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SCIENTIFIC SECTION

Does oral health promotion influence the oral hygiene and gingival health of patients undergoing fixed appliance orthodontic treatment? A systematic literature review

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Objective: To determine the effectiveness of orthodontic oral health promotion (OHP) upon gingival health.

Data sources: The Cochrane Central Register of Controlled Trials [CENTRAL (January 2005)], MEDLINE [OVID and PubMed platforms (1966 to May 2005)] and EMBASE (1966 to May 2005) were searched. A grey literature search was also conducted.

Data selection: Of the 218 studies identified, 37 were retrieved for detailed examination. Methodological quality was determined using a checklist and inter-rater reliability was calculated using the unweighted kappa statistic. Six randomised (RCT) and quasi-randomised controlled clinical trails (CCT) met the inclusion criteria.

Data extraction: Categorical data about the effect of oral health promotion on dental plaque levels and/or gingival bleeding were independently collected from the four RCTs and two CCTs by two reviewers using a data extraction pro-forma.

Data synthesis: Positive effects on plaque and/or gingival health were produced in only four of the included trials. OHP resulted in no difference being detected in two of the included trials. None of the trials that were included produced a negative effect of orthodontic oral health promotion on oral hygiene and gingival health. Direct comparison between the trials was difficult due to the heterogeneity in the outcome measures between the included studies.

Conclusions:

- An OHP programme for patients undergoing fixed appliance orthodontic treatment produces a short-term reduction (up to 5 months) in plaque and improvement in gingival health
- No particular OHP method produces a greater short term benefit to periodontal health during fixed appliance orthodontic treatment
- Further studies using appropriate methods and in particular longer follow up periods are required

Key words: Orthodontics, oral health promotion, gingivitis, periodontal health

Introduction

Orthodontic appliances impede tooth cleaning and can encourage the onset of chronic hyperplastic gingivitis (CHG). The exact aetiology of chronic hyperplastic gingivitis is unknown, although plaque is accepted to be the principle causative factor.[1] It is also recognised that certain individuals are rendered susceptible by genetic and/or environmental factors. These include polymorphisms in the gene for interleukin 1, cigarette smoking, leukopenia, and diabetes among others. In these situations, CHG leads to periodontitis and loss of attachment over time.

Of importance in orthodontics is whether appliances accelerate the transition from gingivitis to periodontitis.[2] This is because plaque can accumulate between the brackets and/or bands and the gingival margins.[3] Moreover, plaque retention during fixed appliance orthodontic treatment has been determined to be an important aetiological factor in the development of

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demineralisation in addition to chronic hyperplastic gingivitis.[1] Indeed it is often postulated that the metals in orthodontic brackets and bands are locally cytotoxic and induce localised inflammatory changes in the gingival tissues. This is clinically obvious where orthodontic bands are positioned sub-gingivally. The resultant gingival hypertrophy subsequently acts as a further obstacle to plaque removal favouring the dominance of periodontopathic microorganisms (Porphyromonas gingivalis, Bacteroides forsythus, and Actinobacillus actinomycetemcomitans).[4] Any subsequent calculus formation around the orthodontic fixed appliance components further impedes plaque removal and in some cases can lead to subgingival plaque deposits.

Importantly, in patients being treated with fixed appliances, CHG causes a small but significant loss of periodontal support.[5–7] Although this is a risk for all patients treated with fixed appliances, it is most significant for those with pre-existing periodontal attachment loss and those predisposed to periodontal attachment loss in the absence of fixed appliances. This latter group includes those susceptible to periodontal disease in general, but also those undergoing hormonal changes due to puberty, pregnancy, menopause and oral contraceptives, smokers and special needs patients where manual dexterity prevents adequate tooth cleaning.

