Journal of Orthodontics, Vol. 33, 2006, 205–212

SCIENTIFIC SECTION

Orthodontic retention: A systematic review

Simon J. Littlewood
St Luke's Hospital, Bradford, UK

Declan T. Millett
Dental School, University College Cork, Eire

Bridget Doubleday
Dental School, University of Glasgow, UK

David R. Bearn, Helen V. Worthington
School of Dentistry, University of Manchester, UK

Objective: To evaluate the effectiveness of different retention strategies used to maintain tooth position after treatment by orthodontic appliances.

Data sources: The search strategy was carried out according to the standard Cochrane systematic review methodology. The following databases were searched for randomized clinical trials (RCT) or controlled clinical trials (CCT): Cochrane Oral Health Group Trials Register, Cochrane Clinical Trials Register, MEDLINE and EMBASE. No language restrictions were applied. Authors of trials were contacted to identify unpublished trials. Inclusion and exclusion criteria were applied when considering the studies to be included and a quality assessment made for each paper.

Data selection: The primary outcome was the amount of relapse. Secondary outcomes were survival of retainers, adverse effects on oral health and patient satisfaction.

Data extraction: Screening of eligible studies, assessment of the methodological quality of the trials and data extraction were conducted in duplicate and independently by two reviewers. Five studies (2 RCTs and 3 CCTs) fulfilled the inclusion criteria.

Data synthesis: There was evidence, based on data from one trial, that there was a statistically significant increase in stability in both the mandibular ($P<0.001$) and maxillary anterior segments ($P<0.001$) when the CSF (circumferential supracrestal fiberotomy) was used in conjunction with a Hawley retainer, compared with a Hawley retainer alone. However, this evidence may be unreliable due to flaws in the study design. There was also weak, unreliable evidence that teeth settle quicker with a Hawley retainer than with a clear overlay retainer after 3 months.

Conclusions: There is currently insufficient evidence on which to base the clinical practice of orthodontic retention.

Key words: Orthodontic retention, relapse, retainers, fiberotomy, Cochrane systematic review

Received 22nd November 2005; accepted 17th March 2006

Introduction

Post-orthodontic retention is one of the most controversial areas in clinical orthodontic practice. Retention is the phase of orthodontic treatment that attempts to maintain teeth in their corrected positions after active tooth movement. Although retention potentially affects every patient, there is minimal agreement as to the most appropriate approach to adopt in an individual case. Without a phase of retention there is a tendency for the teeth to return towards their initial positions. The aetiology of relapse is not fully understood, but relates to a number of factors, including periodontal and occlusal factors, soft tissue pressures and growth.[1] Attitudes to the use of retention have changed over the years, but it has been suggested that there is a shortage of reliable evidence to apply clinically.[1]

Retention can be achieved by placing removable or fixed retainers. There is no recognized duration for retention, although it has been shown that, at least in relation to periodontal factors, it takes, on average, a minimum of 232 days for fibres around the teeth to remodel to the new tooth position.[2] However, even if the teeth are held in position during this period, in the long-term they can show relapse.[3,4] Some clinicians, therefore, prefer to retain for longer periods, sometimes indefinitely.

Address for correspondence: Simon Littlewood, Orthodontic Department, St Luke's Hospital, Little Horton Lane, Bradford, BD5 0NA, UK.
Email: simonjlittlewood@aol.com

DOI 10.1179/146531205225021624

Additional or 'adjunctive' procedures can also be applied to the teeth or surrounding periodontium to aid the retention process. Examples include reshaping teeth, such as interproximal stripping[5] or circumferential supracrestal fiberotomy.[6,7]

In order for retainers or adjunctive techniques to be acceptable they must maintain the teeth in position without compromising oral health. They must also be acceptable to patients and be reliable. All these important outcomes need to be considered when assessing methods of orthodontic retention.

This review is based on a Cochrane review, published in the Cochrane library.[8] The objectives of this review were to evaluate the effectiveness of different retention strategies used to maintain tooth position after treatment with orthodontic appliances It does not attempt to identify the causes of relapse. It assesses the effects of retainers whilst in place, not the long-term changes after they are no longer in use.

