Methods: Electronic searches in 8 databases (1980 to July 2006) and handsearches in six dental journals (1980 to July 2006) were completed. Data were extracted using standardized forms. **Main**

results: Weak evidence from 10 non-randomized and 1 randomized study suggested that orthodontic therapy was associated with 0.03 mm of gingival recession (95% Confidence Interval [CI]: 0.01 - 0.05), 0.13 mm of alveolar bone loss (95%CI: 0.07 - 0.20), and 0.23 mm of increased pocket depth (95%CI: 0.15 - 0.30) when compared to no treatment. The effects of orthodontic therapy on gingivitis were inconsistent across studies preventing calculation of a summary estimate ($I^2 > 70\%$).

Conclusions: This systematic review identified an absence of reliable evidence that orthodontic therapy improves or harms the periodontal status.

INTRODUCTION

There are three types of evidence that can provide a scientific basis for assessing the periodontal effects of orthodontic therapy: (a) evidence based on common-sense, biological plausibility, or animal studies, (b) indirect evidence from clinical studies that identify risk factors for deteriorating periodontal parameters that are modifiable by orthodontics, and (c) direct evidence from clinical studies that relate orthodontic therapy to periodontal outcomes.

The most common biological plausibility arguments are that dental alignment obtained with orthodontic therapy facilitates plaque removal and reduces occlusal trauma. With severe crowding, the bristles of the toothbrush cannot access all tooth surfaces and plaque and stain removal can consequently be difficult. As a result, to the extent that one considers plaque control important in the management of periodontal conditions, orthodontic therapy can be considered equally important to facilitate this process. Analogously, occlusal factors have been hypothesized to have an ability to cause periodontal harm, in particular when associated with inflammation. One example is an impinging deep-bite that leads to stripping of the palatal periodontal tissues and consequently may compromise the periodontal status of maxillary incisors ¹. Since such deep bites can be corrected by means of orthodontic therapy, it seems plausible that certain forms of periodontal harm can be avoided through orthodontic therapy.

A second line of evidence is epidemiological evidence on periodontal risk factors that are modifiable through orthodontic therapy. Of particular relevance to orthodontic therapy is that – among patients with established periodontitis - occlusal forces have been related to pocket depth in a small number of studies ²⁻⁴. Potentially, there are other factors such as dental plaque that have been associated with gingivitis, and that at the same time can be influenced by dental alignment. The evidence in favor of

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such modifiable periodontal risk factors has been weak and inconsistent. For instance, the reported relationships between crowding and periodontal status have ranged from no relationship^{5,6}, a weak relationship⁷, or a relationship limited to the maxilla⁸. Or, the reported clinical relationships between crowding and oral hygiene performance^{9,10}, and indeed oral hygiene and caries and chronic periodontitis¹¹ have been reported to be absent or weak

The strongest evidence in establishing a relationship between orthodontic therapy and periodontal conditions is a comparison of the periodontal status among individuals who did and did not receive orthodontic therapy. The aim of this study was to conduct a systematic review of the direct evidence on the impact of orthodontic therapy on the periodontal status.

MATERIAL AND METHODS

Search strategy

Study selection criteria:

- Study designs: randomized controlled trials, cohort studies, case-control studies, and cross-sectional studies.
- Population: No restriction in terms of patient's age or occlusion characteristics (e.g., severe crowding) was formulated. Studies restricting the population to patients with severe periodontal diseases or craniofacial anomalies were excluded.
- Intervention/control characteristics: Placebo- or no- treatment control group compared to fixed and/or removable orthodontic treatment. In order to eliminate most studies that involve full banding (which may be associated with more adverse periodontal effects) no studies published before the 1980s or reporting fully banded appliances were included. If it was unclear from the publication whether fully banded appliances were utilized, the authors were contacted. Author replies were accepted until June 12, 2007. A priori, it was decided that studies involving orthognatic surgery and distraction osteogenesis would be excluded because the procedures and consequences may be substantially different from non-surgical orthodontic therapy. Studies involving dental extractions were not excluded.
- Types of outcome measures: Due to the heterogeneity of endpoints in periodontal studies¹², no a priori single periodontal outcome measure could be formulated. Instead, all studies that included at least one type of periodontal parameter were included for review. Periodontal parameters that were identified during the review included gingivitis, gingival recession, attachment loss, periodontal

pockets, alveolar bone loss, tooth mobility, and tooth loss. Root resorption was excluded because it was considered unrelated to the primary focus of this study, periodontal diseases.

Length of follow-up after orthodontic treatment termination: Studies that assessed periodontal outcomes only at the time of appliance removal were excluded to eliminate the potential short-term adverse effects of orthodontic appliances on periodontal structures.

Search methods for identification of studies

Article citations were obtained through electronic search of databases, hand searching, and bibliographic references listings of published primary and review studies. Authors of relevant studies were contacted for additional information and their responses accepted until June 12, 2007. References were managed using Reference Manager® software and the codings were entered in a database using Microsoft Access® software.

