# A randomized clinical trial of thermoplastic retainer wear

## E. Thickett and S. Power

Department of Orthodontics, Royal Bournemouth Hospital, Dorset, UK

SUMMARY The purpose of this study was to determine whether thermoplastic retainers need to be worn full-time for a limited period or whether part-time wear from the outset is adequate to maintain tooth position, arch form, and occlusion. This study was a randomized clinical trail, conducted in a district general hospital. Sixty-two participants were enrolled in the study. Group 1, full-time wear, consisted of 30 patients (12 males and 18 females, aged  $13.6 \pm 1.5$  years) and group 2, part-time wear, 32 patients (14 males and 18 females, aged  $13.8 \pm 1.5$  years).

Each patient was assigned to one of the groups by random number generation. Clinical records in the form of study models were taken at the start of active treatment (T1), at debond (T2), 6 months into the retention phase (T3), and 1 year post-debond (T4). The irregularity index, intercanine width, intermolar width, arch length, overbite, overjet, and Peer Assessment Rating (PAR) scores were measured on study models using digital callipers. A Mann–Whitney test was used to evaluate the treatment changes within each group.

The only statistically significant difference was found to be at T3 and T4 for overbite (P = 0.05 and P = 0.02, respectively). PAR scoring showed more variable changes in group 2. There was good correlation for the measurement method. There was no statistical difference for the two groups for overjet, arch length, intermolar width, intercanine width, and irregularity index at any time point.

## Introduction

Relapse has been defined as a return of teeth to their original position or a shift in arch relationship at the end of treatment. The aetiology of relapse is multifactorial and can be divided into three main areas: physiological recovery, unfavourable growth, or 'true relapse' due to the placement of the teeth in an unstable position.

Relapse is also subject to individual variation. Reitan (1967) showed that the periodontal ligament takes 232 days to reorganize and can derotate teeth after 1 year. The periodontal ligament requires 3–4 months' masticatory stimulation for the organization of its fibres. In addition, research has shown that alveolar bone is laid down after 1 month and supracrestal fibres require 1 year to remodel. Several measures have been suggested in order to minimize relapse (Table 1).

Many articles have been published concerning the reasons for relapse, such as one type of retainer versus another, but there is very little evidence for an appropriate retention regimen. Littlewood *et al.* (2006) stated that there was an urgent need for randomized controlled trials to determine appropriate retention regimens for clinical practice. Destang and Kerr (2003) investigated maxillary retention with the use of Hawley retainers. They determined that a regimen of 1 year of 6 months full-time and 6 months of night-time only wear was clinically beneficial.

Ponitz (1971) described an alternative to the traditional removable retainer—the clear thermoplastic retainer. This type of retainer is durable, aesthetic, easy to clean, and approximately one-third less expensive than a conventional Hawley device (Hichens *et al.*, 2007), although the durability has been questioned by some authors. As there has been an increase in the use of thermoplastic retainers in current orthodontic practice, it would be helpful to have evidence to support the regimen of wear required for optimum stabilization of the teeth with thermoplastic retainers.

The aim of this study was thus to determine whether thermoplastic retainers need to be worn full-time or whether part-time wear is adequate to maintain tooth position, arch form, and occlusion. The null hypothesis tested was that there is no difference in the control of tooth position, arch form, and occlusion between full- and part-time thermoplastic retainer wear following fixed appliance therapy.

#### Subjects and methods

Ethical approval for the study was sought and granted from the East Dorset Local Research Ethics Committee (Ref no. 05/Q2201/76). The participants and parents (as appropriate) were invited to take part in the study after their recall from the treatment waiting list in preparation for active orthodontic therapy. After discussion, only those willing to provide fully informed consent were included.

Sixty-two participants were enrolled in the study. Group 1 (full-time) comprised 30 patients (12 males and 18 females, mean age  $13.6 \pm 1.5$  years) and group 2 (part-time) 32 patients (14 males and 18 females, mean age  $13.8 \pm 1.5$  years).

Clinical records in the form of study models were obtained at the start of active treatment (T1), at debond

(T2), 6 months into the retention phase of treatment (T3), and 1 year post-debond (T4). The retention regimen is shown in Table 2.

The sample size was determined to allow the study a statistical power of 0.988 to detect a 2 mm difference in lower incisor position at the significance level of P = 0.05. Each patient was assigned to one of the groups by random number generation. The majority of participants had either a Class I or a mild Class II division 1 incisor relationship with crowding (Class I, 29; Class II division 1, 29; Class II division 2, two; Class III, two, with a uniform distribution between groups 1 and 2).