Materials and methods

The method for this review is presented according to Cochrane guidelines with the help of the Cochrane Oral Health Group (http://ohg.cochrane.org).

Types of studies

Randomized controlled trials and controlled clinical trials (defined as quasi-randomized trials such as randomization based on odd or even dates of birth) were included in this review.

Types of participants

We included children and adults who had retainers fitted or adjunctive procedures undertaken following orthodontic treatment. There was no restriction for the presenting malocclusion or type of active orthodontic treatment undertaken.

The following were excluded:

- Individuals who had undergone orthognathic surgery
- Individuals with a cleft lip and/or palate or other craniofacial syndrome
- Individuals who had orthodontic treatment based on extractions alone and/or the fitting of a passive space maintainer

Types of interventions

We included any study that investigated retainers and/or adjunctive techniques after treatment with orthodontic appliances. However, only studies where the full course of orthodontic treatment was completed were included: data on retention strategies at the end of a first phase of treatment were excluded.

Types of outcome measures

Primary outcome

- The primary outcome was change in tooth position, or stability. This can be assessed by an index of tooth irregularity, for example Little's index[3] or how the teeth meet together, using an index such as the PAR index.[9] This assessment had to be made at least three months after the fitting of the retainer and/or after the adjunctive procedure was carried out.

Additional outcomes

- *Survival of the retainers*. This assessed how long the retainers lasted without breaking (in months), or how many times they needed to be replaced or repaired during wear.
- *Patient satisfaction*.
- *Adverse effects on oral health*. This included demineralization, caries and periodontal disease.

Search strategy for identification of studies

For the identification of studies included in or considered for this review detailed search strategies were developed for each database searched. These were based on the search strategy developed for MEDLINE, but revised appropriately for each database to take account of differences in controlled vocabulary and syntax rules.

The MEDLINE search strategy combined the subject search with phases 1 and 2 of the Cochrane Sensitive Search Strategy for RCTs.[10] The subject search used a combination of controlled vocabulary and free text terms, and is shown in full in Table 1.

a) Databases searched. The following databases were searched:

- Cochrane OHG Trials Register (9 May 2005).
- The Cochrane Central Register of Controlled Trials (CENTRAL; Issue 2, 2005).
- MEDLINE 1966–9 May 2005.
- EMBASE 1989–Week 18, 2005.

b) Language. There was no language restriction and if papers had been found in non-English language journals, these would have been translated.

c) Hand searching. The following journals were identified as important to this review and the reviewers contributed to the hand searching of these journals as part of the Oral Health Group's hand search program:

- *American Journal of Orthodontics and Dentofacial Orthopedics (formerly American Journal of Orthodontics)*
- *Angle Orthodontist*
- *European Journal of Orthodontics*
- *Journal of Orthodontics (formerly the British Journal of Orthodontics)*

In addition, conference proceedings and abstracts from the British Orthodontic Conference and European Orthodontic Conference were searched for the same time period as the hand searching.

d) Checking reference lists. The bibliographies of papers and review articles identified were checked for studies published outside the hand searched journals.

e) Personal communication. The first named authors of identified randomized trials were contacted. They were sent the protocol for the review asking for further information relevant to the review that was not apparent in the published work. They were also asked if they knew of any other published or unpublished studies relevant to the review and not included in the list.

Table 1 Subject search strategy for MEDLINE via OVID (controlled vocabulary is given in upper case type and free text terms in lower case)

1. exp ORTHODONTICS/
2. orthodontic$.mp.
3. or/1–2
4. (retention or retain$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
5. (stabilise$ or stabilize$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
6. (fraenectom$ or frenectom$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
7. (fiberotom$ or fibreotom$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
8. 'interproximal stripping'.mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
9. pericision.mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
10. reproximat$.mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
11. ((gingiv$ or periodont$) adj4 surg$).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
12. (retain or retention).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]
13. 11 and 12
14. or/4–10
15. 13 or 14
16. 3 and 15

Data extraction

Data were extracted and methodological quality assessed by two independent reviewers. Data were recorded on specially designed data extraction forms. The data extraction forms were piloted on several papers and modified as required before use. Any disagreements were resolved by discussion with one of the other two reviewers in the team.

