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An approach to maintain orthodontic alignment of lower incisors without the use of retainers

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SUMMARY The purpose of this investigation was to examine the long-term stability of orthodontic alignment of lower incisors without the use of retainers. The study sample comprised 56 patients treated according to a protocol that included over-correction of rotated teeth at an early stage of treatment and systematic enamel reduction (stripping) of the approximal surfaces in the mandibular anterior region, both during treatment and follow-up. Care was also taken to maintain dental arch form and to avoid lateral expansion of the lower dental arch and proclination of the incisors. Dental study casts were obtained pre-treatment, at the end of treatment, and 3 years post-treatment. Alignment of the mandibular incisors was recorded using Little's irregularity index. The inter-canine distance and the sum of the mesio-distal widths of the mandibular incisors and canines were also measured.

The total amount of enamel removed from the approximal surfaces of the lower anterior teeth ranged from 0.3 to 5.0 mm (mean 1.9 mm). The mean increase in irregularity index score of 0.6 from post-treatment to 3 years follow-up indicated good stability. In 45 per cent of the patients the change in score during this period was less than 0.5, indicating that the treatment approach presented may be considered an alternative strategy to placement of lower retainers to safeguard the stability of alignment of mandibular incisors.

Introduction

Over the last two to three decades, bonded lower lingual retainers have become widely used in orthodontics, and indications for their use, fabrication, and efficacy have been thoroughly described and discussed (Zachrisson, 1985, 1993). Their introduction has expanded the range of malocclusions that can be handled successfully. Treatment results that previously were difficult to retain, such as closure in spaced dentitions and major dental irregularities in adults, can now be stabilized with bonded retainers.

Well-aligned lower incisors are an important feature of successful orthodontic treatment, not only because of aesthetics and the patient's well-being, but also because relapse in this area may affect occlusal stability (overjet and overbite) as well as maxillary incisor alignment. Routine use of lower retainers is therefore an attractive option to safeguard the corrections obtained during treatment. On the other hand, widespread use of retainers implies challenges for the professional, both of a practical and an ethical nature. Extended wear of bonded retainers substantially increases the number of patients under supervision, placement may be an unnecessary adjunct in many subjects, and the long-term consequences have not been well documented.

Lower incisor irregularity after orthodontic treatment may either be due to growth and development, or result from relapse of tooth movements carried out during treatment (Little *et al.*, 1988). Age-related growth changes result from continuous long-term processes. Little attention has been paid as to when an incipient relapse may be identified clinically. Many years of clinical experience indicate that in most patients signs of relapse may be detected during the first weeks after the end of treatment. A treatment strategy was therefore developed that included a 4 week period without archwires before debonding, and in patients showing relapse tendencies, stripping to reduce the mesio-distal width of the lower anterior teeth was carried out before realignment. During treatment, rotated teeth were over-corrected at an early stage of treatment and care was taken to avoid transversal and anterior expansion. This treatment protocol was adhered to in all patients with the intention of maintaining lower incisor alignment without using retainers. The objective of the present study was to examine the long-term changes in incisor alignment in patients treated according to this protocol.

Subjects and methods

The study comprised patients treated in private practice by one author (TOA). All were treated with upper and lower fixed edgewise appliances (0.022 × 0.025 inch slot). Sixty-seven of the 71 patients who were consecutively finished during a 6 month period in 1997 attended a clinical examination 3 years after the end of treatment. Eleven patients were excluded from the study because treatment had been initiated before eruption of the mandibular permanent canines. The sample thus consisted of 56 individuals (34 girls, 22 boys). Before treatment 34 were Angle Class I, 17 Class II division 1, two Class II division 2, and three Class III. Treatment involved extraction of premolars in 22 patients (upper and lower in 16, and upper only in six). The individual's age and

duration of treatment are shown in Table 1. Dental study casts were obtained pre-treatment, at the end of treatment, and 3 years post-treatment.