In medicine and dentistry, the main methods used for health promotion include verbal, printed materials and videodata (via magnetic tape, CD/DVD and internet-based applications). Of these, written instructions have been shown to be the least effective at promoting change.[8–12]

General oral health promotion (OHP) has focused primarily on the prevention of periodontal disease, but several recent studies[4,13–16] have expressed concerns as to its value. Orthodontic OHP has predominately been aimed at preventing demineralisation during fixed appliance orthodontic treatment.[17] Interestingly, there are no studies investigating the effect of patient advice regarding dietary control of refined carbohydrate in order to prevent white-spot lesions (and caries) formation in patients with fixed orthodontic appliances.[18] Furthermore, there is limited evidence supporting the use of fluoride releasing compounds, the use of chlorhexidine during fixed appliance orthodontic treatment, polymeric tooth coating around orthodontic brackets and fluoride releasing bonding materials in the prevention of white spot lesions during orthodontic treatment.[17] Notwithstanding, the influence of OHP in patients being treated with fixed orthodontic appliances upon gingival health is generally not well understood.

This review is therefore intended to assess the influence of OHP upon gingival health in patients being concomitantly treated with fixed orthodontic appliances and to determine whether such programmes confer long-term post orthodontic therapy benefits.

Objective

To systematically review the effectiveness of oral health promotion interventions in improving oral hygiene and gingival health for patients undergoing orthodontic fixed appliance treatment.

Null hypothesis

There is no difference in the plaque levels and/or gingival bleeding between individuals undergoing orthodontic treatment who have received oral health promotion and those who have not.

Methods

The systematic review method was used to eliminate bias within this study arising from literature searching, study selection, data abstraction and data synthesis.

An electronic search strategy was conducted initially using MEDLINE via the OVID platform (1966 to May 2005). The search method was as follows:

1. exp orthodontics/
2. orthodontic$.mp.
3. 1 or 2
4. exp hygiene/
5. hygiene$.mp.
6. 4 or 5
7. exp education/
8. education.mp.
9. promotion.mp.
10. programme$.af.
11. technique$.af.
12. exp behaviour/
13. behaviour$.mp.
14. 7 or 8 or 9 or 10 or 11 or 12 or 13
15. 3 and 6 and 14

Subsequently, the Cochrane Central Register of Controlled Trials (CENTRAL) (January 2005) and EMBASE (1980 to May 2005) were also searched. The search method was revised appropriately for these latter databases as they all require subtle differences in the searching technique. A hand search was also carried out involving the American Journal of Orthodontics and Dentofacial Orthopaedics (1965–2005), (British) Journal

Effectiveness of oral health promotion in orthodontics: Methodology checklist

A. Study groups
1. Children or adults?
2. Male-only, female-only or mixed?
3. Were the same fixed appliance types used in all the study groups?
4. Attempts to contact subjects who defaulted for record collection?

B. Intervention
1. What interventions were being examined?

C. Outcome measures
1. What specific indices or scoring system was used?
2. Were the same observers used for the experimental and control groups?

D. Other
1. Study design?
2. Were there any biases?
3. Was an error study reported?
3. Were the variables used valid?
4. Could there be confounding?
5. What statistical analyses were used?
6. Was there data dredging?
7. Were important findings overlooked?

E. Specific questions
1. Randomisation?
2. Concealment?
3. Blinding?
4. Withdrawals?

Figure 1 Data extraction form

of Orthodontics (1974–2005), European Journal of Orthodontics (1979–2005), and Angle Orthodontist (1965–2005). A grey literature search was carried out using combinations of the key words orthodontic, hygiene, education, promotion, programme, technique and behaviour in Google Scholar (www.scholar.google.com). Other pertinent reports identified in the reference lists of relevant articles were also included. A total of 218 possible studies were found.

Only randomised (RCT) and quasi-randomised controlled clinical trials (CCT), which specifically stated that they assessed reductions in dental plaque levels and/or gingival bleeding when comparing health promotion interventions were included. Trials that involved plaque removal by a professional (except at baseline) or the use of proprietary antiplaque agents were excluded as these would not be relevant to the current investigation. Furthermore, only trials involving patients undergoing orthodontic treatment with fixed appliances were included. There were no restrictions imposed on the age of participants or language of the publication. Authors were not contacted for missing data.