The quality of the eligible trials was assessed using the following criteria:

- method of randomization and allocation concealment;
- blinding of patients, clinicians and outcome assessors where appropriate;
- reporting and analysis of withdrawals and drop-outs.

Kappa scores were used to assess agreement between reviewers.

Data synthesis and analysis

For dichotomous outcomes, the estimate of effect of an intervention was expressed as relative risks together with 95% confidence intervals. For continuous outcomes, mean differences and 95% confidence intervals were used to summarize the data for each group.

Clinical heterogeneity was assessed by examining the types of participants, interventions and outcomes in each study with no planned subgroup analyses. Meta-analyses would have been done only with studies of similar comparisons reporting the same outcome measures. Relative risks would have been combined for dichotomous data and standardized mean differences for continuous data, using a random effects model. The significance of any discrepancies in the estimates of the treatment effects from the different trials would have been assessed by means of Cochran's test for heterogeneity and any heterogeneity was investigated.

Results

Identified studies

Five studies were identified as fulfilling the inclusion criteria.[7,11–14] The screening process is summarized in Figure 1. One additional RCT that also fulfilled the inclusion criteria was identified, but there were

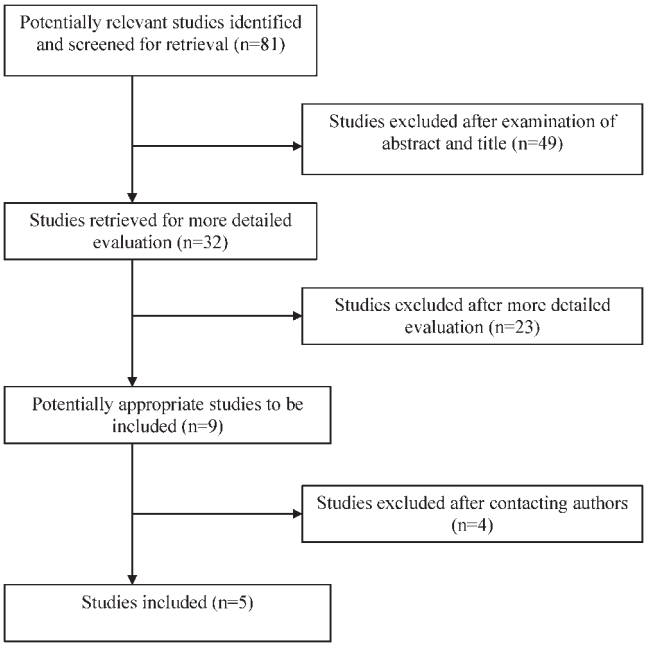

Figure 1 Flow diagram showing screening of studies in this systematic review

insufficient data within the paper to make a meaningful assessment.[15] When the authors were contacted they did not wish to release the original data, so this study had to be excluded. There was complete agreement between the two assessors for assessment of allocation concealment and blinding. There was disagreement on one paper with regard to the withdrawals. This was resolved by discussion with other members of the team. Table 2 shows characteristics of included studies.

Types of included studies

Two of the studies were randomized[11,12] and three were quasi-randomized (controlled clinical trials).[7,13,14] Data and subjects from previous smaller trials[6,16] were reported in two of these studies.[7,11]

Setting of included studies

Three studies were undertaken in a hospital setting,[12–14] one in practice[11] and in one study the setting was unclear.[7] The countries of origin were USA,[7,11,13] Germany[12] and Turkey.[14]

Area of mouth being assessed

Two of the studies assessed the lower labial segment,[11,12] while the remaining studies assessed stability in the upper arch only.[7,13,14]

Comparisons used in included studies

The following comparisons were found:

- Circumferential supracrestal fiberotomy (CSF) and removable retainer (full-time) versus removable retainer (full-time).[14]
- Three types of fixed retainers and a removable retainer.[11]
- CSF and removable retainer (nights only) versus removable retainer (nights only).[7]
- Hawley removable retainer versus clear overlay removable retainer.[13]
- Multistrand wire and a direct-bonded polyethylene ribbon-reinforced resin composite for lingual retention.[12]

Further details of the comparisons are shown in Table 2.