Clinical procedures

The treatment protocol included the following elements with the intention of reducing relapse in the mandibular incisor area:

1. Care was taken to avoid proclination of the lower incisors, to keep or slightly reduce the inter-canine width, and to maintain dental arch form. Class II elastics were never used in non-extraction cases.
2. Reduction of enamel (stripping) on the approximal surfaces of the mandibular anterior teeth was performed in all patients: at the beginning of treatment in subjects with anterior crowding, and in the remaining cases at the end of treatment. In addition, slight stripping was undertaken during the follow-up period if a trend to relapse in combination with a decrease in inter-canine width was observed. The procedure was carried out manually from the mesial aspect of one lower canine to the mesial aspect of the other (Figures 1 and 2).
3. Rotated incisors were over-corrected during treatment. For example, a tooth being rotated 20 degrees mesio-lingually before treatment was rotated to a position 20 degrees mesio-labially at an early stage of treatment, and then moved to its correct position in the dental arch (Figures 3 and 4).
4. To ensure alignment in the apical area of the lower incisors, a heavy rectangular archwire (stainless steel 0.021 × 0.025 inch in the 0.022 slot) was kept in place for at least 2–3 months (Figure 4).
5. Extensive palatal marginal crests on the maxillary incisors were reduced by grinding.
6. At the end of the finishing stage, the archwire was removed leaving the patient with brackets and bands for 4 weeks. If the tooth position had not changed during this period, all appliances were removed. In patients with some relapse, the teeth were stripped and realigned before the archwire was again taken out for another 4 weeks.
7. Mandibular retainers (bonded or removable) were not used in the mandibular dental arch.

Table 1 Age and duration of treatment (in years) of 56 patients treated without retention in the mandibular dental arch.

	Mean	Standard deviation	Minimum	Maximum
Age at the start of treatment	12.6	1.5	10.1	18.3
Age at the 3 year follow-up	18.5	1.6	15.3	24.0
Treatment duration	2.7	0.6	1.5	4.5

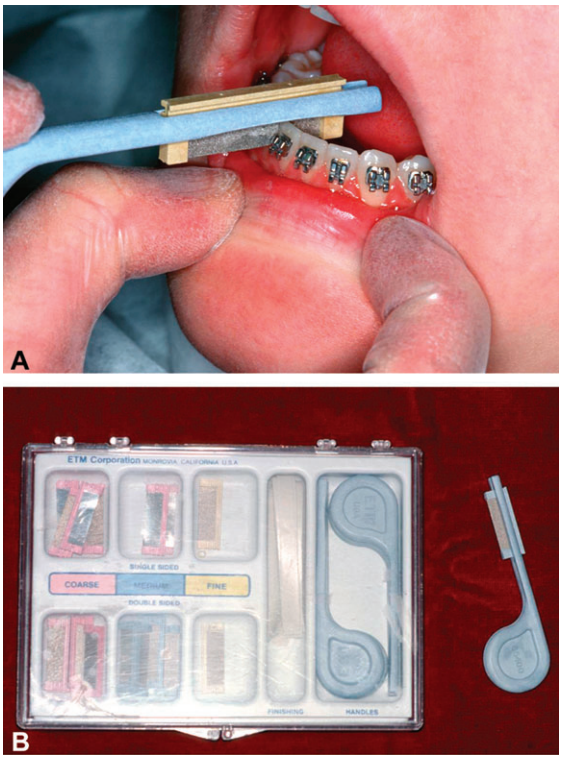

Figure 1 (A) Manual stripping, (B) the equipment used (ETM Corporation, Glendora, California, USA).

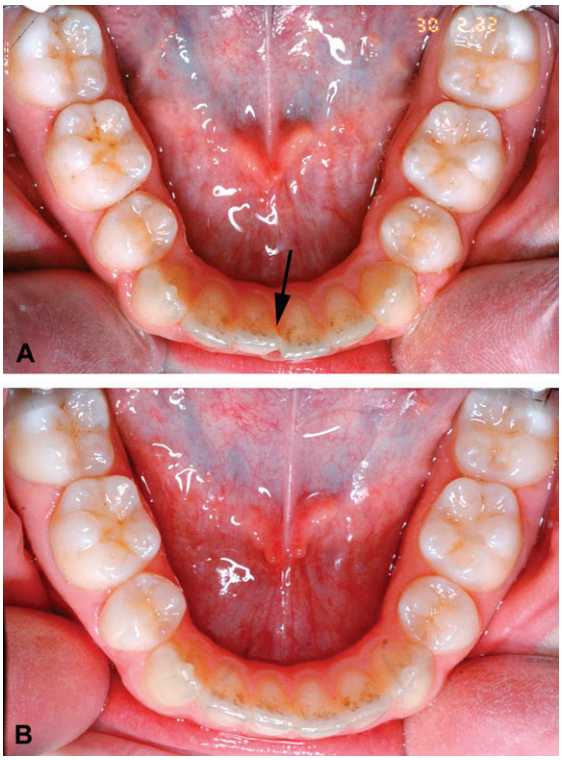

Figure 2 (A) A right mandibular central incisor (arrow) showing a slight relapse 18 months after the end of treatment, (B) 3 years post-treatment: self-correction after some stripping.