Electronic Searches: The development of a search strategy was assisted by an information specialist at the University of Washington Health Sciences Library and included terms related to types of treatment and outcomes (see annex 1 for the search strategies used in each electronic database). The search strategy did not include search terms relating to the study type because almost half of the publications may not be identified¹³. The electronic databases used were: MEDLINE (1980 to 2006); Web of Science (1980 to 2006); and Cochrane Library (1980 to 2006), including Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts of Reviews of Effects (DARE), and Health Technology Assessment (HTA). CENTRAL contains the results of the Cochrane Oral Health Group's Trials Register which includes handsearches

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for reports of randomized controlled trials (RCTs) and Controlled Clinical Trials (CCTs) in the main dental journals and proceedings abstracts.

Citations were coded according to type of study, participants, presence of an orthodontic intervention, presence of a periodontal outcome, presence and type of the comparison group. The searches were limited to reports of studies on humans in any language published between January 1980 and October 2006.

Electronic searching of unpublished literature or 'grey' literature: ClinicalTrials.gov

(<http://www.clinicaltrials.gov> - accessed 10.08.2006) and the National Research Register (UK)

(<http://www.controlled-trials.com> - accessed 10.08.2006) were searched using the following phrase:

Orthodontic AND periodontal. ProQuest Dissertation Abstracts and Thesis database

(<http://wwwlib.umi.com./dissertations>) was also searched using the truncated terms “Orthodontic*” and “periodont*”.

Hand searching: Six journals were selected as they published the majority of reports on orthodontics

and periodontal diseases accordingly to a search on Web of Science: *American Journal of*

Orthodontics & Dentofacial Orthopedics, Angle Orthodontist, European Journal of Orthodontics,

Journal of Periodontology, Journal of Dental Research, and Journal of Clinical Periodontology. These

dental journals were hand searched for studies reporting on the periodontal effects of orthodontic treatment published between January 1980 and June 2006.

All reports identified through hand- and electronic searches were coded according to type of study, participants, presence of an orthodontic intervention, presence of a periodontal outcome, presence and

type of the comparison group. In addition, the references in selected papers were screened for eligible studies.

Assessment of methodological quality

The quality assessment was performed independently by two reviewers (JCC and AMB) and disagreements were resolved by discussion between the reviewers.

For RCTs, 9 items were assessed: random allocation, allocation concealment, baseline similarity of groups, reporting of eligibility criteria, point estimates and measure of variability of primary outcome, blinding of outcome assessors, care provider and patient and intent-to-treat analysis ¹⁴.

For cohort studies, case-control studies (none were identified) and cross-sectional studies, the Newcastle - Ottawa Quality Assessment Scale was used which included eight items: 4 items on selection - representativeness of exposed cohort, selection of non-exposed groups, ascertainment of exposure and baseline assessment of outcome (not applicable for cross-sectional studies); 1 item on comparability of the groups on design or analysis (confounding); and 3 items on outcome assessment - blinding, follow-up duration and dropout or response rates ¹⁵. One additional item not present in the scale was included in the quality assessment which was the reporting of number of observations, point estimates and measure of variability for the primary outcome.

Based on these items, all studies were classified as having low (all quality items were met), moderate (one or two quality items not met), or high risk of bias (three or more criteria not met).¹⁶

Data extraction and synthesis

Data extraction was performed by one reviewer (JCC). Patient mean and standard deviations for the continuous outcomes were extracted from the reports or estimated by pooling the results presented by surfaces or sites. Standard deviations not reported by studies were estimated as a linear function of the means from the same outcome of the other studies included in this review.

For alveolar bone loss, patient mean and standard deviation of the orthodontic treated and untreated groups were estimated by calculating patient means from tooth/surface specific results presented in tables by two studies^{17,18} and figures by another study¹⁹. Gingivitis, attachment loss and pocket depth data from two orthodontic groups (with and without 4 pre-molar extractions) were pooled in one study²⁰. For attachment loss, one study did not include the number of participants in the untreated group and the standard deviation of both treated and untreated groups and the missing data could not be estimated²¹. For gingival recession, one study presented tooth-specific data which were averaged to patient means for the purpose of this systematic review²². For gingivitis, the mean gingivitis index (GI) was calculated from a figure and the standard deviation estimated based on the mean and standard deviation of other three studies²³.

The results were synthesized by study design and type of outcome. It was planned to – when possible, to separate reporting and analysis of the results for children versus adolescents, and adults, surrogate versus true endpoints; and fixed versus removable appliances. Heterogeneity was assessed by means of the I-squared statistic. Weighted mean differences (SMD) between groups were calculated using RevMan 4.2.7 based on fixed effect models. If the heterogeneity levels of the fixed effect models were higher than 70%²⁴, a random effect model was estimated. The results of the random effect models were presented if the heterogeneity levels of the random effects models were below 70%. No summary

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estimates were calculated if both the random and fixed effects models had an heterogeneity larger than 70%..

It was planned to perform sensitivity analysis, subgroup analysis and publication type bias²⁵. as feasible to determine bias and the significance of contributing factors (study quality, diagnostic criteria and severity of the outcome, duration of orthodontic treatment; and duration of follow-up) to the overall results.