Outcomes of included studies

The following outcomes were found:

- assessment of stability (in terms of changes in tooth alignment);[7,11,14]
- assessment of stability (in terms of changes in occlusion);[13]
- adverse effects on dental health;[7,11,12,14]
- survival of retainers;[7,13]
- patient satisfaction.[13]

Methodological quality of included studies

Two studies used adequate allocation concealment and appropriate generation of randomization sequence.[11,12] In three studies the interventions were allocated alternately.[7,13,14]

Blinding of the clinicians and patients was not possible in any of the studies due to the nature of the research. Blinding of outcome assessors was not possible in one study.[11] Blinding of outcome assessors was used in two studies,[13,14] but was not mentioned in the other two studies.[7,12]

Withdrawals and drop-outs were not fully reported and analyzed in any study. Personal communication with authors confirmed no withdrawals or drop-outs in three studies.[11–13] The authors of one study confirmed the drop-out of one subject[14] who was not included in the analysis. In the final study,[7] there was an 85% drop-out but this was not fully analyzed.

Comparison of retention techniques

Multistrand or polyethylene ribbon-reinforced resin composite for lingual retention. One study[12]

Table 2 Characteristics of included studies

Study	Methods	Participants	Interventions	Outcomes	Author contacted
Rose 2002	Parallel group	n=11	0.0175-inch multistrand wire versus a direct-bonded polyethylene ribbon-reinforced resin composite for lingual retention	Failure rate.	Author successfully contacted, who confirmed appropriate randomization technique and no drop-outs
	RCT	Age 22.4 years (SD 9.7 years)		Adverse oral health effects or patient satisfaction were reported in narrative form only. Relapse was not assessed	
Taner 2000	Parallel group	n=23 (11 test and 12 control)	CSF with a Hawley retainer worn full-time versus Hawley retainer worn full-time. Surgery was performed 1 week after debond	Assessment of stability using Little's Index. Adverse effects reported in narrative form only. No patient satisfaction assessment	Author successfully contacted. They confirmed allocation of intervention was alternate and one patient dropped out, but this was not analyzed
	CCT	Age 12–20 years Patients who had initial crowding of 2.3–25.5 mm (Little's Index)			
Årtun 1997	Parallel Group.	n=49 (11, 13, 11 and 14, respectively, in each group)	Thick plain 0.032-inch canine and canine	Survival of retainers was reported	Author successfully contacted, but no additional data were available to that shown in the paper
	RCT	Age 12–55 years Treated by 2 orthodontists with edgewise fixed	Thick spiral 0.032-inch canine and canine Thin flexible 0.0205-inch bonded to canines and incisors Removable Hawley retainer	Relapse reported using Little's Index. Adverse effects on health were reported but the data was incomplete No patient satisfaction was reported	
Sauget 1997	Parallel group	n=30	Hawley vs clear overlay retainer.	Assessment of settling made by number but not quality of contacts. There was no assessment of patient satisfaction, adverse effects on health or failure rates	Author successfully contacted. They confirmed allocation of intervention was alternate and there were no drop-outs
	CCT	Age 13 years 6 months to 42 years 2 months (mean 19 years 6 months)	Hawley prescribed full-time except meals, Clear overlay prescribed 3 days full time except meals then nights only		
Edwards 1988	Parallel group	n=320 initially with n=48 at the end of the study	CSF and a removable retainer at night vs removable retainer only	Assessment of stability was measured using Little's index, but there was insufficient data to allow analysis. Author recorded epithelial attachment loss to assess health	It was not possible to contact the author
	CCT	Age 10.9–14 years at start of study			

compared the reliability of post-treatment 0.0175-inch multistrand wire canine to canine retainers with resin composite reinforced with plasma-treated polyethylene ribbon. This RCT failed to demonstrate a significant difference in failure rate over 2 years, although the sample size was small. There was no sample size calculation. Comparing the ribbon reinforced retainer (five out of ten retainers failed) with the multi-strand wire retainer (one out of ten retainers failed), the relative risk was 5 (95% CI: 0.7, 35.5; $P=0.11$). There were no data reported on patient satisfaction or oral health, and the degree of relapse was not recorded.