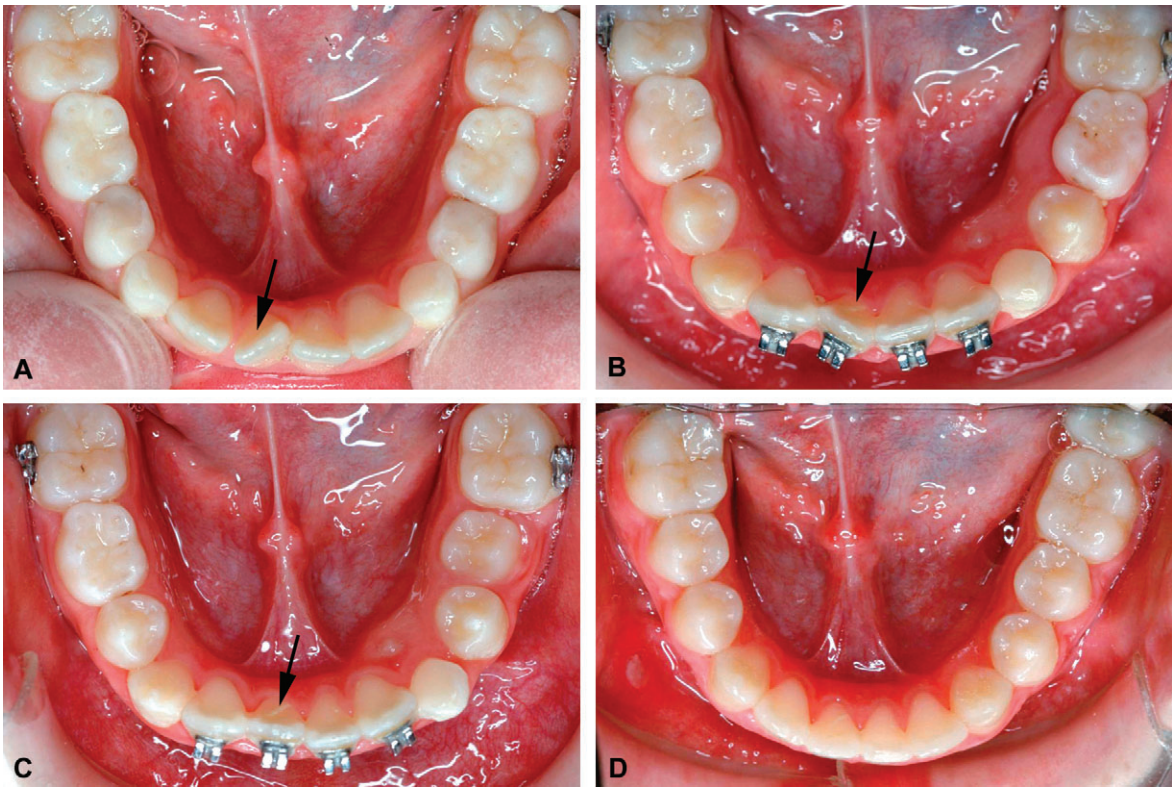

Figure 3 (A) Pre-treatment: a right mandibular central incisor (arrow) is mesio-lingually rotated. (B) At an early stage of treatment, the incisor is over-corrected. (C) Later in treatment, the incisor is moved towards a normal position. (D) Three years post-treatment. No retention was used.

Measurements

Recordings were made on the dental study casts. Mandibular anterior alignment was measured according to Little's irregularity index (Little, 1975). With this method the linear distance between the adjacent anatomic contact points of each mandibular incisor is measured in millimetres, and the sum of the five measurements represents the index score (Figure 5). The mandibular inter-canine distance was measured as the distance between the cusp tips. The total amount of enamel removed from the approximal surfaces was estimated from tooth width measurements pretreatment and 3 years post-treatment.

All measurements were made on two occasions 3 weeks apart by the same examiner (TOA) using a digital calliper accurate to the nearest 0.01 mm. If the difference between duplicate recordings was 0.5 mm or more, a third measurement was taken and the average of the two closest recordings was used.

Statistical analyses

Differences between genders were analysed by a Student's *t*-test for unpaired data. A paired *t*-test was used to analyse changes during time.