RESULTS

1. The search

The electronic searches retrieved 3,552 unique citations. After scanning titles and abstracts (when available), the full-text articles of 104 citations were retrieved for evaluation. After evaluating the full-text and querying primary authors, thirteen studies met the inclusion criteria (Figure 1). No studies meeting the inclusion criteria were found through the electronic searching of ‘grey’ literature.

Of these 13 studies, one study was excluded because it reported on a publication of a study which was already included, and 2 studies because of the absence of statistics. Ten studies from the electronic search were included in this review.

During the handsearching, 20,551 full-text reports were coded. Of these 20,551 studies, 214 (~1%) were studies on humans reporting an orthodontic intervention and a periodontal outcome. Of these 214 reports, 7 (4%) met the inclusion criteria. One was a previous report of an included study (Figure 1).

From the 17 studies retrieved by either the electronic- or the hand-searches, 6 were duplicates. Thus, 11 studies were included in this review.

2. Description of included studies

2.1 Study Design and Duration

RCT: One study was a randomized clinical trial (RCT)²⁶ with a total duration of 16 weeks with 12 weeks of orthodontic treatment and 4 weeks of follow-up after the treatment.

COHORT studies: Two prospective cohort studies followed patients for 2.5 and 5 years^{17,23}. One cohort reported that the assessment of the outcome was on average 2 years after the active orthodontic

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treatment was completed¹⁷. The other study did not report how long after the end of the orthodontic active phase the outcome was measured.

CROSS-SECTIONAL studies: 8 out of 11 studies were cross-sectional^{18-22,27-29}.

2.2 Setting and publication characteristics

Two studies were conducted in Sweden^{17,23}, two in Brazil^{18,28}, two in Norway^{19,20}, and one in Denmark²², Germany²¹, Spain²⁷, Italy²⁶ and Japan²⁹. Participants were recruited at university practices^{20-22,26-28}, a combination of both private and university practices¹⁸ and a community-type dental health care setting in Sweden^{17,19}. One team of investigators recruited participants in schools²³ and one study did not report in what setting participants were recruited²⁹.

Seven studies were published in English, two were published in German^{20,21} and one in Portuguese²⁸. One study was published in English as an abstract only²⁹. Information was abstracted – in addition to the 11 primary studies - from a prior report of a study³⁰ and a thesis³¹.

2.3 Participants and malocclusion severity

Eight studies reported including both sexes and four studies did not report the gender of participants^{20,23,27,29}. The participant's age ranged from 12 to 47 years old and two studies did not report the age of the participants^{20,27}.

Eight studies included participants with varying forms of malocclusion such as anterior crowding, and Class II. One study restricted the inclusion of participants to those presenting anterior crowding on both arches²⁶ and another study included only participants with severe malocclusions²³. Three studies did not report the malocclusion status of the orthodontic treated group^{21,27,29}.

The malocclusion status of the untreated group was similar to the orthodontic treated group in two studies^{20,26}. One study reported that the untreated group was waiting orthodontic treatment, but it did

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not report if the malocclusion status were similar to the orthodontic treated group²². Five studies had untreated comparison groups with no or minor malocclusion^{18,17,23,28,29}. Three studies did not report the malocclusion status of the untreated comparison groups^{19,21,27}.

2.4 Interventions

The orthodontic treatments included fixed appliances (with magnets and coils¹⁷, edgewise^{20,23,26,28}, edgewise and bioefficient techniques¹⁸), with pre-molar extractions as part of the orthodontic treatment^{18,20,23,28}, and removable appliances²¹. One study did not report the type of orthodontic treatment²⁹. Three studies reported that both the orthodontic treated group and the comparison group received regular dental care during the study period^{17,19,23} with two of those^{17,23} including oral hygiene instructions before or during the study.

2.5 Outcomes

Periodontal Outcomes: Five surrogate markers of periodontal status were identified in the selected reports:

- 1) Alveolar Bone Loss or Cemento Enamel Junction- Alveolar Crest Height: Three studies evaluated alveolar bone loss¹⁷⁻¹⁹. Two studies used bitewing radiographs^{17,18} and one study included both bitewing and periapical radiographs¹⁹.
- 2) Pocket Depth: Pocket depth was evaluated in four studies^{20,21,26,28}. One of these studies indicated that it was measured, but it did not report the results for this outcome²¹.
- 3) Attachment loss: Three studies evaluated attachment loss^{20,21,28}.
- 4) Gingival Recession: Three studies evaluated gingival recession^{22,28,29}. Gingival recession was measured by clinical examination²⁸, from intra-oral slides²², and from plaster models and photographs²⁹.

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5) Gingivitis: Five studies evaluated gingivitis^{20,23,26-28}. Gingivitis was measured using the WHO Gingival Index²⁷, the Loe and Silness Gingival Index^{20,23,28}, and bleeding on probing²⁶.

2.5 Adverse Effects: No adverse effects were reported in the included studies.

2.6. Missing outcomes Tooth loss and tooth mobility were not evaluated.

2.7. Funding sources Two government agencies and one dental association were the funding sources reported in three studies^{17,18,23}. One study did not receive funding²⁸ and seven studies did not report the source of funding^{19-22,26,27,29}.

