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Original Article

A longitudinal index study of orthodontic stability and relapse

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Background: Previous studies of stability and relapse after orthodontic treatment report short-term stability is generally followed by slow relapse to the original condition. What these studies do not report is whether this relapse is continuous or interspersed with periods of improvement or stability.
Methods: A subjective 0–10 index of malocclusion was used to record post-treatment stability and relapse over 10 to 12 years following fixed appliance orthodontic treatment of 24 patients. The severity scores were plotted on timelines.
Results: Episodes of change, both favourable and unfavourable, were interspersed with episodes of stability.
Conclusions: Changes in the first 3 and 12 months post-treatment are indicative of the 10 to 12 years post-treatment outcomes. This index may provide a useful instrument to analyze patients and/or their study models longitudinally.
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Introduction

Orthodontic relapse is defined as a return towards the pretreatment condition,[1] and includes the recurrence or development of all traits of malocclusion. The following traits have been investigated: rotations,[2–5] crowding,[6–12] openbite,[13] deep overbite,[14] overjet, crossbite and Angle Class II molar relationship.[15] Stability and relapse after orthodontic treatment are unpredictable.[16,17] Possible exceptions to this statement are arches with generalized spacing,[18] which tend to show little or no crowding after orthodontic treatment, and severe anterior openbites which frequently relapse.[13] In addition, there is nothing documented about the methods of undertaking orthodontic treatment that will predict stability or relapse, providing the lower intercanine width and arch shape are maintained.[17]

To date, the majority of studies of post-treatment stability have been cross-sectional in design, and hampered by the absence of an index able to be used conveniently and equally well on both patients and study models. In Draker's[19] view an ideal index should be quick, simple, accurate, reliable, reproducible, objective and yield quantitative results for analysis. According to Otuyemi and Jones,[20] no such index is available.

Recently the PAR index has been used to investigate post-treatment stability both longitudinally and cross-sectionally.[21–26] In one long-term study of patients with Class II division 1 malocclusion no significant

Table I. Modified Orthodontic Treatment Priority Index (After Grainger, 1967).

Malocclusion severity scale	Interpretation
0	Virtually classic normal occlusion
1, 2, 3	Minor manifestation, treatment need is slight
4, 5, 6	Definite malocclusion, but treatment elective
7, 8, 9	Severe handicap, treatment highly desirable
10	Very severe handicap, treatment mandatory

changes were found one year post-retention, suggesting early stability.[25] However, there was no difference between the alignment of the lower incisors pretreatment and 10 years post-retention, indicating complete relapse of this trait.[25] The philosophies of treatment and retention used in this study were not described. Al Yami *et al.*[26] also used the PAR index to assess the pretreatment, post-treatment, and 10 year "post-retention" study models of 1,016 patients: 11 per cent of the patients had fixed lower retainers at the end of the study. The malocclusions, treatment and retention methods used in this study were not described. Al Yami *et al.*[26] concluded that 67 per cent of the treatment results were maintained 10 years post-retention, about half of the total relapse occurred during the first two years following removal of retention. All occlusal traits, except lower incisor alignment, relapsed gradually for the first five years and then remained stable. Lower incisor alignment, on the other hand, continued to deteriorate so that in some cases the final score exceeded the pretreatment score.

The Orthodontic Treatment Priority Index[27] was developed as an objective measurement based index (Table I). It has been developed into a simple subjective scoring index suitable for use in epidemiology,[28] as the basis for determining priority for public sector orthodontic treatment in Queensland, and as a standard for assessing other indices.[29] The intra-examiner reproducibility of this modified index was addressed by Freer and Olive[28] and found to be satisfactory. Inter-examiner reproducibility was investigated by Keay *et al.*[29] who reported that some orthodontists familiar with the index scored consistently high while others scored consistently low. This is a shortcoming of this index.