## Patient selection

The inclusion criteria for patient entry into the study were a malocclusion requiring the extraction of all first premolars and no previous orthodontic treatment. The exclusion criteria were patients requiring fixed retention, functional appliance treatment, extra oral orthopaedic force, craniofacial anomalies, or orthognathic surgery.

## Treatment protocol

The treatment procedure was as follows:

- 1. All participants were treated by the same operator (SP).
- 2. All first premolars were extracted approximately 1–2 weeks prior to fitting of the appliances.
- Upper and lower fixed appliances using Dyna Lock pre-adjusted edgewise brackets (3M Unitek, Loughborough, Leicestershire, UK) from the non-extraction

series (Andrews' values for tip and torque using a 0.022 inch slot).

4. All retainers were made using Essix B material (GAC International, Bohemia, New York, USA) to a similar design, fabricated by the same laboratory and fitted on the same day as the fixed appliances were removed. The fit of the retainers was checked at each visit.

The following measurements were made by one author (ET) on the study models using digital callipers (Digimatic, Mitutoyo, Andover, Hampshire, UK) accurate to 0.001.

- *Irregularity index*: the summed labiolingual displacement of the five linear distances from one anatomical contact point to the adjacent contact point of the anterior teeth (Little, 1975; Figure 1).
- *Intercanine width*: the distance between the cusp tip points of the right and the left canines (Figure 2).
- *Intermolar width*: the distance between the distolingual cusp tips of the right and the left first permanent molars. The estimated cusp tips were used in cases of excessive wear (Figure 2).
- *Arch length*: a point measured midway between the incisal edges of the central incisors, bisecting the line connecting the mesial marginal ridges of the right and the left permanent molars (Figure 2).
- *Overbite*: the mean overlap of the maxillary to the mandibular central incisors.
- *Overjet*: the distance parallel to the occlusal plane from the incisal edge of the most labial maxillary central incisor to the most labial mandibular central incisor.
- Peer Assessment Rating (PAR) score.

Table 1 The different measures that can be undertaken to minimize relapse.

|  | Action  | Author                        |  |  |
|--|---|-------------------------------|--|--|
| Arch form                              | Maintain existing arch form   | Felton et al. (1987)          |  |  |
| Intercanine width                      | Maintain intercanine width  | Little et al. (1988)          |  |  |
| Antero-posterior position of the lower | Maintain antero-posterior position of the lower labial segment          | Mills (1968)                  |  |  |
| labial segment                         |   |                               |  |  |
| Rotations                              | Correct early on and consider circumferential fiberotomy before debond  | Reitan (1967); Edwards (1988) |  |  |
| Interproximal contact                  | Interdental stripping for triangular lower incisors to increase contact | Peck and Peck (1972)          |  |  |
| Growth                                 | Active retention of skeletal change throughout growth                   | Nanda and Nanda (1992)        |  |  |
| Midline diastema                       | Fraenectomy prior to debond   | Edwards (1988)                |  |  |
| Edge centroid                          | Correct to maintain incisor relationship                                | Houston (1989)                |  |  |
| Control of upper incisor               | Upper incisors under control of lower lip                               | Proffit (1978)                |  |  |

#### Table 2Retention regimens.

| Group | 0–3 months post-debond    | 3–6 months post-debond    | 6–9 months post-debond | 9-12-months post-debond |  |  |
|-------|---------------------------|---------------------------|------------------------|-------------------------|--|--|
| 1     | Full-time wear            | Part-time wear (10 h/day) | Alternate nights       | 1–2 times per week      |  |  |
| 2     | Part-time wear (10 h/day) | Part-time wear (10 h/day) | Alternate nights       | 1–2 times per week      |  |  |

#### Statistical analysis

All statistical analyses were performed using the Minitab statistical package (version 14, Minitab, Coventry, Warwickshire, UK) and masked to group membership. A Mann–Whitney test was used to evaluate the treatment changes within each group.

## Error of the method

The error of method was calculated to determine the reproducibility and reliability of the study cast measurements. All study models were remeasured by the same examiner at three different times, 3 weeks apart, for two of the interventions, overbite and lower intercanine width. Intraclass correlation was calculated using StatsDirect (Altrincham, Cheshire, UK, v.2.6.2).

#### Results

## Group characteristics

Patients in the two groups were matched for age at T1 (group 1: full-time wear, mean age  $13.6 \pm 1.5$  years and



Figure 1 Measurement of the irregularity index by adding the sum of all the contact point displacements.

group 2: part-time wear, mean age  $13.8 \pm 1.5$  years). Treatment time was similar at T2–T1 (group 1,  $17.1 \pm 2.5$  months and group 2,  $17.1 \pm 2.3$  months). There was a similar gender distribution between the two groups.

