Effects of Malocclusions and Orthodontics on Periodontal Health: Evidence from a Systematic Review

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Abstract: Many patients seek orthodontic treatment for esthetic improvement. These patients mostly present with mal-alignment of the anterior teeth. The positive effects of orthodontic treatment on their appearance and self-esteem are easy to envision. However, does orthodontic treatment provide dental health benefits in addition to the esthetic benefits? Do malocclusions harm the periodontium? Is correcting malocclusions with orthodontic treatment beneficial for periodontal health? The purpose of this study is to present evidence available on this topic. Two systematic reviews were conducted to address these questions: does a malocclusion affect periodontal health, and does orthodontic treatment affect periodontal health? Inclusion and exclusion criteria were established for both reviews, and an electronic search and a hand search were conducted. Several papers were included in both reviews, but the overall quality of the studies was weak. The first review found a correlation between the presence of a malocclusion and periodontal disease. Subjects with greater malocclusion have more severe periodontal disease. This may be dependent on oral health status. One should keep in mind that an association does not necessarily mean causation. The second review identified an absence of reliable evidence on the effects of orthodontic treatment on periodontal health. The existing low-quality evidence suggests that orthodontic therapy results in small detrimental effects to the periodontium. The results of both reviews do not warrant recommendation for orthodontic treatment to prevent future periodontal problems, except for specific unusual malocclusions.

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Sources of Scientific Evidence in Dentistry

Scientific evidence in dentistry and medicine can be classified into different levels of reliability: 1) biological plausibility, animal studies, case series, and reports; 2) clinical studies that identify occlusal risk factors that are modifiable by orthodontics; and 3) clinical studies on the impact of orthodontic treatment on periodontal health.

The first level involves biological plausibility. One could logically analyze the benefits of orthodontic treatment on periodontal health as follows: plaque causes periodontal disease; it is easier to remove plaque from teeth that are aligned; thus, orthodontic alignment should reduce periodontal disease. The literature supporting the benefits of orthodontic treatment based on biological plausibility is quite extensive. Numerous studies have compared the plaque accumulation between malocclusions (mainly mal-aligned lower incisors) and non-malocclusions. Most find greater plaque accumulations with greater crowding. It seems to make common sense that, from this, we should be able to deduce that orthodontic treatment must improve periodontal health. However, this common sense deductive reasoning provides us with the lowest level of evidence. There are several examples in medicine in which such reasoning has led to treatments that are unnecessary or harmful. Examples are hormone replacement therapy and medications to reduce cardiac arrhythmias.

The second source of evidence comes from clinical studies that identify occlusal risk factors for periodontal diseases that are modifiable by orthodontics. If certain malocclusions cause periodontal problems, then eliminating these malocclusions through orthodontic treatment should reduce periodontal disease. This article will provide the results from a systematic review of the literature on the interaction between malocclusion and periodontal disease. However, as with the previous types of studies, these results do not provide direct evidence on the effects of orthodontic treatment on periodontal health. One needs to take a leap of faith to deduct that if a malocclusion is associated with periodontal problems, correcting this malocclusion through orthodontic treatment will therefore result in a healthier periodontium.

Clinical studies on the impact of orthodontic treatment on periodontal health provide the third and most reliable source of information to answer questions our patients ask. The best way to design such a study is to take a group of patients and randomly assign each patient to either a control group or an orthodontic treatment group. After treatment, differences in periodontal conditions between the two groups would provide us information on the effects of orthodontic treatment on periodontal health. A survey of the literature indicates that there are no such long-term randomized clinical trials available (there is one twelve-week randomized clinical trial). The reasons for the absence of such studies are the length of time needed and ethical and other obstacles. In the absence of randomized clinical studies, we may have to rely on studies utilizing less reliable study designs such as cross-sectional studies and cohort studies.

Even with the best study design, the results obtained in one particular study may not be applicable to all populations and circumstances. Therefore, instead of relying on one particular study, combining all similar studies on a specific subject and comparing their results will provide a more powerful conclusion. This can be accomplished through a systematic review.

A systematic review uses a systematic, explicit, reproducible method to identify, select, and appraise relevant research about a clearly formulated question. To be a systematic review, the search has to be systematic, explicit, and reproducible, and the criteria used to identify/select and appraise the literature have to be clearly stated before the search is started.