Data extraction was carried out independently by two reviewers (both orthodontists) using a pro-forma (Figure 1), which was designed specifically for this study and piloted beforehand. In the case of disagreement consensus was achieved through discussion. The methodological quality of the studies was determined using specific questions on the pro-forma (section E in Figure 1) concerning method of allocation, concealment of allocation, masking of assessment and reporting of withdrawals (simple dichotomous yes/no outcomes). Criteria were not applied to determine the risk of bias. The inter-rater reliability for the 'specific questions' was

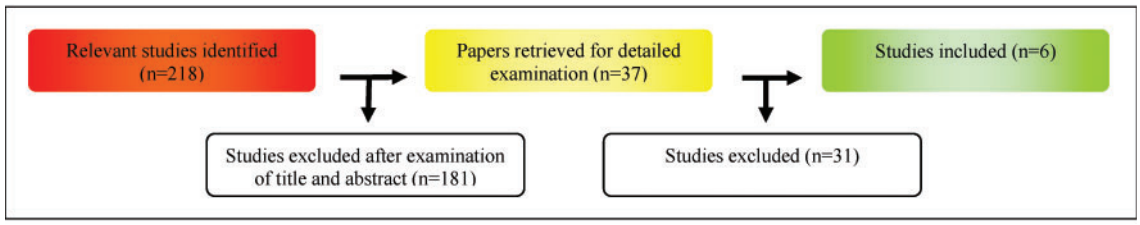

Figure 2 Flow diagram outlining the process of the review

calculated using an unweighted kappa statistic[19] and the results were interpreted with reference to Landis and Koch's work.[20]

Results

The numbers of studies identified through the search strategy, those retrieved for detailed examination, those excluded and those finally included are detailed in Figure 2. Six reports,[21–26] each from different studies, were included in the review. Four studies were RCT's[22,24–26] whilst two were CCT's.[21,23] Of the six trials that were included, five evaluated educational interventions,[21–24,26] and one (Richter *et al.*)[25] assessed if an environmental change, could improve oral hygiene (Table 1). Follow up data were collected beyond 5 months in all but one trial.[26] A range of different outcome measures was used to assess plaque and gingival bleeding. These included the plaque index,[27] gingival index,[28] orthodontic patient cooperation scale,[29] oral hygiene index[30] and modified oral hygiene index[31] (Table 1).

The design quality of the trials was variable. None of the trials described allocation concealment. Three clearly described blind outcome assessment[22,23,26] and two included withdrawal rates.[23,24] Inter-rater reliability (assessed using unweighted kappa scores) of the methodological quality of the trials was as follows: randomisation 0.78 (substantial agreement), concealment 0.86 (almost perfect agreement), blinding 0.95 (almost perfect agreement) and withdrawals 0.92 (almost perfect agreement).

Surprisingly, positive effects on plaque and/or gingival health were produced in only four of the included trials.[21–23,25] In the other two studies [24,26] OHP resulted in no difference being detected in dental plaque levels and/or gingival bleeding. None of the studies detected a negative effect of orthodontic OHP on gingival health. Direct comparison between the trials was difficult due to the heterogeneity in the outcome measures that were used.

In the short term (up to 5 months), significant reductions in plaque levels can be expected when an OHP programme is instituted for patients undergoing fixed appliance treatment ($P<0.05$).[21–23,25] However, because the studies by Rinchuse *et al.*[24] and Lees and Rock[26] failed to find an improvement in oral health during orthodontic treatment with their OHP programmes it was not possible to determine if an educational intervention was superior to an environmental change in improving oral hygiene. Advice on smoking cessation did not form part of any of the OHP programmes.