## Intraclass correlation

The interventions repeated on three occasions showed good correlation (overbite group 1 = 0.995 and group 2 = 0.996; lower intercanine width group 1 = 0.981 and group 2 = 0.977).

As the data were not normally distributed, non-parametric statistical tests were used. Friedman tests revealed that there was a statistically significant difference for all categories measured when compared at all time points (Table 3).

In order to determine whether there was a difference between groups 1 and 2 for each time period, Mann–Whitney tests were carried out. The only significant difference was at T3 and T4 for overbite (P = 0.05 and P = 0.02, respectively; Table 3; Figure 3).

## PAR score

Figure 4 illustrates the changes in PAR scores at T2 and T4. The most significant changes were found in group 2. There was no statistical difference between the groups.

#### Discussion

The number of subjects who failed to finish the study was small (group 1, n = 5 and group 2, n = 3), although the initial sizes of the groups were also relatively small.

As expected, there were general trends for the measurements to decrease significantly between T1 and T2 as a result of treatment.

## Irregularity index

There was no statistical difference between full- or part-time wear at any time point, although the degree of irregularity was seen to increase by T4, albeit not significantly. Rowland *et al.* 



Figure 2 Measurements of intercanine and intermolar width and arch length. A, intercanine width; B, intermolar width; and C, arch length.

**Table 3** The medians for full- (group 1) and part-time (group 2) wear and the P value at the start of active treatment (T1), at debond (T2), 6 months into retention phase (T3), and 1 year post-debond (T4).

| Mann–Whitney test—Medians    |         |         |         |         |         |         |         |         |         |         |         |         |
|------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                              | T1      |         |         | T2      |         | Т3      |         | T4      |         |         |         |         |
|                              | Group 2 | Group 1 | P value | Group 2 | Group 1 | P value | Group 2 | Group 1 | P value | Group 2 | Group 1 | P value |
| Total lower incisor crowding | 9.31    | 8.72    | 0.48    | 0.14    | 0.04    | 0.46    | 0.29    | 0.15    | 0.08    | 0.89    | 0.71    | 0.5     |
| Total upper incisor crowding | 12.12   | 14.92   | 0.06    | 0.14    | 0.21    | 0.14    | 0.46    | 0.35    | 0.67    | 1.09    | 1.08    | 0.8     |
| Lower interncaine width      | 26.1    | 26.56   | 1       | 27.07   | 27.24   | 0.22    | 26.75   | 27.43   | 0.31    | 26.47   | 27.07   | 0.65    |
| Lower intermolar width       | 36.93   | 38.45   | 0.92    | 33.32   | 34.09   | 0.52    | 33.82   | 33.67   | 0.69    | 33.6    | 34.35   | 0.61    |
| Lower arch length            | 26.05   | 25.88   | 0.43    | 21.02   | 21.1    | 0.44    | 19.88   | 20.57   | 0.14    | 20.14   | 21.28   | 0.06    |
| Upper intercnanine width     | 33.92   | 34.76   | 0.95    | 34.79   | 35.49   | 0.08    | 34.79   | 34.95   | 0.34    | 34.56   | 34.93   | 0.52    |
| Upper intermolar width       | 41.92   | 42.23   | 0.88    | 39.57   | 40.23   | 0.35    | 39.72   | 39.93   | 0.62    | 39.39   | 40.34   | 0.68    |
| Upper arch length            | 31.09   | 30.29   | 0.73    | 24.19   | 24.98   | 0.22    | 24      | 24.57   | 0.4     | 25.15   | 25.07   | 0.97    |
| Overjet                      | 3.9     | 4.13    | 0.76    | 2.36    | 2.54    | 0.6     | 2.68    | 2.32    | 0.55    | 2.39    | 2.76    | 0.37    |
| Overbite                     | 4.26    | 4.26    | 0.68    | 3.31    | 2.86    | 0.14    | 3.73    | 2.96    | 0.02*   | 3.74    | 3.14    | 0.05*   |

\**P* < 0.05.



**Figure 3** Boxplot showing the variation for overbite for group 1 (full-time) and group 2 (part-time) at the start of active treatment (T1), at debond (T2), 6 months into retention (T3), and 1 year post-debond (T4).



**Figure 4** Peer Assessment Rating (PAR) scores for T2 (end of active treatment) and T4 (1 year into retention) for full- (group 1) and part-time (group 2) wear.

(2007) found when comparing Hawley and vacuum-formed retainers that the only statistical difference was for irregularity of the incisors. This was not the case in this present study.