Perusing the literature without a specific plan may exclude some studies. Only a systematic search will allow inclusion of all relevant material. The investigators conducting the systematic review have to be explicit about the inclusion and exclusion criteria of the studies to be included in the review. This will allow other investigators to repeat the identification and subsequent selection of relevant material. To combine the results of the various studies, a final appraisal is also included in the review. The clearly formulated question for systematic reviews has to provide information on four specific items: 1) the population that will be included, 2) the intervention, 3) the control, and 4) the outcome. The acronym “PICO” is used to represent these four items.

The evidence provided by systematic reviews can only be as good as the studies included in the review. Unfortunately, in dentistry there is a lack of randomized clinical trials and well-controlled cohort or case-control studies available. This deficiency has prompted some investigators to question the use of systematic reviews in dentistry in general and in
orthodontics in particular. However, until higher quality studies become available, the need to provide answers to these questions can be addressed through the use of systematic reviews.

**Systematic Review of Effects of a Malocclusion on Periodontal Health**

The first systematic review addresses this question: does a malocclusion affect periodontal health? The inclusion/exclusion criteria for the systematic review in PICO format were as follows:

- **The population** was limited to humans. Studies on individuals with disabilities or specific syndromes were excluded since the results of these studies may not be applicable to the general population.
- **The intervention (exposure)** was malocclusion. Studies that evaluated occlusal interferences other than what orthodontists typically call malocclusions were excluded. Thus, studies on the effects of occlusal trauma, interfering contacts, balancing contacts, or parafunctions were excluded. Typically, these conditions are not the malocclusions that are treated with orthodontic treatment. There are numerous studies on the effects of occlusal trauma on the periodontium (mainly in periodontal patients). These studies, viewed in the context of providing evidence for the benefits of orthodontic treatment on malocclusions, provide the lowest level of evidence. They provide biological plausibility (or common sense evidence) that orthodontic treatment would benefit periodontal health.
- **Studies were only included if there was a control group, either a comparison group of individuals without a malocclusion or various grades/levels of the malocclusion.**
- **The outcome** was periodontal conditions: gingivitis, alveolar bone levels, recession, or tooth loss.

The search consisted of an electronic search and a hand search. Search criteria for the electronic search included malocclusion and periodontal search terms. The electronic search included all publications from 1960 through 2006 on Medline, Web of Science, Cochrane Library, and the grey literature. Publications in all languages were included. Items retrieved through the search (titles or abstracts if available) were coded for exclusion or potential inclusion. Articles that were coded as possibly meeting the inclusion criteria were retrieved. The full text was read, and the study included or excluded based on the criteria. The hand search was limited to six journals during the years 1980 through 2006. Full text articles were coded for inclusion or exclusion in the review. References in the articles were screened for the presence of additional publications. Full articles were retrieved and coded. Data were extracted from the included studies.

The electronic search identified 2,646 unique publications. Titles and abstracts (when available) were screened for inclusion in the search. A total of ninety-seven publications were retrieved for review. These full-text publications were read; of these, eighty-two were selected for inclusion in the review. Articles were excluded because of lack of data (seven), lack of controls (three), and the absence of a malocclusion exposure (five). The eighty-two articles selected for inclusion in the systematic review were divided into five groups depending on the type of malocclusion that was evaluated (some studies reported on more than one aspect of malocclusion). There were thirty-six articles that evaluated the interactions between crowding (mal-alignment, rotations, spacing) and periodontal health. Sixteen studies evaluated the correlation between overjet/overbite and periodontal health. Twelve studies were identified that evaluated the interaction between crossbite and periodontal health. Six studies evaluated the correlation between an anterior open bite and periodontal health. A total of twenty-five studies evaluated the association between a malocclusion (identified as a malocclusion index) and periodontal health. For the purpose of this review, only these twenty-five studies were included. Because malocclusion indices usually combine several aspects of a malocclusion (such as crowding and overjet/overbite), studies on the effect of this exposure on periodontal health were chosen rather than studies limited to separate entities of a malocclusion (such as crowding only).