This was a well designed study, but relates to only one operator.

Effects of circumferential supracrestal fiberotomy. There were two studies identified which compared CSF combined with a removable retainer versus a removable retainer alone. In one study, the removable retainer was worn full-time[14] and in the other study it was worn at night only.[7]

The results would suggest that CSF and a full-time removable retainer provide a clinically significant reduction in relapse (approx 2 mm) over 1 year, compared with using a removable retainer alone.[14] CSF was reported as having no adverse effects on dental or periodontal health. However, no numerical data were reported on this outcome. There was no assessment of the patients' level of satisfaction with this treatment. It should be noted that the trial used pseudorandomization and allocation bias may exist.

The other prospective study, comparing CSF and a removable retainer (nights only) with a removable retainer (nights only)[7] cannot be analyzed using the stability data presented in the paper. The author was contacted, but no reply was received. There were significant drop-outs during the study and only the average data for all the initial subjects are reported. There was also a risk of allocation bias and the length of removable retainer treatment was not controlled. The study suggested that CSF had no adverse effects on the periodontal health compared with the non-surgical group. However, this finding should be interpreted with caution, because the randomization was not adequate, allocation bias may exist and there was a high drop-out rate.

The inherent bias in both studies makes it difficult to draw any definitive conclusions about the effectiveness of CSF.

Bonded retainers or removable retainers. The study by Årtun and co-workers[11] compared three types of bonded retainers and one removable retainer. The three types of bonded retainers were:

- 0.032-inch plain canine to canine retainer;
- 0.032-inch spiral canine to canine retainer;
- 0.0205-inch spiral wire bonded to both canines and all lower incisors.

The patients were followed up for 3 years. Assessment of stability and adverse effects could not be further analyzed due to the lack of standard deviations. The author was contacted, but was unable to supply any additional information. Assessment of survival of retainers suggested no difference in survival rates over the 3 years for any of the retainers. However, this could have been due to the relatively small sample size (no sample size calculation was reported). There were insufficient data to analyze adverse effects on health and no assessment was made of patient satisfaction of the treatment.

Despite the appropriate randomization, it was difficult to reach any definite conclusions from this study, for the reasons mentioned.

Settling of occlusion. One study[13] looked at settling of the occlusion, which could be considered to be a 'beneficial' type of relapse. This is changes in the occlusion during the retention stage that increases the number of occlusal contacts.

The study compared a Hawley retainer worn full-time with a clear overlay retainer worn full-time for 3 days (except meals), then nightly after that. The Hawley retainer allowed a statistically significant greater degree of settling than the clear overlay retainer, with a mean difference of 6.53 contacts between teeth (95% CI: 2.57, 10.49) after 3 months. No assessment was made on adverse effects of health, survival of retainers or patient satisfaction of the treatment.

This study would, therefore, suggest that there was a significantly increased number of occlusal contacts after three months with the Hawley retainer. The study, however, did not address whether these increased number of occlusal contacts were in the correct locations. Contact with the authors revealed that the patients were allocated alternately, so the results need to be interpreted with caution due to the possibility of allocation bias. It should also be noted that the study only investigated the first three months of retention.

Discussion

By their very nature, studies of post-orthodontic retention are difficult to undertake. Relapse is a long-term problem and long-term follow-up of patients is practically difficult and financially demanding. This systematic review has demonstrated that, at the time of writing, there

is a shortage of high quality published research on orthodontic retention. Future research in this field should aim to demonstrate the following features:

- adequate allocation concealment and appropriate generation of randomization;
- blinding where appropriate (particularly of outcome assessors);
- adequate reporting and analysis of withdrawals and drop-outs;
- sample size calculations;
- follow-up for a minimum of 3 months, but ideally for a number of years, given the nature of post-orthodontic relapse;
- outcomes that include changes in tooth position, adverse effects on dental and periodontal health, survival of retainers (if appropriate) and patient satisfaction assessment.