The aim of this study was to determine in orthodontic patients treated consecutively by the same orthodontist, the changes and outcomes present up to 12 years post-treatment. These changes were assessed using a modified Orthodontic Treatment Priority Index.[27]

Subjects and methods

Out of a potential sample of 100 consecutively treated patients by the same clinician, 24 patients (16 women, 8 men) were able to be traced and recalled for full records in 1999 and 2000: 10 to 12 years after their fixed appliances were removed in 1988. The mean pretreatment age of the recalled sample was 16 years 3 months. In 1988 four of the subjects were adults and 20 were children. Prior to treatment 12 subjects had Angle Class I malocclusions, seven had Class II division 1 malocclusions, and five subjects had Class II division 2 malocclusions. Fourteen subjects were treated without extractions, nine subjects were treated with extraction of teeth in both arches usually the upper first and the lower second bicuspids, and one subject had the upper first bicuspids only extracted.

The majority of patients were treated with full fixed pre-adjusted edgewise appliances.

One patient had maxillary fixed appliances only. Headgear and inter-arch elastics were used depending on the position of the lower incisors. The pretreatment form of the lower arch, and the lower intercanine width were maintained during treatment. At the completion of treatment all maxillary incisors with pretreatment rotations greater than 10 degrees were pericised. In cases with an inter-arch tooth size discrepancy, or minor crowding with blade-shaped incisors, the widths of the lower incisors were reduced during treatment. After removal of the fixed appliances, retainers were fitted within 24 hours. Generally, the retainers used were a lower fixed banded retainer from tooth 34 to tooth 44, and a removable Begg-type wrap-around maxillary retainer. Patients were asked to wear the maxillary appliances full-time for the first three months, and then for as long as practicable at nights. Impacted third molars were extracted if impaction could be ascertained or symptoms occurred and persisted.

For each patient, study models, intra-oral and extra-oral colour slides, lateral cephalometric radiographs, and panoramic radiographs were available before treatment, at the end of treatment, and 10 to 12 years post-treatment. At each appointment during retention a full description of the clinical condition observed by the clinician or reported by the patient, was recorded. Using the Modified Treatment Priority Index given above, severity scores were recorded before treatment, at the end of treatment, and at each successive appointment. For each post-treatment appointment, the available records were checked before a severity score was assigned.

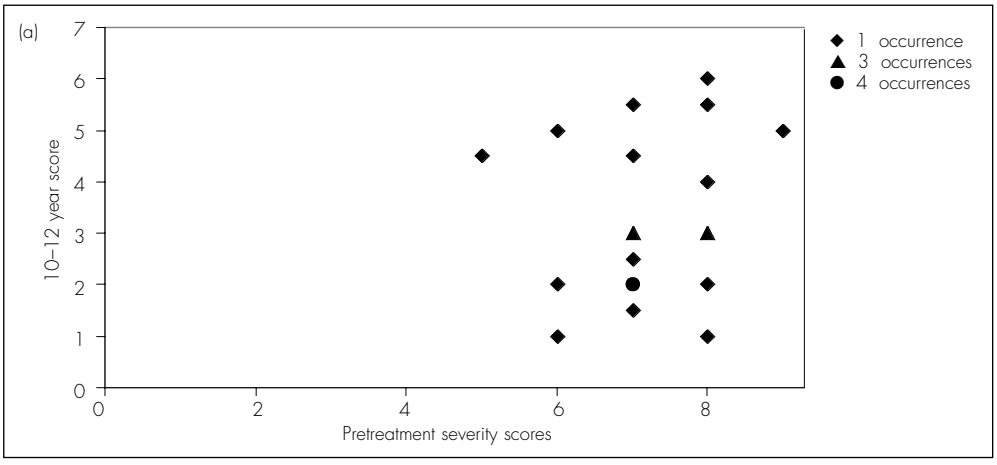
For the purposes of this investigation none of the end-of-treatment models scored as 0 or as a virtually classic normal occlusion. A score of 1 indicated a very good result, while a score of 2 indicated minor imperfections only. A score of 3 was assigned if there were noticeable manifestations of malocclusion, but treatment need or retreatment need remained slight. Increasingly obvious malocclusions attracted higher scores of 4 to 6, which indicated that there was definite malocclusion, but treatment need was elective. None of the post-treatment scores reached the severe handicap categories of 7 to 10.

