

# Paying attention to retention

Invisalign practitioner and clinical speaker Paul Humber examines the subject of retention

As Jane Austen might have said, had she been a dentist, 'It is a truth universally acknowledged that teeth in possession of orthodontic treatment must be in want of a retainer.' But what is best practice for retention, and what thinking underpins the protocols? This article presents a 'How To' for orthodontic retention along with a detailed overview of the background research in this area.

## Background

In 2002 Linklater *et al*<sup>1</sup> evaluated post-treatment changes in 100 consecutively started patients at a reputable university orthodontic department in the UK. The patients were 'at least five years post-retention' and the study concluded, 'Occlusal deterioration after orthodontic treatment is almost universal.' Various authorities have sought to add nuance and insight to such an observation. They have, on the one hand, sought to establish that some orthodontic appliances are better than others at achieving long-term stability, while some feel it is the treatment plan itself that may dictate the outcome. Yet more authorities seek to show that the original nature of the malocclusion may have the most influence on subsequent events.

De Freitas *et al* conducted a study of 87 patients treated with the extraction of four first premolars and edgewise mechanics<sup>2</sup>, five years after treatment, published in 2007. They concluded that, 'The greater the quality of the orthodontic finished occlusion... the greater the amount of relapse.' Brian *et al*<sup>3</sup> evaluated 100 post-treatment cases and drew similar conclusions, 'Well-treated cases tended to deteriorate, and poorly finished cases tended

to improve, illustrating a regression to the mean.' Williams *et al*<sup>4</sup> meanwhile, when taking an overview of evidence-based dentistry in this field, concluded that 'Arch expansion shows worse levels of relapse' and, 'Extracting teeth does not guarantee future stability.'

All clinicians have their instincts about which malocclusions worry them the most. It may be considered, at one extreme, that if one solitary lateral incisor is 'pushed over the bite' into a positive overjet and overbite, then this may be inherently stable; at the other extreme, however, addressing anterior open bites tends to be thought of as a course of treatment that will readily relapse. Certainly there is evidence to support the latter view: a 10-year longitudinal study of patients treated orthodontically to address anterior open bite showed that 35% of patients demonstrated a 'post-retention open bite of 3mm or more.'<sup>5</sup>

In the light of the above, it is not too surprising therefore that Littlewood *et al* (2006) in their Cochrane review<sup>6</sup> concluded, 'To prevent relapse, almost every patient who has orthodontic treatment will require some type of retention.'

The question therefore is what sort of retention is most efficient, how it should be delivered, and for how long.

## Fixed vs removable retainers

In the light of the almost universal propensity for teeth to relapse, it may be tempting to believe that a clinician should consider fixed retention. MacDonald *et al*<sup>7</sup> when discussing lower incisor relapse in their review of evidence-based dentistry stated, 'The only real guarantee would be permanent retention... this might be a bonded wire retainer, lingual to the lower incisors (Figure 1a), or a removable retainer worn on a part time basis, both of which have dental health implications.' Various types of fixed and removable retainers have been investigated for their efficacy and durability. Rose *et al*<sup>8</sup> investigated the longevity of multi-strand wire placed lingually, compared to the use of polythene ribbon. In what was described as a well-designed study by a Cochrane review, the ribbon-reinforced retainer was shown to fail more often than the wire. A common



Figure 1a: Fixed retainer



Figure 1b: Hawley retainer



Figure 1c: Vacuum-formed retainer (Essix retainer)

gut instinct amongst clinicians is that a fixed retainer would be more effective at controlling the teeth than a removable retainer, but doubt has been cast on whether this is so. Tynelius *et al*<sup>9</sup> studied 75 patients over a year who were randomly assigned varying combinations of vacuum-formed retainers, positioners, fixed lower anterior tooth retention and interproximal reduction in the lower anterior region. It was concluded that all groups demonstrated excellent levels of retention. A theoretical advantage of avoiding fixed retention is that periodontal and gingival condition can



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be monitored and treated more effectively, but Booth *et al*<sup>10</sup> studied sixty patients who had fixed retention for a minimum of 20 years and found there to be no detrimental effects to the periodontal health. However, fifteen of these patients had had their retainers removed for a variety of reasons, including concerns about oral hygiene and gingivitis, and only 28 of the original 60 patients had had no issues whatsoever over the 20 years; for example they did not need the fixed retainer repaired or replaced.

**Hawley v vacuum-formed retainers**

Of the removable retainers available, the most commonly used appliances are Hawley retainers (Figure 1b) and vacuum-formed ‘Essix’ retainers (Figure 1c). Sauget *et al*<sup>11</sup> demonstrated that if the clinician is trying to get the occlusion to ‘settle in’, then a Hawley retainer may be preferable to vacuum-formed retainers. Littlewood *et al*<sup>6</sup> considered that there will be instances where ‘settling of the occlusion... could be considered a beneficial type of relapse’ in the hope that there will be an increase in the number of occlusal contacts.