Results

No statistically significant differences between boys and girls were observed for any of the occlusal variables and pooled data are therefore presented.

The mean pre-treatment irregularity index score for the 56 patients was 5.6 (Table 2). After treatment, the score was reduced to 0.4 ($P < 0.001$), and 3 years post-treatment a mean score of 1.1 was observed. These values include a deliberate over-correction, i.e. slight mesio-lingual rotation of the mandibular canines in 23 of the patients (30 teeth). The two patients with the highest score 3 years post-treatment are illustrated in Figure 6. The mean increase in irregularity index score during the follow-up period was 0.6 ($P < 0.001$). In 25 patients (45 per cent) the change in score was less than 0.5 (Figure 7). The two individuals with the greatest change had an increase in score of 2.7 and 2.8, respectively. In both subjects an unintentional expansion (1.7 and 0.9 mm, respectively) in the canine region had occurred during treatment. It appears that the mandibular inter-canine width was reduced by an average of 0.5 mm during treatment ($P < 0.05$; Table 3). The follow-up period gave a further mean reduction of 0.6 ($P < 0.001$). The amount of enamel reduction of the lower anterior teeth (10 approximal surfaces) ranged from 0.3 to 5.0 mm (mean 1.9 mm, standard deviation 0.8 mm).

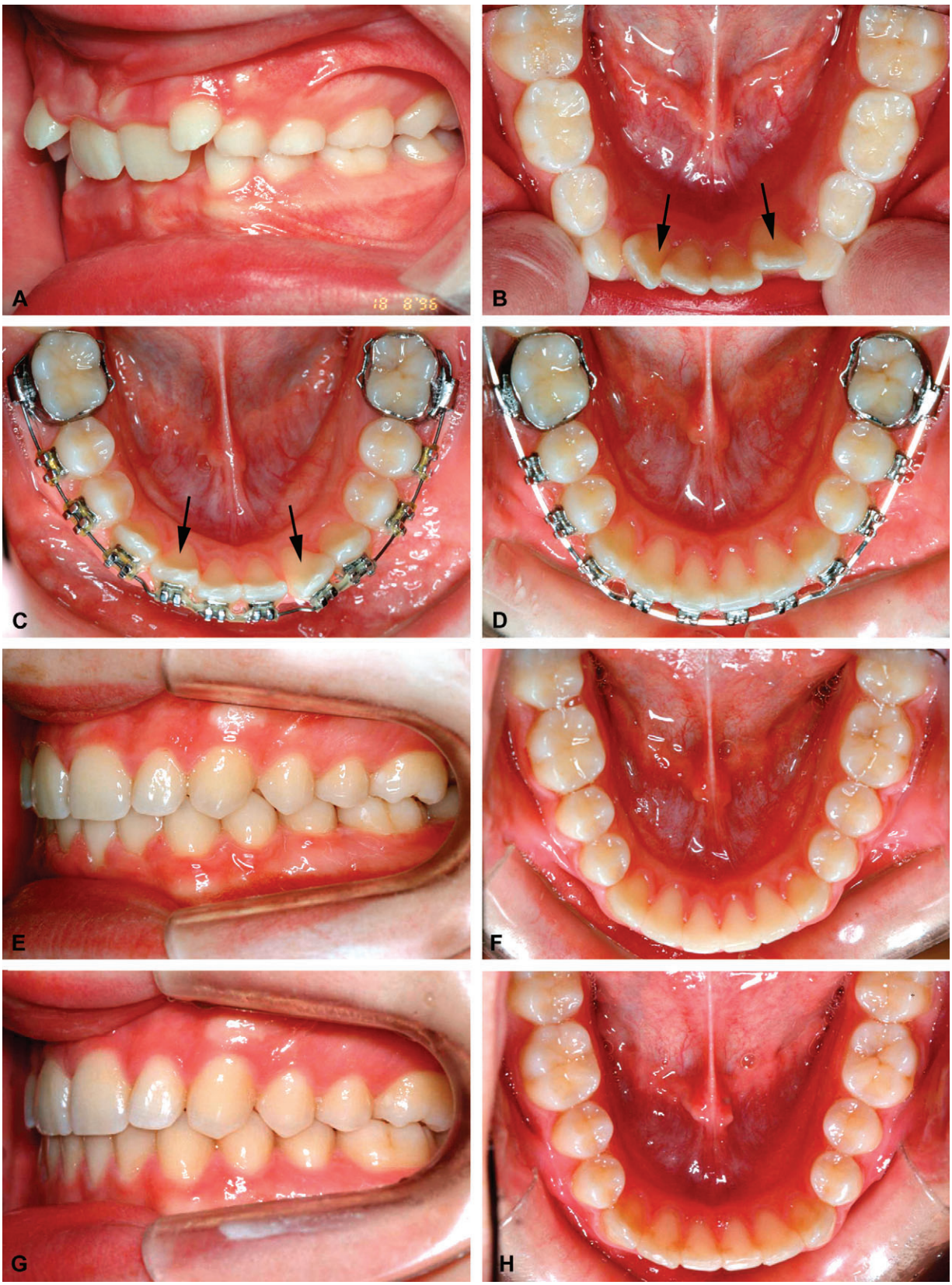

Figure 4 Early treatment of a patient with an Angle Class II division 2 malocclusion treated with cervical headgear and lip-bumper. (A, B) Pre-treatment. Marked rotation of mandibular lateral incisors (arrows). (C) Over-correction of the lateral incisors (arrows). (D) A heavy archwire (stainless steel 0.021 × 0.025 inch in 0.022 slot) in place towards the end of treatment. (E, F) The end of treatment. (G, H) Three years post-treatment.

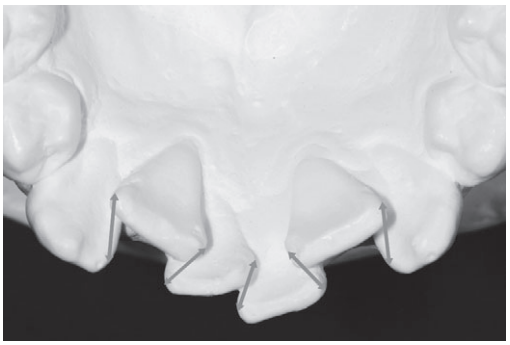