To assess the intra-examiner reproducibility the severity scores for all appointments from the end of treatment were re-scored more than 12 months after the first scoring. If both scores were in agreement a 1 was assigned, and if they disagreed 0 was assigned. Assuming that the patient scores were independent of each other and that for every patient there is the same probability of examiners scoring them equally, this new variable has a binomial distribution. Thus, it is possible to construct the confidence interval for the probability of having consistent scores for a patient for any appointment. The examiners are said to be consistent if the lower level of the confidence interval is greater than 0.5.[30]

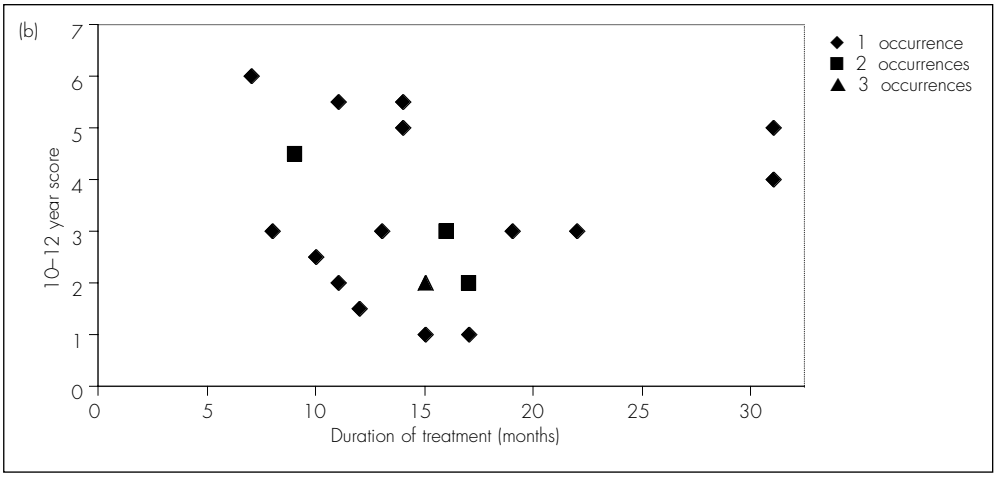
For further analysis, first and second scores for each appointment were averaged. The 10–12 year severity scores were plotted against pretreatment scores, duration of treatment, duration of maxillary retainer wear, duration of mandibular retainer wear, first recall scores, and the highest scores during the first 12 months. Associations between the severity scores at 10–12 years and the six variables given above were calculated using Pearson's product-moment correlation coefficients. Severity score timelines were then generated for each patient.

Results

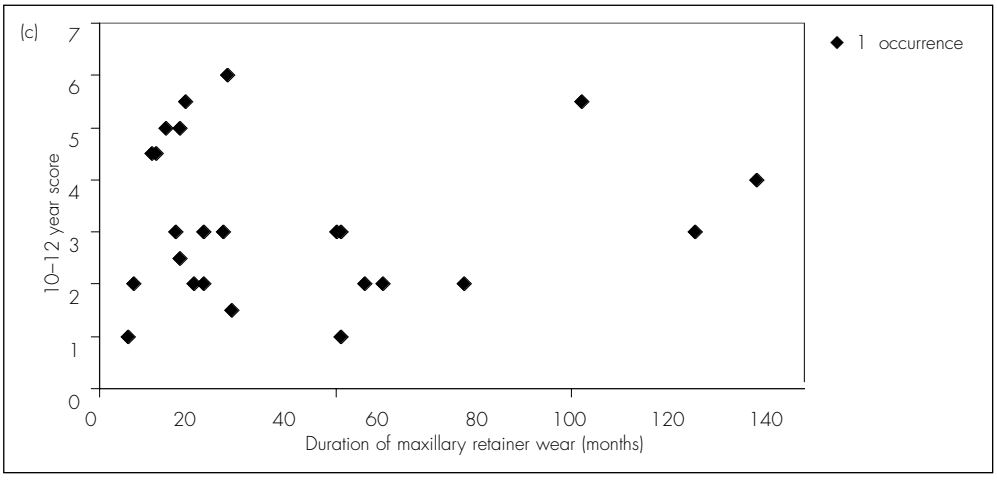
Intra-examiner reproducibility was found to be satisfactory for the severity scores at the end of treatment, first retention recall and highest score in the first 12 months. It could be concluded with 90 per cent confidence that, for every patient, the probability of having both scores equal was greater than 0.5, that is, there is 90 per cent confidence in the consistency of the data.