The latter notwithstanding, a large scale randomised controlled trial was conducted whereby 397 patients were assigned either vacuum-formed retainers or Hawley retainers, with the results evaluated over a six month retention period<sup>12</sup>.

The results showed ‘significantly greater changes in the irregularity of the incisors in the Hawley group.’ It was concluded that vacuum-formed retainers are more effective at holding the correction of maxillary and mandibular labial segments. This study has been cited as a good example of evidence based dental research<sup>13</sup>. As a result, a large number of clinicians prefer vacuum-formed retainers over Hawley retainers, and in cases where the clinician is hoping for the posterior occlusion to ‘settle in’, some authorities recommend that the vacuum-formed retainers can have the molar section removed completely, or trimmed to be thinner occlusally<sup>14</sup>.

Another aspect when considering choice of retainer may be their durability. Sun *et al*<sup>15</sup> studied 120 patients who were randomly assigned Hawley or vacuum-formed retainers. They concluded that survival times of both appliances were similar, that lower retainers in either instance are more prone to fracture, and that patients are more likely to mislay clear retainers.

Table 1: Features of Vivera versus Essix retainers

Features	Vivera	Essix
Patient’s dentition on file for future retainer orders	Yes	No
Made from Clincheck stage	Yes	No
Made from new PVS impression or oral scan	Yes	Yes
Pontic support	Yes	Yes
Bonded wire support	Yes	Yes

**Essix v Vivera retainers**

If vacuum-formed style retention is the best option, how best should these retainers be constructed? In a retrospective audit conducted at our own dental practice we compared two different vacuum-formed style retainers that had been provided to orthodontic patients post-treatment. Laboratory records were analysed to ascertain patients who had been provided with Essix and Vivera retainers more than one year previously, and the patients were contacted to ascertain whether the retainers had deteriorated in the view of the patient during their first year of wear. The nature of the deterioration was recorded. Patients who reported that they wore their retainers either full-time or every night were included in the study. Patients who wore their retainers less often were not included, and if a patient could not be contacted, they were not included. A typical patient would have worn a retainer full time for three to six months, and every night thereafter.

The Essix retainers were obtained from one local laboratory. They were formed from plaster models created from alginate impressions. The Vivera retainers were obtained from Align Technology. Vivera retainers can be created by either taking a PVS impression of the full dental arch or arches, they can be created by an intraoral scan, or they can be created digitally by using the information previously used to create an Invisalign aligner as part of the Invisalign system of orthodontics. By chance, all the Vivera retainers in this study were created through the latter, digital, method. The template upon which Vivera retainers are formed is created digitally via stereolithography and finished by a robotic and automated factory system. If there are any teeth missing from the arch, they can be added as a pontic digitally by the software, and the tooth shape thus created can be filled in by hand with the relevant colour pontic material; this might either

Table 2: Vivera versus Essix retainers at 1 year:

	Vivera	Essix
Number of retainers studied	87	58
Presence of fracture	4 (5%)	21 (36%)
Broken, completely unusable	1 (1%)	21 (36%)
Discoloured but functional	15 (17%)	0 (0%)
Lost	14 (16%)	3 (5%)
Functioning (after 12 months of wear)	72 (83%)	34 (59%)

be to help prevent over-eruption from the opposing arch or to aid the appearance when the retainer is worn. Similarly a good laboratory should be able to add a pontic to an Essix retainer. In the case of both the Essix and the Vivera retainers a lingual fixed retainer can be accommodated, and the retainer can be either cut short of the fixed retainer or can be placed over it (Table 1).

A sample of 87 Vivera retainers was included in the study. During the study period four (5%) were reported as broken; in two of these cases there was a tear that progressed from the gingival margin but had not spread beyond the occlusal surface, in the third instance the tear resulted in the retainer splitting into two pieces, and in the fourth instance the tears were incomplete but along the cusp of a canine and a first premolar. A total of only one Vivera retainer was therefore unusable at all (1%). Fifteen (17%) of the Vivera sample were reported by the patient as discoloured but functioning. A further fourteen were lost by the patient (16%). By contrast 58 Essix retainers were studied. 21 fractured (36%) – in each case the fracture was complete, and ran lingually/palatally to labially. None were reported as discoloured, but the mean longevity of the Essix retainers was lower than for Vivera and so there was less time for the Essix retainers to discolour. Three Essix retainers (5%) were reported as lost (Table 2).

These findings are in line with previous *in vitro* research undertaken by Align Technology, which has also demonstrated that Vivera displayed greater durability and longevity compared to proprietary vacuum-formed retainers (83% of Vivera retainers were in use/functioning at 1 year versus 59% for Essix retainers).

It is inevitable that patients lose retainers or that on occasion they deteriorate, so Align Technology supplies the retainers in packs of

three along with instructions for their use and care, and a protective storage case; they may be supplied as either three uppers or three lowers, or three uppers and lowers together in the pack. If there are no changes to the dentition thereafter, further supplies can then be ordered via their website without further impressions being necessary because digital records have been retained. The patient does not need to be a previous Invisalign patient, but the clinician does need to be Invisalign certified.