#### Intercanine and intermolar width

The widths were generally well maintained and no statistically significant differences were observed at any time interval between the two groups; therefore, the arch relationships were maintained during both active treatment and retention.

## Arch length

As a consequence of extractions, arch length was reduced in both groups. During retention, there was no significant difference between the two groups. Therefore, it can be concluded that the retention regimens were equally effective in maintaining arch length, although by T4 the decrease in arch length was approaching significance (P = 0.06).

#### Overbite

There was a significant difference in the increase in overbite between the two groups both at T3 and T4 (P = 0.02 and P = 0.05, respectively), with group 2 showing an increase in overbite (Figure 3). This may reflect more rapid settling in this group. Gill *et al.* (2007) also found no significant change in the irregularity index, overjet, intercanine width, or intermolar width between debonding and 6 months into retention. However, contrary to the current findings, they found no statistical difference for overbite.

#### Overjet

There was no significant difference between the two groups in overjet at any time point.

#### PAR score

There was an increase in PAR score for group 1 between T2 and T4 when compared with group 2 (Figure 4). The differences were related to overjet and growth changes rather than an increase in the irregularity index when the outliers were analysed for both groups.

#### Conclusions

The following conclusions can be made:

- 1. There was good correlation for the measurement method.
- There was no statistical difference for the two groups for overjet, arch length, intermolar width, intercanine width, and irregularity index for each time period.
- 3. There was a statistical difference at T3 and T4 for overbite between groups 1 and 2.

There is no real difference in retention of tooth irregularity whether thermoplastic retainers are worn on a full- or parttime basis. The finding that there was a statistically significant increase in overbite between the two groups at T3 and T4 may not be clinically significant as the difference was 0.6 mm. It is therefore suggested that part-time wear can be advised for patients who have undergone fixed appliances in conjunction with extractions.

#### Address for correspondence

E. Thickett Department of Orthodontics Royal Bournemouth Hospital Castle Lane East Bournemouth Dorset BH7 7DW UK E-mail: eleanor.thickett@rbch.nhs.uk

#### References

- Destang D L, Kerr W J S 2003 Maxillary retention: is longer better? European Journal of Orthodontics 25: 65–69
- Edwards J G 1988 A long-term prospective evaluation of the circumferential supracrestal fiberotomy in alleviating orthodontic relapse. American Journal of Orthodontics and Dentofacial Orthopedics 93: 380–387
- Felton J M, Sinclair P M, Jones D L, Alexander R G 1987 A computerized analysis of the shape and stability of mandibular arch form. American Journal of Orthodontics and Dentofacial Orthopedics 92: 478–483
- Gill D S, Naini F B, Jones A, Tredwin C J 2007 Part-time versus full-time retainer wear following fixed appliance therapy: a randomized prospective controlled trial. World Journal of Orthodontics 8: 300–306
- Hichens L *et al.* 2007 Cost-effectiveness and patient satisfaction: Hawley and vacuum-formed retainers. European Journal of Orthodontics 29: 372–378
- Houston W B J 1989 Incisor edge-centroid relationships and overbite depth. European Journal of Orthodontics 11: 139–143
- Little R M 1975 The irregularity index: a quantitative score of mandibular anterior alignment. American Journal of Orthodontics 68: 554–563
- Little R M, Riedel R A, Årtun J 1988 An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. American Journal of Orthodontics and Dentofacial Orthopedics 93: 423–428
- Littlewood S J, Millett D T, Doubleday B, Bearn D R, Worthington H V 2006 Retention procedures for stabilising tooth position after treatment with orthodontic braces. Cochrane Database Systematic Review 25: CD002283
- Mills J R E 1968 The stability of the lower labial segment. A cephalometric survey. Dental Practitioner and Dental Record 18: 293–306
- Nanda R S, Nanda S K 1992 Considerations of dentofacial growth in longterm retention and stability: is active retention needed? American Journal of Orthodontics and Dentofacial Orthopedics 101: 297–302
- Peck H, Peck S 1972 An index for assessing tooth shape deviations as applied to the mandibular incisors. American Journal of Orthodontics 61: 384–401
- Ponitz R J 1971 Invisible retainers. American Journal of Orthodontics 59: 266–272
- Proffit W R 1978 Equilibrium theory revisited: factors influencing position of the teeth. Angle Orthodontist 48: 175–186
- Reitan K 1967 Clinical and histologic observations on tooth movement during and after orthodontic treatment. American Journal of Orthodontics 53: 721–745
- Rowland H *et al.* 2007 The effectiveness of Hawley and vacuum-formed retainers: a single-center randomized controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics 132: 730–737

Copyright of European Journal of Orthodontics is the property of Oxford University Press / UK and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.