(a) Pretreatment severity scores.

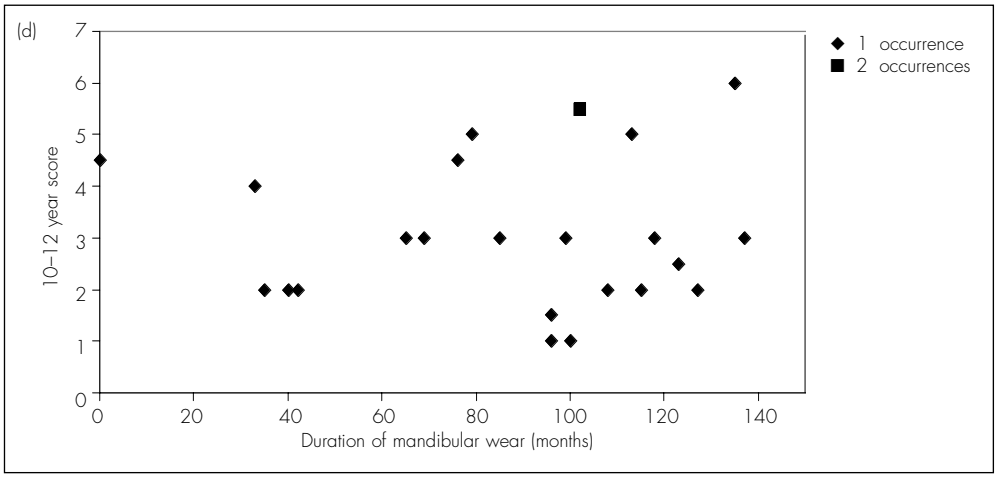


(b) Duration of treatment (months).

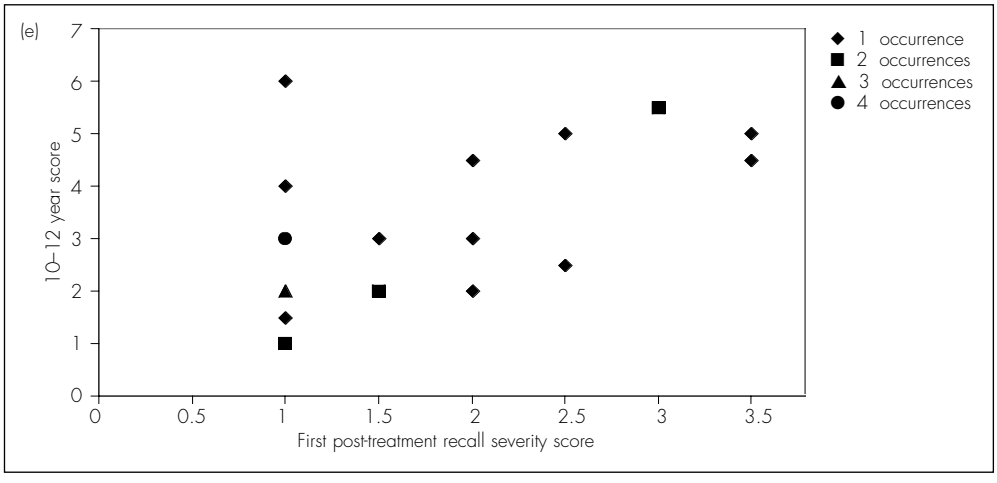


(c) Duration of maxillary retainer wear (months).