One cohort study, two case-control studies, and twenty-two cross-sectional studies were identified. A variety of malocclusion classifications were used, ranging from the classic Angle classification (Class I, II, III) and commonly used malocclusion indices (OFI, DAI), to custom-designed indices based on overjet/crowding and other aspects of the malocclusion. Outcome measures ranged from periodontitis (not defined) to various periodontal disease indices to tooth loss. Five of the twenty-five studies adjusted for possible confounding factors (age, socioeconomic status, and/or oral hygiene). The
total number of subjects included in these twenty-five studies was 35,300, with a mean age of twenty-two (range: three to sixty).

Nineteen of the twenty-five articles reported greater periodontal disease in subjects with greater malocclusion, five failed to find a correlation, and one was undecided. In some of the studies, it was possible to combine the published data since they used similar exposure (malocclusion indices) and outcome measures (periodontal condition) and presented their results in similar fashion. The results from six studies on the interaction between “malocclusion” and “periodontopathies” found significantly greater periodontal problems in subjects with malocclusions compared to subjects without malocclusions (p<0.00001). None of these studies adjusted for confounding variables. Two studies on the interaction between malocclusion and gingivitis found greater levels of gingivitis in subjects with a malocclusion compared to subjects without a malocclusion (p<0.0001). One of these studies adjusted for oral hygiene.

The first systematic review leads to the conclusion that there is a correlation between the presence of a malocclusion and periodontal disease. Subjects with greater malocclusion have more severe periodontal disease. This correlation may be dependent on oral health status. It is important to keep in mind that the finding of a positive correlation between the presence of a malocclusion and periodontal disease does not necessarily mean causation.

**Systematic Review of Effects of Orthodontic Treatment on Periodontal Health**

The same search criteria were used as for the first review except that this review was limited to articles published after 1980. The purpose of the review was to evaluate the effects of contemporary orthodontic treatment on periodontal health, and treatment mechanics (use of new metal alloys), appliance design (fully banded versus bonded appliances), and treatment philosophy have changed dramatically since the 1970s. Therefore, the search was limited to publications after 1980. The population was limited to humans. Studies on individuals with craniofacial syndromes or periodontal diseases were excluded. The intervention was orthodontic treatment. Studies involving fully banded treatment were excluded. Only studies with untreated controls were included. The outcome was periodontal health (pocket depth, gingivitis, alveolar bone loss, gingival recession, pocket depth). The outcome had to be measured after the removal of the orthodontic appliances to eliminate the transient periodontal effects during the treatment. More information on this systematic review can be found in a forthcoming publication.

The electronic search identified 3,552 unique citations. Of these, 104 full articles were retrieved for review. During the hand search, 20,551 full reports were coded. Of these, 214 were considered for inclusion in the review. After reading the full articles, I included twelve in the final review. From the 104 articles, ninety were excluded for the following reasons: absence of an untreated control group (forty-one), periodontal outcome absent (twenty-three), inclusion criteria for the intervention not met (fourteen), inclusion criteria for the study design not met (six), and inclusion criteria for the population not met (six). Of the remaining fourteen articles, two were excluded due to lack of data analyses.

The final twelve studies were conducted in Brazil, Norway, Sweden, Denmark, Spain, Italy, England, and New Zealand. They were published in English (ten), German (one), and Portuguese (one). One study was a randomized clinical trial that lasted sixteen weeks (twelve weeks in treatment, with measurement of periodontal outcomes four weeks after treatment). The remainder of the studies were cohort and cross-sectional studies. The number of treated and control subjects in each study was relatively small for some studies (twenty to fifty per group) but larger for others (150 to 300 subjects per group). In some studies, the subjects in the control group did not have a malocclusion; other studies did not indicate their malocclusion status. The total number of participants was 1,415, with 681 participants in the intervention groups and 734 in the untreated comparison groups. The orthodontic intervention was fixed orthodontic treatment for ten of the studies (one study was on removable appliances, and one did not specify what type of orthodontic treatment was performed).

The quality of the retrieved articles was weak. Many aspects of the study design were not reported, such as the inclusion and exclusion criteria of the exposed and control groups, blinding of the investigators, and the comparability of the exposed and control groups. An important weakness for the majority of
the studies was the lack of malocclusion in the control group, as well as differences in socioeconomic class and the lack of adjustment for such factors.

Data were extracted from the studies. Patient mean and standard deviations for the continuous outcomes were obtained from the reports or estimated by pooling the results presented by surfaces or sites. The results were synthesized by study design and type of outcome. Heterogeneity was assessed by means of the I-squared statistic. For continuous variables, weighted mean differences between groups were calculated using RevMan based on a fixed-effects model. If the statistical heterogeneity levels were higher than 70 percent with fixed and random effect models summary estimates, summary estimates were not presented.