3. Methodological quality

3.1 RCT

Selection: The term ‘random allocation’ was used but it was not reported how the randomization was done and if the allocation of maxillary and mandibular arches was concealed to whom?. The inclusion criteria for the participants was that they had to have a similar amount of malalignment and crowding of the anterior sextants in both arches and no clinical attachment loss. Assessment of baseline periodontal conditions confirmed the similarities. The intervention was performed by the investigators²⁶.

Outcome and follow-up: Blinding at outcome assessment was not reported²⁶, as well as losses to follow-up and reasons for them. Blinding of care providers and patients was not possible.

Statistical analyses and data reporting: The RCT did not report measures of variability for the primary outcome and correlation between arches was not taken into account during data analyses²⁶. Losses to follow-up were not reported²⁶.

3.2 Cohort Studies

Selection: One cohort study reported the selection of the treated group from a dental practice and the selection of the untreated group from the patients with no or minor malocclusion from the same practice¹⁷. The other cohort study did not report how participants were selected, suggesting a convenience sample, and compared the treated group with malocclusion to an untreated group without malocclusion²³.

The intervention was performed by the investigators on both orthodontic and comparison groups in one cohort study (both groups received oral hygiene instructions and annual dental check-up)¹⁷ and on the orthodontic group in another study²³. This latter study did not report how information on lack of orthodontic treatment in the untreated group was obtained²³.

Assessment of baseline periodontal conditions suggested that the groups were comparable at baseline in one study¹⁷, but not in the other²³.

Comparability of the groups: None of the cohort studies controlled for oral hygiene habits. One cohort study reported matching of the treated and untreated groups by age, sex, residential area, DMFT and DMFS, but they did not report a conditional analysis¹⁷.

Outcome and follow-up: One cohort study reported blinding of outcome assessors¹⁷. The other cohort study did not report blinding at outcome assessment²³.

The outcomes were assessed after the orthodontic treatment end in the cohort studies, but only one reported the time after the treatment end (2.2 years)¹⁷.

One study did not have loss to follow-up¹⁷. The other cohort study did not report losses to follow-up or reasons for drop-out²³.

Statistical analyses and data reporting: One cohort study reported the number of observations, point estimates and measure of variability for each comparison group ¹⁷.

3.3 Cross-sectional Studies

Selection: One cross-sectional study reported the inclusion of 19-year-old participants presenting for regular check-up at a public rural clinic and the untreated participants were drawn from the same group of dental patients as the orthodontic treated group ¹⁹.

Two studies selected the untreated group from nursing staff ²¹ and dental students ²⁸. Two studies reported the selection process for only one of the groups being compared ^{18,22,27} and the remaining studies did not report the selection suggesting that groups of patients were conveniently sampled ^{20,27,29}.

Orthodontic treatment was performed by the investigators, university students or staff in three cross-sectional studies ^{18,22,28}. Information on lack of orthodontic treatment in the untreated group was obtained through questionnaire in one study ²⁸. This information was not reported in the other two studies ^{18,22}. Ascertainment of orthodontic treatment for treated and untreated groups was not reported in five studies ^{19-21,27,29}.

Comparability of the groups: None of the studies controlled for potentially confounding variables such as oral hygiene habits. Two studies reported matching of the treated and untreated groups by age or age and gender, but they did not report an analysis for matched data ^{22,29}.

Outcome and follow-up: Two cross-sectional studies reported that outcome assessment was blinded to orthodontic treatment status ^{18,22}. One study reported that blinding was not done ²⁸ and the remaining studies did not report on blinding ^{19-21,27,29}.

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Six studies assessed the outcome(s) at least 1 year²⁷, 2.7 years¹⁸, 5.7 years¹⁹, 6.5 years²⁸, 11.4 years²¹ and 15-20 years²⁹ after the end of orthodontic treatment and two did not report the timing of outcome assessment^{20,22}.

Response rates and reasons for non-response by groups were not reported by the cross-sectional studies, except two. These two studies did not have non-response^{18,28}.

Statistical analyses and data reporting: The cross-sectional studies adequately reported the data, except two^{21,29}.

3.4 Overall quality

All 11 studies were classified as having a high risk of bias. Out of a total of 7 reviewed quality items for RCTs, the one available RCT satisfied two quality items. Out of total of 10 quality items for cohort studies, the 2 included cohort studies satisfied 7 and 1 quality item. And finally, out of a total of 9 quality items for cross-sectional studies, the 7 cross-sectional studies satisfied 0 to 4 quality items.

4. Results for comparison: Orthodontic Treatment versus No treatment

This comparison involves 1058 participants from 11 studies; 597 participants in the intervention groups and 461 in the untreated comparison groups.

4.1 Periodontal Outcomes

RCT

Pocket Depth: The orthodontic treated group had on average a 0.3 mm deeper pocket depths than the untreated groups. Standard deviations were not reported.

Gingivitis: The orthodontic treated teeth had a similar number of bleeding sites as the non-orthodontically treated sites (20 out of 96 sites versus 18 out of 96 sites)

Cohort and Cross-Sectional Studies

Alveolar Bone Loss: The mean alveolar bone loss was 0.13 mm (95%CI: 0.07;0.20) greater among the orthodontic treated groups than among the untreated groups (Figure 2).