Discussion

We found that in the short term (up to 5 months), significant reductions in plaque levels can be expected when an OHP programme is instituted for patients undergoing fixed appliance treatment.

It was surprising to note that positive effects on plaque and/or gingival health were produced in only four of the included trials, whilst, in two of the studies, orthodontic OHP produced no difference. Reassuringly, none of the investigations produced a negative effect. These findings are in accordance with the non-orthodontic investigation by Watt and Marinho.[14] Unfortunately, none of the studies we identified had linked their interventions to gingival probing and all simply identified the oral health status using visual scales. The effect of orthodontic OHP on gingival pocket depths and potential bleeding on probing is therefore unknown. Thus, the effect of OHP on preventing significant periodontal attachment loss during fixed appliance orthodontic treatment[5–7] was not measured and remains unquantified. A linear relationship for both of these is unlikely due to the susceptibility of some patients to rapidly destructive periodontal disease resulting from minimal amounts of plaque.

Interestingly, there was no clear indication that a particular type or style of orthodontic OHP was more effective than any other method. Furthermore, there was no indication that an OHP programme conferred

Table 1 Included studies

Study	Study design	Duration	Gender	Type of fixed appliances	Intervention	Outcome measures
Tersin[21]	CCT	190 days	Male and female	Preformed bands with attachments	No oral hygiene instruction (n=18) compared with verbal oral hygiene instruction (n=20)	Flow of gingival exudate
Boyd[22]	RCT	10 months	Male and female	Full banded Standard Edgewise	No oral hygiene instruction (n=8) compared with verbal oral hygiene instruction (n=8) with/without plaque disclosing programme (n=8)	Plaque index[28] and gingival index[27]
McGlynn *et al.*[23]	CCT	8 weeks	Not specified	Banded fixed appliances	Group 1 (n=30) written oral hygiene instruction Group 2 (n=29) verbal oral hygiene instruction	Gingival index[27]
Rinchuse *et al.*[24]	RCT	8 months	Male and female	Not specified	Group 1: assessment of oral hygiene by Orthodontist Group 2: assessment of oral hygiene by Orthodontist and parent Group 3: assessment of oral hygiene by Orthodontist and patient Group 4: assessment of oral hygiene by Orthodontist, parent and patient (numbers in each group not specified)	6-point scale (ranging from very poor to good)
Richter *et al.*[25]	RCT	6 months	Not specified	Fixed appliances	Verbal oral hygiene instruction compared with written instructions associated with feedback/reward schemes	Orthodontic patient cooperation score[29] Modified oral hygiene index[31]
Lees and Rock[26]	RCT	8 weeks	Not specified	Straight-Wire (A-Company)	Group 1 (n=21) written oral hygiene instruction Group 2 (n=22) videotape of oral hygiene instruction Group 3 (n=22) verbal oral hygiene instruction	Oral hygiene index[30] Gingival index[27] Measured on second or first premolars

improvements in oral hygiene in the longer term, including the later stages of fixed appliance orthodontic therapy and post fixed appliance orthodontic therapy.

Although the six studies that met the inclusion criteria were a combination of RCTs[22,24–26] and CCTs[21,23], there was considerable heterogeneity in study design and quality. Five studies evaluated educational interventions,[21–24,26] whilst the investigation by Richter *et al.*[25] determined that written feedback and a reward scheme (including prizes such as ice cream, and raffles for compact disks and a wristwatch) did not have a positive effect on oral hygiene levels. There was also substantial variability in the outcome measures that were used in the studies involving the plaque index,[27] gingival index,[28] orthodontic patient cooperation scale,[29] oral hygiene index[30] and modified oral hygiene index.[31] Regarding the quality of the included studies, none described allocation concealment, only three clearly described blind outcome assessment[22,23,26] and only two included withdrawal rates.[23,24] Follow up data were collected beyond 5 months in all but one trial.[26] Because of the variability, we could not synthesise the data and ideally produce a forest plot of the effectiveness of OHP in fixed appliance orthodontic therapy. We were however able to collate the data.