Figure 5 The irregularity index (Little, 1975) was used as a measure of anterior irregularities in the mandibular dental arch. Using this method, the linear distance between adjacent anatomic contact points of each mandibular incisor is measured and the sum of the five measurements represents the irregularity index score.

Table 2 Irregularity index scores for the 56 patients.

	Mean	Standard deviation	Minimum	Maximum
Pre-treatment	5.6	3.7	0	15.3
Post-treatment	0.4	0.5	0	2.1
3 years post-treatment	1.1	0.9	0	3.2

Statistical significance of differences (paired *t*-test): pre-treatment to post-treatment $P < 0.001$; post-treatment to 3 years post-treatment $P < 0.001$.

Discussion

Sampling of consecutively finished patients implies that various malocclusions will be represented, and the sample was therefore representative of routine patients in private practice. Because the initial occlusions varied, data for relapse of overjet and overbite were not included in the present study, as the focus was exclusively on changes taking place in the anterior region of the mandibular dental arch. The variables analysed, the inter-canine width and the irregularity index score, are well established and allow for comparison with other studies. Changes in incisor inclination during treatment and follow-up were not examined in the present investigation and will be analysed cephalometrically in another study.

A mean irregularity index score of 1.1, 3 years post-treatment should be regarded as satisfactory, as part of this was due to the deliberate over-correction of canines in 23 of the patients. The trend to a slight decrease in inter-canine width during adolescence was demonstrated by Moorrees (1959). The findings from the present study are in agreement with the results of Sinclair and Little (1983), Bondevik (1998) and Schütz-Fransson *et al.* (1998) and confirm the importance of avoiding transversal expansion in the mandibular canine area during treatment.

The other prerequisites for a stable result incorporated in the treatment protocol have also been underlined previously. The trend for relapse associated with proclination of mandibular incisors as well as lateral widening of the