Pocket Depth: The orthodontic treated group had on average a 0.23 mm (95%CI: 0.15;0.30) deeper pocket depths than the untreated groups (Figure 3).

Attachment Loss: No summary estimate was calculated due to high level of heterogeneity ($I^2=94.5\%$). Orthodontic treatment was associated with 0.11 mm (95%CI: 0.07;0.15) higher attachment loss in one study²⁸ and with 0.05 mm (95%CI:-0.11;0.01) lower attachment loss in another study²⁰, compared to no orthodontic treatment (Figure 4).

Gingival Recession: A 0.03 mm (95%CI: 0.01; 0.05) higher gingival recession was observed among the orthodontic treated group than among the untreated group (Figure 5).

Gingivitis: No summary estimate was calculated due to high levels of heterogeneity ($I^2=77.8\%$ and 98%). The gingival index was 0.15 units (95%CI: 0.07; 0.23) higher in the orthodontic treated group in one study²⁸, and lower in the other study²⁷ (Figure 6).

5. Publication bias and sensitivity analysis

There were too few studies by outcome to assess publication bias and to perform a sensitivity analysis.

DISCUSSION

Controlled weak evidence suggests that orthodontic therapy is associated with small amounts of alveolar bone loss, gingival recession, and increased pocket depth. The available data do not allow determining whether these adverse changes are associated with site-specific factors such as banding or extractions, host-specific factors such as altered oral hygiene habits during orthodontic therapy, an inherent adverse consequence of the orthodontic forces to move teeth, or due to study biases such as socio-economic differences between those individuals receiving and not receiving orthodontic therapy. Neither are data available to determine whether the small adverse changes – if real - are predictive of long-term adverse or beneficial events. In conclusion, the main conclusion of this exhaustive systematic review is that there is an absence of controlled evidence to either recommend or advise against the use of orthodontic therapy to improve the periodontal status.

The available weak evidence suggest that orthodontic therapy is associated with increased pocket depth, increased bone loss, and increased gingival recession. An important limitation of the evidence was the common uncertainty whether individuals with and without orthodontic therapy were comparable with respect to factors such as socioeconomic status, smoking, or oral hygiene practices. Not only were these factors not evaluated either at baseline or at follow-up, but in none of the studies were any adjustments performed to see what the impact of potential imbalances in subject characteristics on the study findings may be. In addition, the common lack of blinding of outcome assessors, the lack of reporting on how many participants were lost to follow-up or reasons for loss to follow-up.

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Reliable evidence on whether indeed orthodontic therapy is associated with small adverse periodontal outcomes would require the conduct of randomized controlled trials. One could consider designing a trial using the guidelines that have been established for approving treatments aimed at slowing periodontitis³²⁻³⁷. A randomized trial with 9 months follow-up using pocket depth as a primary outcome variable could be designed with random assignment to either immediate or delayed orthodontic treatment with an evaluation 9 months after orthodontic treatment completion. Just like for periodontal drugs, such a trial would not provide information whether the observed short-term changes in periodontal surrogates translate into any long-term benefits or harms.

One could argue that the real scientific questions on the periodontal effects of orthodontic therapy do not relate to the short-term intangible periodontal changes, but to the long-term impact of orthodontic therapy on the periodontal health of the patient as can be measured by either oral-health related quality of life and tooth loss. Randomized controlled trials to address such questions are unlikely to occur due to ethical concerns and practical difficulties. In addition, some may consider that there is the lack of a convincing scientific rationale for making either short- or long-term studies a pressing research issue. Further epidemiological studies on the role of occlusion in the progression of periodontitis in patients with established chronic periodontitis may further elucidate whether orthodontic therapy may play a role for particular groups of patients. The short- and long-term safety of orthodontic treatments could be investigated using mechanisms similar to the evaluation of long-term drug safety.

Professional organizations commonly make the claim that straight teeth are less prone to gum disease {American Association of Orthodontics, 2007 #243}. The ability to make such periodontal claims for

orthodontic therapy - in the absence of either supporting randomized or non-randomized evidence- illustrates the continuing double-standard for drugs and devices. For drugs, when claims are made for health or therapeutic benefits other than those for which the drug was approved, such claims are referred to as off-label claims, sometimes considered illegal, and sometimes prosecuted {Hampton, 2007 #244}. Whether off-label periodontal health claims for devices such as orthodontic appliances can remain a common clinical practice is unclear. Regardless of the legal implications, the current review identified an absence of evidence on which to base recommendations of orthodontic therapy for improving the periodontal status. Any such claims should be considered as the drug equivalent off-label claim and treated as such.

Strengths of this study include the comprehensive literature search including grey literature, the inclusion of non-English studies, and the assessment of the scientific quality of the included studies. The large effort on identifying evidence leads us to believe with a high degree of confidence that there is absence of reliable evidence on the effects of orthodontic therapy on the periodontal status. In summary, there is an absence of reliable evidence that orthodontic therapy improves or harms the periodontal status. Whether this issue is of sufficient scientific importance is unclear given that the primary goals of orthodontic therapy are function and esthetics. Care should be taken however not to promote orthodontic therapy for improvement of health outcomes for which no reliable evidence exists.