We used the systematic review method to eliminate bias arising from literature searching, study selection, data abstraction and data synthesis. We aimed to identify all the relevant sources of literature via a wide search of the key electronic databases and backed this up by an extensive hand search. This was because of the variability in the indexing of orthodontic OHP studies by the relevant libraries.[32] A grey literature search was also conducted to identify unpublished work and those studies not identified within the mainstream peer-reviewed journals.

The results of this study indicate that each patient scheduled to embark on fixed appliance treatment should be provided with orthodontic OHP material at the start of treatment. This is because increased plaque formation not only produces CHG, but also generates more prolonged acid challenges to the enamel, potentially resulting in enamel demineralisation.[33] However, no single OHP method will suit all patients.[34] Therefore, it is recommended that each patient should receive direct advice from an oral health professional, backed up by written and where possible, video evidence. Despite the initial costs of producing suitable video material, this method of information delivery confers significant advantages, in terms of the dissemination of consistent information to a large number of subjects.[26] There is also some evidence that videodata are more effective at positively influencing patient behaviour than written information alone.[35] Such information could be shown within waiting areas on a videotape loop, browsed at a waiting area computer kiosk or accessed from the internet by podcast.[36] Furthermore, verbal advice from an oral health professional incorporating a plaque disclosing programme has been shown to be superior to verbal oral hygiene advice alone in reducing plaque levels.[22]

Although the results of this study do not indicate whether an orthodontic OHP programme confers any long-term benefit on periodontal health, it is likely that certain patients would benefit from further OHP during fixed appliance orthodontic treatment. This includes patients with pre-existing periodontal attachment loss and those predisposed to periodontal attachment loss in the absence of fixed orthodontic appliances. Therefore, patients in the latter group (immunosuppressed, diabetics, pubertal, pregnant, menopausal, those taking oral contraceptives and special needs patients with manual dexterity difficulties) should probably receive regular OHP from either a hygienist or dental therapist during orthodontic treatment irrespective of their effectiveness of plaque control at the start of treatment. Furthermore, it is also likely that smokers embarking on orthodontic treatment should receive a combination of both orthodontic OHP and specific smoking cessation advice.[37] This is because smoking not only favours the development of gingivitis and periodontitis (among other conditions), but because periodontal cell turnover is slower in smokers,[38] tooth movement is slower resulting in longer treatment times and orthodontic-induced gingivitis acting over a longer period of time. Thus any loss of attachment is likely to be of a greater significance in smokers undergoing fixed appliance orthodontic treatment.

Clinicians should not only provide orthodontic OHP to eliminate or minimise CHG but could also use treatment strategies to minimise plaque build up around fixed appliance components. For example, the use of small brackets with relatively small occlusogingival dimensions[39] and bracket positioning gauges may help to provide consistent bracket placement avoiding unnecessary proximity to the gingival margins and thus assist in reducing plaque accumulation. Brackets with minimised labiolingual/buccolingual profile and ensuring all excess bonding adhesive is removed may also reduce plaque accumulation. Similarly, for patients where calculus build up occurs during orthodontic treatment around the fixed appliance components, regular scaling and polishing and the use of an appropriate anti-plaque and anti-calculus mouthwash are advisable. Complex bracket designs such as self-ligating varieties containing relatively large clips, auxiliary arch

wires and other auxiliaries are plaque retentive and should probably be avoided in periodontally susceptible orthodontic patients.[40]

Conclusions

- An OHP programme for patients undergoing fixed appliance orthodontic treatment produces a short-term reduction (up to 5 months) in plaque and improvement in gingival health.
- No particular OHP method produces a greater short term benefit to periodontal health during fixed appliance orthodontic treatment.
- Further studies using appropriate methods and in particular longer follow up periods are required.

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