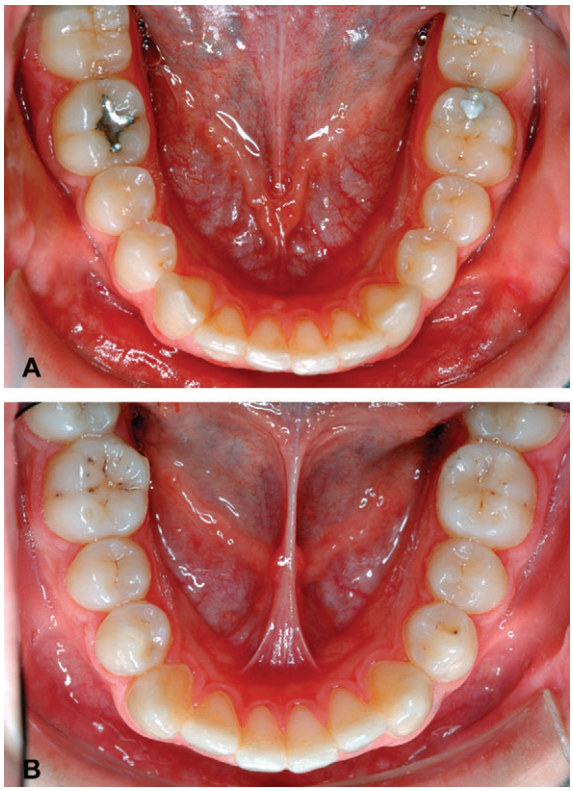

Figure 6 The two patients with the highest irregularity index score 3 years post-treatment. (A) A score of 3.2, (B) a score of 2.8.

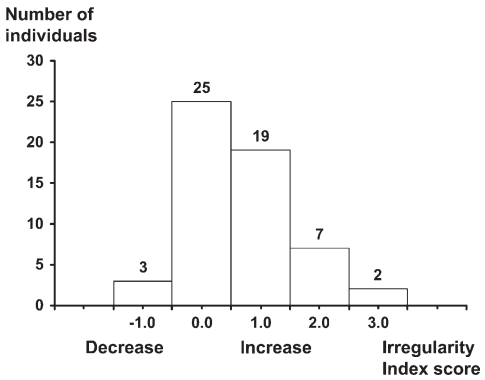

Figure 7 The distribution of individuals according to the change in irregularity index score from the end of treatment to 3 years post-treatment.

dental arch during treatment is generally agreed. Nance (1947a, b) proposed the concept of using leeway space to avoid expansion in the correction of mandibular crowding. Recently, Little (2002) reported that expansion as an approach to early treatment of arch length deficiency showed the poorest results of all strategies. The importance of maintaining the pre-treatment mandibular dental arch form has also been emphasized (De La Cruz *et al.*, 1995; Surbeck *et al.*, 1998).

The general trend for relapse of de-rotated teeth may be dealt with by pericision. This approach was used by

Table 3 Mandibular inter-canine widths (mm) in the 56 patients.

	Mean	Standard deviation	Minimum	Maximum
Pre-treatment	26.2	2.1	20.4	33.2
Post-treatment	25.7	1.3	21.2	28.9
3 years post-treatment	25.1	1.4	21.2	28.6

Statistical significance of differences (paired *t*-test): pre-treatment to post-treatment $P < 0.05$; post-treatment to 3 years post-treatment $P < 0.001$.

Boese (1980a, b), who reported good stability 9 years after treatment with no retention. The present approach of over-correcting rotated teeth during an early stage of treatment may be looked upon as an alternative strategy to fiberotomy.

Enamel reduction was an essential element of the present treatment protocol. Traditionally, tooth mass reduction is carried out in cases with discrepancies in the width of the maxillary and mandibular teeth (Bolton, 1958). Previous studies have demonstrated that approximately 20 per cent of patients have a tooth size discrepancy due to an excess of tooth mass in the mandible (Crosby and Alexander, 1989; Freeman *et al.*, 1996). In a study comparing adults with ideal occlusion and those with slight crowding in the mandibular an-terior segment, it was observed that in the latter group the mesio-distal diameter of the four incisors was significantly greater, whereas the inter-canine width and the frequency of third molars did not differ between groups (Norderval *et al.*, 1975; Schütz-Fransson *et al.*, 1998). In addition to compensating for tooth width discrepancies, the rationale for stripping in the present study was to obtain space for correction of crowding and to compensate for the normally occurring reduction in inter-canine width during adolescence.

In some of the patients in the present sample, incipient relapse was observed after removal of the archwire. Realignment and repeated stripping was then carried out before removing the appliances and obtaining post-treatment records. This extended period of active treatment compared with the placement of retainers, should be taken into account in cost–benefit considerations. The strategy of removing the archwires for a 4 week period at the end of treatment in order to detect incipient relapse may be used to select patients in whom a period of retention should be considered, and accordingly contribute to the establishment of guidelines for the selective use of retainers in the mandibular dental arch.

Conclusions

The objective of the study was to examine the long-term changes in incisor alignment in patients treated according to the described protocol. The changes observed indicated good stability 3 years after debonding. The approach presented may therefore be considered realistic in many patients if the intention is to avoid long-term use of mandibular retainers.

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