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Figure 1. Flow-diagram of the selection of studies for the review of the effects of orthodontic treatment on periodontal conditions

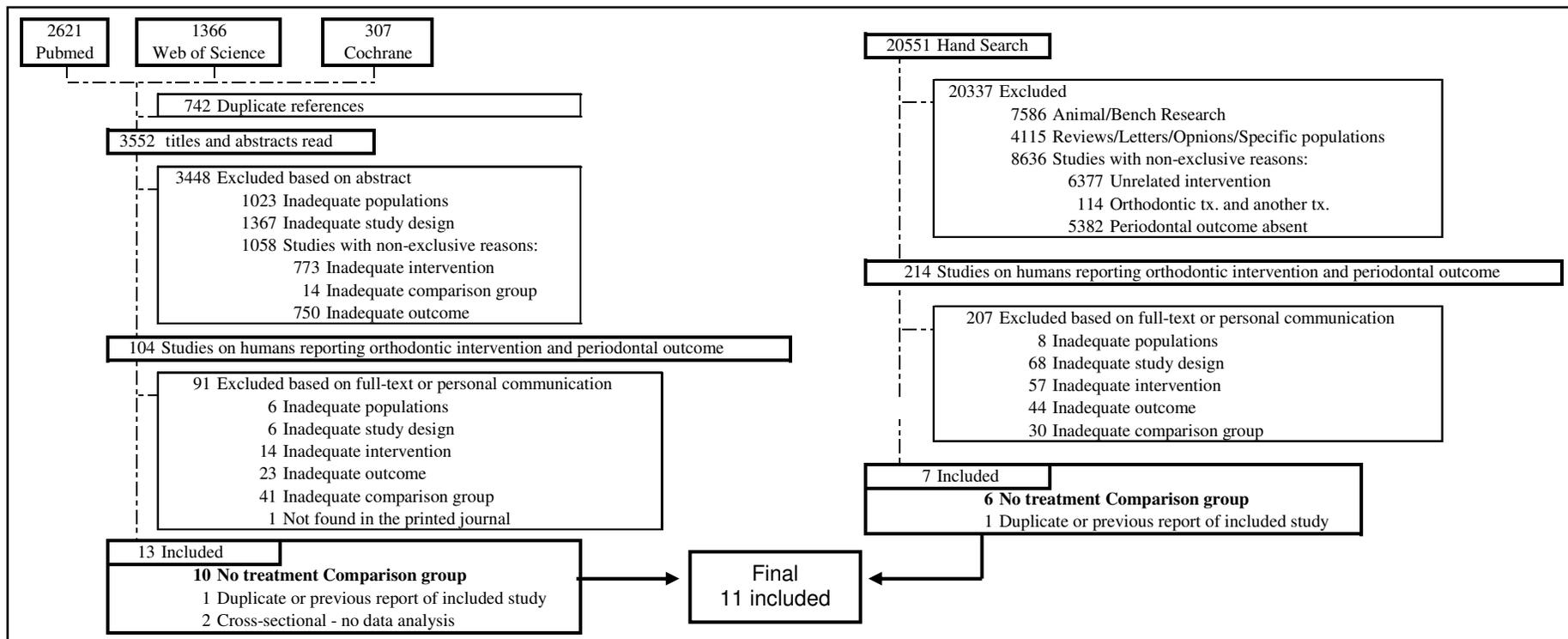


Figure 2. Results of cohort and cross-sectional studies reporting on the effect of orthodontic treatment on alveolar bone loss

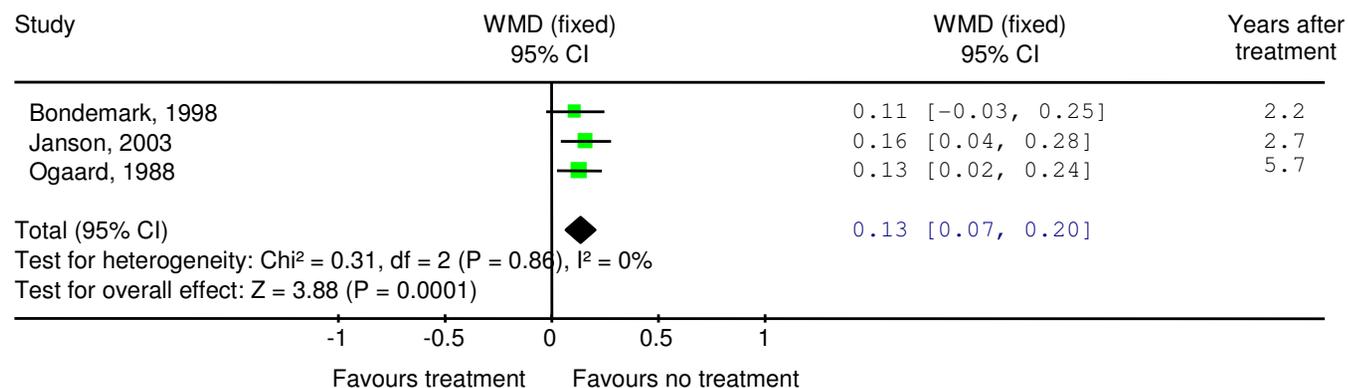


Figure 3. Results of cross-sectional studies reporting on the effect of orthodontic treatment on periodontal pocket depth