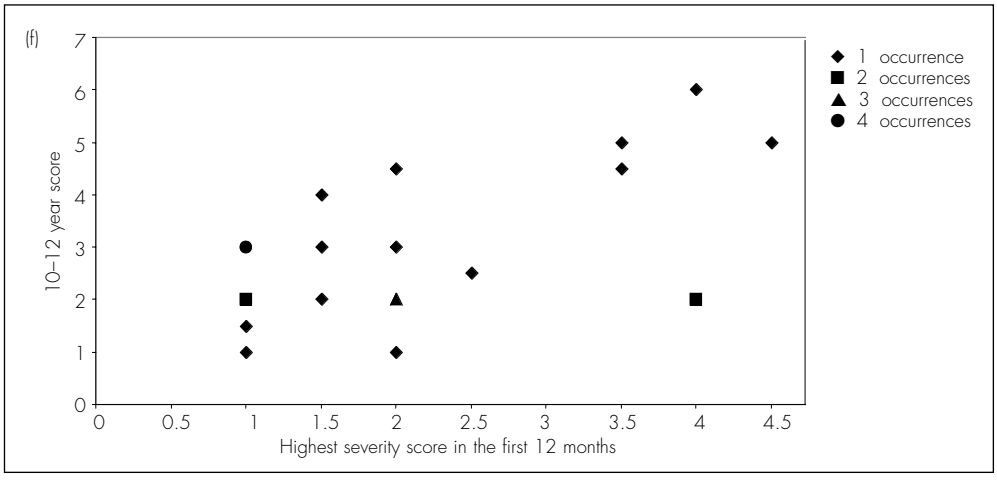
Figure 1a to c. Graphs of 10–12 year severity scores plotted against 3 variables: (a) Pretreatment severity scores, (b) Duration of treatment (months), (c) Duration of maxillary retainer wear (months).



(d) Duration of mandibular retainer wear (months).



(e) First post-treatment recall severity score.



(f) Highest severity score in the first 12 months.

Figure 1d to f. Graphs of 10–12 year severity scores plotted against 3 variables: (d) Duration of mandibular retainer wear (months), (e) First post-treatment recall severity score, (f) Highest severity score in the first 12 months.

Table II. Associations between six variables and the 10–12 year post-treatment severity scores.

Variable	N	r	*p*
Pretreatment score	24	0.155	0.471
Duration of treatment	24	-0.030	0.890
Duration of maxillary retainer wear	24	0.038	0.862
Duration of mandibular retainer wear	24	0.026	0.903
First recall score	24	0.597	**0.002**
Highest score in the first 12 months	24	0.777	**0.000**

Significant values are shown in bold

The 10–12 year severity scores were plotted against pretreatment scores, duration of treatment, duration of maxillary retainer wear, duration of mandibular retainer wear, first recall scores, and the highest score during the first 12 months of retention (Figure 1). The most striking feature of these graphs is variability. For example, there appears to be no consistent relationship between the 10–12 year severity scores and the pretreatment severity, the duration of treatment, the duration of maxillary retention, and the duration of mandibular retention. On inspection there appears to be a positive association between the severity scores at 10–12 years and the scores at the first recall and the highest score in the first 12 months post-treatment.

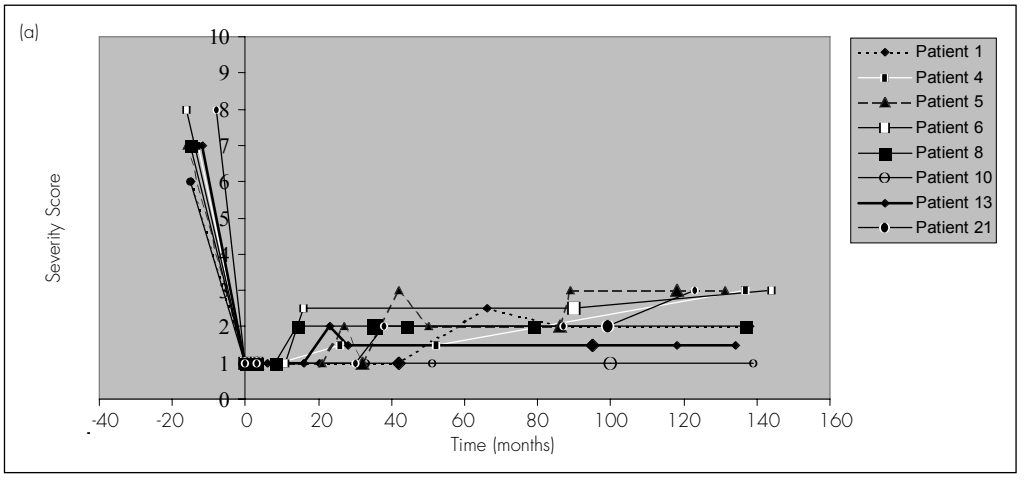
These data were tested for correlation using Pearson's correlation coefficient, and significant correlations were found between the 10–12 year scores and the first recall scores, and between the 10–12 year scores and the highest scores during the first 12 months of retention (Table II).