### How long and how much?

Littlewood *et al*<sup>6</sup> when conducting their Cochrane review are very firm in their conclusion that, 'There is currently insufficient evidence on which to base the clinical practice of orthodontic retention.' So how might we go about forming a clinical protocol for our daily practice?

Firstly it may be worth considering the periodontal factors that are involved. Robert-Harrys *et al*<sup>16</sup> point out that with most orthodontic treatment, 'When an orthodontic force is applied, the tooth is displaced many more times more than the periodontal ligament. Bone bending must therefore occur to account of the tooth movement over and above the width of the periodontal ligament.' Clearly if there was no retention in the early weeks after orthodontics then this 'bone bending' would cause the teeth to move back almost immediately. This effect should be minimised by at least one of the new generation of orthodontic techniques. The Invisalign system has computer-assisted treatment planning at its core. The computer charts six points on every tooth in both dental arches and plots the movements that each point will be required to make in order to achieve alignment. The one point in the entire arch that has the longest journey or requires the most rotation is identified by the software, and this one point will be set to move at the speed which is known to be biologically compatible. This will typically be 0.2mm movement in any two weeks, or 2 degrees of rotation, or 1 degree of root torque. This will determine the notional length of time needed to align the arch as a whole. Every other point in the entire dental arch will then be set by computer to move, when possible, at a speed that spreads their journey out over that length of time. As a result most points on most teeth in the entire dental arch will move at a speed that is known to be considerably within the tolerances and pressures that are best practice to allow maximum dental,

periodontal and osteoid health<sup>17</sup>. This is a massive step forward for orthodontics and among the many outcomes will be that 'bone bending' will be minimised by such treatment.

The next question is how long does it take for the periodontal fibres to replace and remodel to the new tooth position? It was demonstrated<sup>18</sup> that it takes on average a minimum of 232 days for fibres to remodel as required. However, there is plenty evidence that suggests that if retention were to be withdrawn at this stage then relapse would still occur<sup>1,19</sup>.

Why might this be? There could be muscular pressures on the teeth, such as a tongue thrust; there could be an issue with what is often called the 'neutral zone' between the pressures of the tongue and lip<sup>7</sup>; there could be skeletal issues or eccentric forces in the occlusion. More intriguing, is the

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finding that even in an occlusion that has not undergone orthodontics there will be long-term changes. The intercanine distance and arch length have a tendency to reduce with age; while the intermolar distance tends to increase in males as time passes, but decrease in females. This is an effect that continues beyond the age of forty, albeit at a slower rate<sup>19</sup>. As mentioned previously in this paper, therefore, retention will be needed to some degree for most patients for life, particularly given that patients are becoming more and more interested in having straighter, whiter teeth to an ever higher standard.

Given the three different mechanisms discussed above that come into play to cause relapse, we can see there may be a case for an early regime of wearing retainers more or less full time, and that this may be reduced in terms of hours per day in later months. A study comparing two retention regimes worn by 38 patients was conducted<sup>20</sup> in 2003 which demonstrated that a regime of wearing a Hawley retainer for six months followed by six months at night had a better outcome than a regime of three months full time wear followed by three months at night. The results in both cases were evaluated three months after

retention was discontinued. Both groups did show a marked degree of relapse however.

When one considers the overall conclusions of the studies cited in this article it is clear why, when looking for long term efficacy and durability, authorities such as Brandt<sup>21</sup> recommend the use of Vivera retainers full time for six months and then every night for a further nine months. After that it would be considered prudent for a patient to wear their retainers alternate nights for many years to come, if not forever.

### Conclusions

The use of long-term retention after orthodontic treatment can be considered more or less mandatory regardless of the nature of the treatment or the nature of the original malocclusion. Vacuum-formed retainers may offer the best option in terms of keeping the alignment of the arch. If the clinician is attempting to allow the occlusion to 'settle' in the molar region, the retainer can be modified by cutting or trimming it in the molar region.

Vivera retainers appear to have a greater longevity than domestically made Essix retainers. Essix retainers will require an impression, probably alginate. Vivera retainers can be created digitally, without further impressions, by Align Technology if the patient has been treated with Invisalign; the retainer being the same shape as an aligner that is known to fit well. Alternatively, the Vivera retainer can be created with a PVS impression or using an intraoral scan by a certified Invisalign provider. A typical regime for retention may be for the patient to wear the Vivera full time for six months, every night for nine months, and alternate nights thereafter.

If fixed anterior retention has been used, then the periodontal and gingival condition must be carefully supervised. Such retention may still deteriorate and therefore it is best practice to also provide some Vivera or Essix retainers which could be used to assist retention in the buccal segments particularly if the active treatment involved arch expansion. In cases where only the labial segments were treated, these retainers may be needed by the patient in emergencies if the fixed retention is lost or broken. The Vivera or Essix retainers can be constructed to envelope the fixed retainer, or they can be designed to stop at the line of the fixed retainer.

For a full list of references please send an email to [andy.myall@fmc.co.uk](mailto:andy.myall@fmc.co.uk)