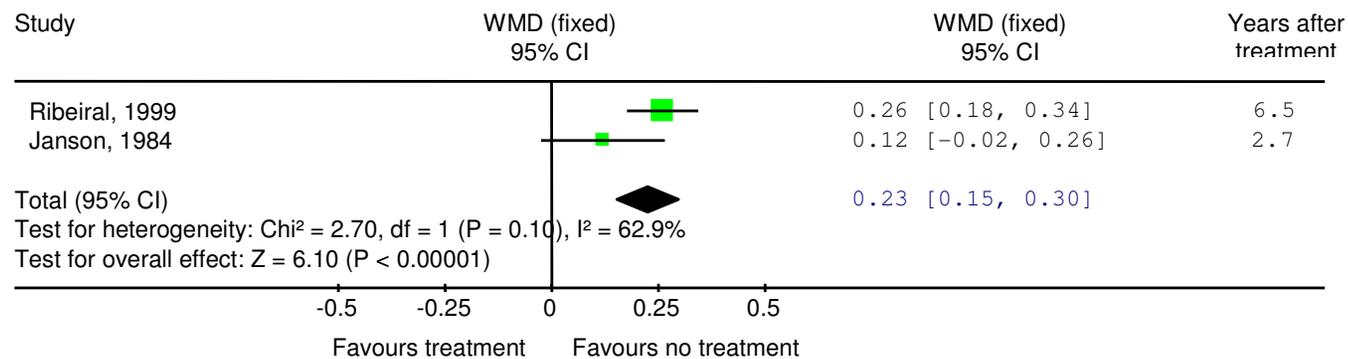


Figure 4. Results of cross-sectional studies reporting on the effect of orthodontic treatment on attachment loss

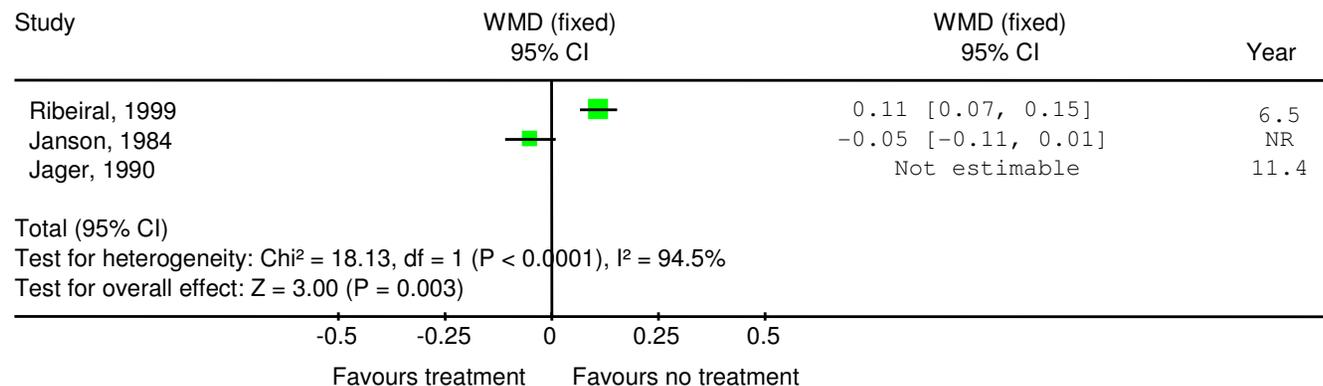


Figure 5. Results of cross-sectional studies reporting on the effect of orthodontic treatment on gingival recession