The timelines were superimposed in 3 groups on the basis of the highest score during the first 12 months of retention. They show that post-treatment changes in severity tend to occur in episodes (Figure 2). These episodes may be in changes of 1, 2 or even 3 in the severity score. Furthermore, deleterious changes may be followed by periods of stability or improvement. Some of the latter changes were due to resumption of retainer wear.

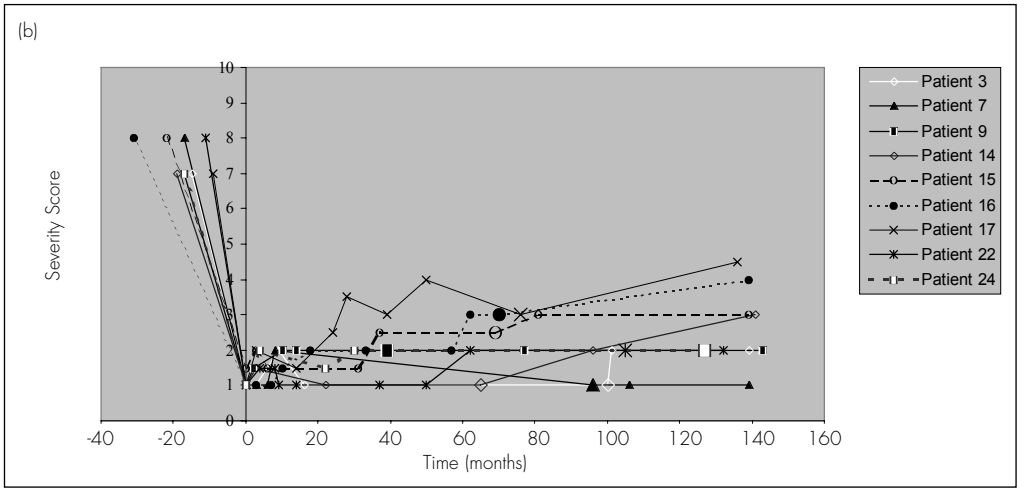
Discussion

There are important limitations inherent in the methodology used in this study. The sample size is too small for statistical comparison of groups based on the type of malocclusion, the different modalities of treatment, the extraction pattern, and different designs of retainers. The retrospective assignment of severity scores could limit the validity of the data. However, the severity scores irrespective of their derivation demonstrated good intra-examiner reproducibility. The index, being subjective, suffers from inter-examiner reliability shortcomings and this may limit comparisons with future similar studies. It is, however, relatively simple and convenient to use, and inter-examiner reliability could be improved with a process of standardization.

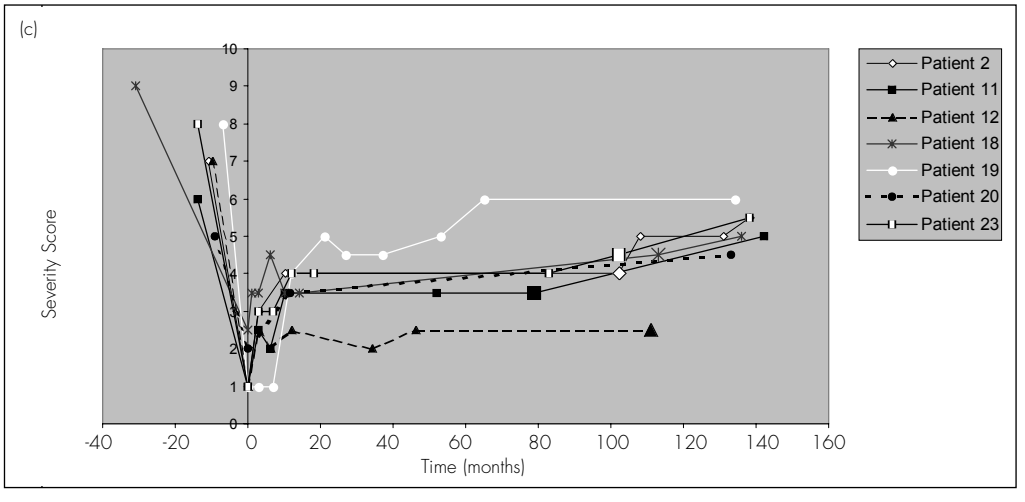
By 10 to 12 years post-treatment, eight patients (33 per cent) had relapsed to the extent that they were classified as having a definite malocclusion, but treatment was elective (Malocclusion severity scale: 4–6). No patients relapsed into the severe handicap category (Malocclusion severity scale: 7–9). This study could not demonstrate any relationship between the pretreatment scores, duration of treatment, duration of wear of either maxillary or mandibular retainers and the 10–12 year severity scores. The significant correlations between the 10–12 year scores and the first recall scores, and between the 10–12 year scores and the highest score in the first 12 months, are consistent with