There is evidence, based on data from one trial,[14] that there was a statistically significant increase in stability in both the mandibular ($P<0.001$) and maxillary anterior segments ($P<0.001$) when CSF is used in conjunction with a Hawley retainer, compared with a Hawley retainer alone. However, this evidence may be unreliable due to flaws in the study design. There is also weak, unreliable evidence that teeth settle quicker with a Hawley retainer than with a clear overlay retainer after 3 months.[13]

The authors are aware of ongoing trials that may fulfill the inclusion criteria and these will be included, if appropriate, in future up dates of the Cochrane review.

Conclusions

- There is a paucity of high quality evidence on which to base our clinical practice of orthodontic retention.
- There is an urgent need for high quality research in this field, which affects the vast majority of our orthodontic patients.

Contributors

Simon Littlewood, Declan Millett, Bridget Doubleday and David Bearn were jointly responsible for study design, conduct, data extraction and quality analysis. Simon Littlewood was responsible for preparation of reports, and was involved in the design of the search strategy. Helen Worthington is responsible for the statistics. Simon Littlewood is the guarantor.

Acknowledgements

We would like to acknowledge the help of Jayne Harrison, Sylvia Bickley, Emma Tavender and the rest of the Cochrane Oral Health Group for their assistance in producing and updating this review. We would also like to thank the investigators who kindly replied to our requests for further information.

References

1. Melrose C, Millett DT. Toward a perspective on orthodontic retention? *Am J Orthod Dentofacial Orthop* 1998; **113**: 507–14.
2. Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. *Am J Orthod* 1967; **53**: 721–45.
3. Little RM, Wallen TR, Riedel RA. Stability and relapse of mandibular alignment—first four premolar extraction cases treated by traditional edgewise orthodontics. *Am J Orthod Dentofacial Orthop* 1981; **80**: 349–65.
4. Little RM, Riedel RA, Årtun J. An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. *Am J Orthod Dentofacial Orthop* 1988; **93**: 423–8.
5. Boese LR. Fiberotomy and reproximation without lower retention, nine years in retrospect: Part I. *Angle Orthod* 1980; **50**: 88–97.
6. Edwards, JG. A surgical procedure to eliminate rotational relapse. *Am J Orthod* 1970; **57***:* 35–46.
7. Edwards JG. A long-term prospective evaluation of the circumferential supracrestal fiberotomy in alleviating orthodontic relapse. *Am J Orthod Dentofacial Orthop* 1988; **93**: 380–7.
8. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Retention procedures for stabilising tooth position after treatment with orthodontic braces. *Cochrane Database of Systematic Reviews* 2006, Issue 1.
9. Richmond S, Shaw WC, O'Brien KD, *et al*. The development of the PAR Index (Peer Assessment Rating): reliability and validity. *Eur J Orthod* 1992; **14**: 180–7.
10. Alderson P, Green S, Higgins JPT, eds. *Cochrane Reviewers' Handbook 4.2.2*, updated December 2003. Available at: http://www.cochrane.org/resources/handbook/hbook.htm (accessed 31 January 2004).
11. Årtun J, Spadafora AT, Shapiro PA. A 3-year follow-up of various types of orthodontic canine-to-canine retainers. *Eur J Orthod* 1997; **19:** 501–9.
12. Rose E, Frucht S, Jonas IE. Clinical comparison of a multistranded wire and a direct-bonded polyethylene ribbon-reinforced resin composite used for lingual retention. *Quintessence* 2002; **33**: 579–83.
13. Sauget E, Covell DA, Boero RP, Lieber WS. Comparison of occlusal contacts with use of Hawley and clear overlay retainers. *Angle Orthod* 1997; **67**: 223–30.

14. Taner T, Haydar B, Kavuklu I, Korkmaz A. Short-term effects of fiberotomy on relapse of anterior crowding. *Am J Orthod Dentofacial Orthop* 2000; **118**: 617–23.
15. Störmann I, Ehmer U. A prospective randomised study of different retainer types. *J Orofac Orthop* 2002; **63**: 42–50
16. Årtun J, Spadafora AT, Shapiro PA, McNeill RW, Chapko MK. Hygiene status associated with different types of bonded, orthodontic canine-to-canine retainers. A clinical trial. *J Clin Periodontol* 1987; **14**: 89–94.