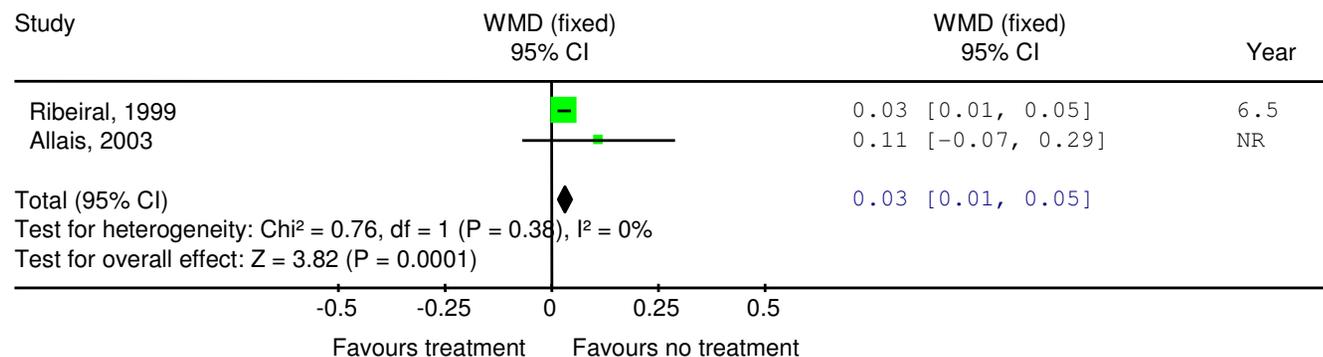
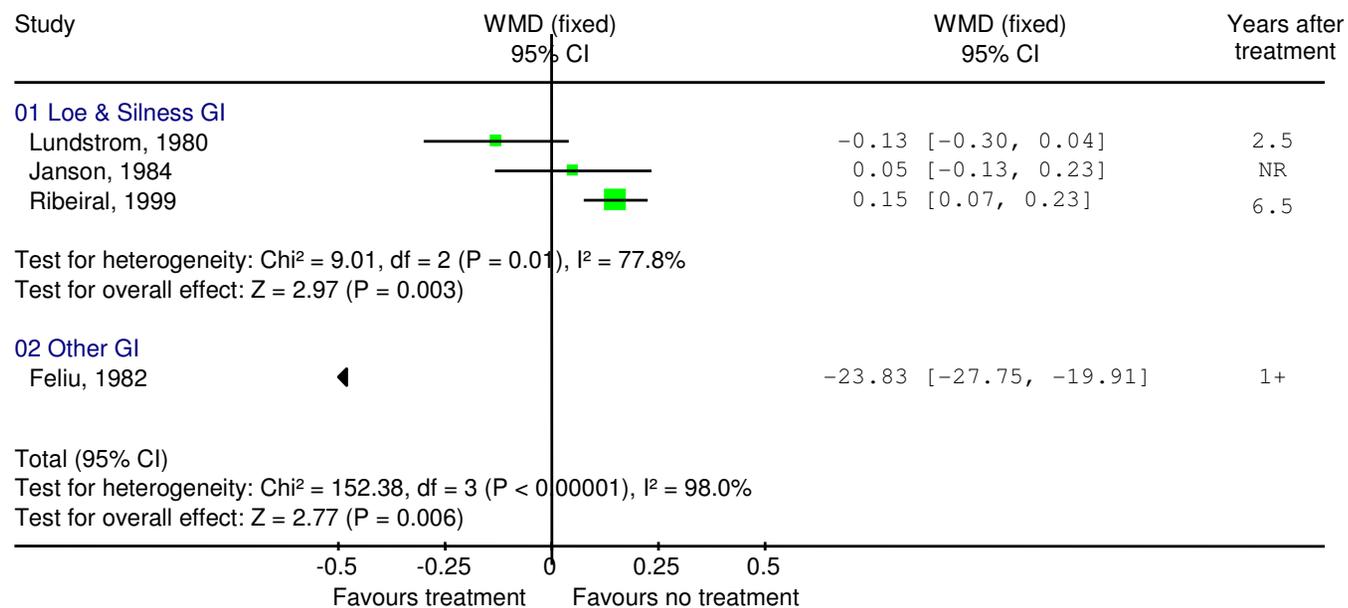


Figure 6. Results of cohort and cross-sectional studies reporting on the effect of orthodontic treatment on gingivitis



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7.3 RFP Update

Attachment #1

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Annex 1

PUBMED Search Strategy (October 10, 2006)

(((((Orthodontics[Mesh] OR Orthodonti*[Text Word] OR functional Orthodontic appliance*[Text Word] OR removable Orthodontic appliance*[Text Word] OR Orthodontic bracket*[Text Word] OR Orthodontic retainer*[Text Word] OR Orthodontic wire*[Text Word] OR Orthodontic Extrusion*[Text Word] OR Orthodontic Space Closure[Text Word] OR Palatal Expansion*[Text Word] OR Tooth Movement*[Text Word] OR Serial Extraction*[Text Word] OR Maxillary Expansion[Text Word] OR Orthodontic appliance*[Text Word] OR corrective Orthodontic*[Text Word] OR Interceptive Orthodontic*[Text Word] OR Orthognathic surger*[Text Word] OR Forced Eruption*[Text Word] OR Tooth Intrusion*[Text Word] OR Tooth Extrusion*[Text Word]))) AND ((Periodontal diseases[mesh] OR Periodont* OR Alveolar bone loss[Text Word] OR Alveolar bone height[Text Word] OR Alveolar bone level*[Text Word] OR Furcation Defect*[Text Word] OR Gingival disease*[Text Word] OR Gingival Overgrowth*[Text Word] OR Gingival Recession*[Text Word] OR Gingivitis[Text Word] OR Periodontal attachment loss[Text Word] OR Periodontitis*[Text Word] OR Periodontal Pocket*[Text Word] OR Tooth mobil* [Text Word] OR Tooth Loss*[Text Word] OR Periodontal disease*[Text Word] OR chronic periodontal disease*[Text Word] OR gingival bleeding*[Text Word] OR clinical attachment level*[Text Word] OR clinical attachment loss*[Text Word] OR gingivitis index*[Text Word] OR supurat*[Text Word] OR periodontal abscess*[Text Word] OR fibromatosis*[Text Word] OR fibrosis*[Text Word] OR gingival hyperemia[Text Word] OR gingival hyperplasia*[Text Word] OR ulcerat*[Text Word] OR microulceration[Text Word]))) AND (((("1980"[PDAT] : "2006"[PDAT]) NOT (animals[mh] NOT human[mh])))