(a) Highest score not exceeding 1.



(b) Highest score exceeding 1 but not exceeding 2.



(c) Highest score exceeding 2.

Figure 2a to c. Severity score timelines for 24 patients superimposed according to highest score during the first 12 months post-treatment: (a) Highest score not exceeding 1, (b) Highest score exceeding 1, but not exceeding 2, (c) Highest score exceeding 2. Initial markers indicate commencement of treatment. End of treatment is month 0. Each retention visit is indicated by a marker. Oversize markers denote end of retention.

other studies indicating that much of the post-treatment change occurs relatively early. For example, Al Yami *et al.*[26] found that much of the post-treatment change happened in the first two years after cessation of retention, but they gave no indication of the duration of retention. Furthermore, 11 per cent of their 1,016 patients still had lower retainers *in situ* at the end of the study. However, the present study indicates that significant occlusal changes can occur during the first 12 and even three months following completion of treatment irrespective of retention. The correlation coefficients indicate that the highest score during the first year following treatment may be the most useful indicator available for predicting long-term stability or relapse.

The timelines demonstrate the episodic, and unpredictable, nature of relapse. For those patients with stable occlusions during the first year post-treatment, later episodes of relapse were generally less detrimental, and less frequent, than episodes affecting occlusions in patients with early relapse. Although the correlation coefficients did not demonstrate a significant relationship between the length of retention and relapse, the timelines show that the end of retention was frequently followed by an episode of relapse. Furthermore, resumption of retainer wear often led to episodes of improvement, as demonstrated in the timelines. Although retention is a major contributor to stability, it did not prevent relapse from occurring in some cases. The five patients who relapsed to severity scores of 5–6 ("definite malocclusion with treatment elective") declined retreatment (Figure 2c). However, it should be noted that five of the seven patients in this group retained a substantial improvement on their original malocclusion despite the relapse.

Failure to find a significant correlation between the pretreatment and 10–12 year post-treatment scores agrees with the literature, which indicates that the severity of a pretreatment malocclusion is generally a poor guide to post-treatment relapse or stability.[16,17] The poor correlation between the duration of treatment and the 10–12 year scores indicates that, for conventional fixed appliance treatment, the duration of treatment is not a reliable guide to post-treatment relapse or stability.

It is of concern that no significant correlation was demonstrated between duration of wear of either maxillary or mandibular retainers and the 10–12 year post-treatment scores. Apart from fixed lower retainers, which prevent the development of lower incisor crowding, long-term retention does not guarantee treatment stability. It appears that post-treatment change is to be expected. These findings disagree with the prevailing view[18,25] that only full-time, and perhaps lifelong, retention will ensure the stability of a result. The present study is only supportive of published work insofar as few patients developed lower incisor crowding while the fixed lower retainers were in place, and the great majority of patients retained substantial improvement in their occlusions 10 to 12 years after orthodontic treatment.

Conclusions

1. A subjective 0–10 index of malocclusion, based on the Orthodontic Treatment Priority Index, proved a useful instrument to analyze patients and/or their study models longitudinally.
2. Changes in the first 3 and 12 months post-treatment are the best indicator of the 10–12 years post-treatment outcomes.
3. Relapse following orthodontic treatment is episodic.

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