For three periodontal outcomes, the heterogeneity levels were lower than 70 percent, indicating that each of the studies found a similar effect. These outcomes were gingival recession, alveolar bone loss, and periodontal pocket depth.

Three studies contributed data on gingival recession.\textsuperscript{33,43,44} When the results of these studies were combined, compared to no treatment, orthodontic therapy was associated with 0.03 mm of gingival recession (95 percent confidence interval [CI] 0.01–0.05 mm).

Three studies contained data on alveolar bone loss (measured radiographically as the distance from the CEJ to the crest of the alveolar bone).\textsuperscript{34,38,41} Combination of the results from these three studies indicated that orthodontic therapy was associated with 0.13 mm of alveolar bone loss (95 percent CI 0.07–0.2 mm). Two studies reported on the pocket depth.\textsuperscript{39,43} The weighted means indicated that, compared to no treatment, orthodontic treatment resulted in 0.23 mm of increased pocket depth (95 percent CI 0.15–0.3 mm).

For attachment loss and gingivitis, the heterogeneity was high, indicating opposite findings between studies on the effects of orthodontic treatment on these variables (for example, some studies reported lower gingivitis in nontreated individuals, and other studies reported greater gingivitis).

The evidence obtained in this review is weak due to the lack of high-quality studies. In addition, the reported overall mean effects on periodontal health do not allow us to distinguish whether orthodontic treatment results in severe periodontal deterioration on a few teeth or has a generalized limited detrimental effect on periodontal health. The relative short-term follow-up does not allow us to conclude the long-term effects of orthodontic treatment on periodontal health. No conclusions regarding the effects of orthodontic treatment of specific malocclusions (such as cross-bites or impinging anterior deep bites) can be obtained.

In summary, the results from this systematic review identified an absence of reliable evidence on the effects of orthodontic treatment on periodontal health. The existing low-quality evidence suggests that orthodontic therapy results in small detrimental effects to the periodontium.

Discussion

The results of the first systematic review indicate that malocclusions may have a negative effect on periodontal health. The results of the second systematic review indicate that orthodontic treatment to correct these malocclusions results in worse periodontal conditions. The results of the two reviews thus seem to contradict each other. If malocclusions result in poorer periodontal health, why does correcting malocclusions with orthodontic treatment not improve periodontal health but may actually be detrimental?

There are several possible reasons for this discord. The results of either systematic review may not be reliable due to the low quality of the studies included. Also, the reviews only provided weak evidence for the reported results. However, it is possible that both findings are correct, but the disagreement results from other factors. The finding that a malocclusion is associated with periodontal disease does not prove causation. Therefore, its elimination (through orthodontic treatment) may have no effect on periodontal health. Also, if subjects with a malocclusion have worse periodontal health, this difference may have been present before the start of treatment, when compared to nontreated control subjects without malocclusions (which was the control group in several studies).

Periodontal health is influenced by numerous factors. Malocclusion and orthodontic treatment may have only a limited effect compared to behavioral influences (smoking, oral hygiene, diet) and genetic conditions. It may not be possible to detect this effect. And (let’s hope this is not the case) it is also possible that the effects of orthodontic treatment on periodontal health are so detrimental that they outweigh the positive effects of eliminating a malocclusion.
Conclusions

The systematic review on the effects of a malocclusion on periodontal health suggests that subjects with a malocclusion have worse periodontal health than subjects without a malocclusion. The systematic review on the effects of orthodontic treatment on periodontal health identified low-quality evidence suggesting that orthodontic therapy results in small detrimental effects to the periodontium.

The clinical implication of these reviews is that, at this time and with the information available, we have no reliable evidence to recommend orthodontic treatment to prevent periodontal disease. However, this information is based on studies of treatment of the more common malocclusions. It does not provide information on the effects of some unusual conditions, such as impinging anterior deep bites or anterior crossbites leading to recession and mobility of the opposing tooth. In these extreme situations, one should use clinical judgment when recommending orthodontic treatment to eliminate the malocclusion. However, for the majority of our patients, we have no evidence to recommend orthodontic treatment to prevent periodontal problems.

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