Retention: taking a more active role

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Key points

- Clinicians are encouraged to anticipate relapse tendencies and consider the use of proactive retention strategies.
- Proactive or reactive retentive strategies may be applied to address alignment and the three planes of space.
- Retainers may also be adjusted for use in special circumstances, such as the replacement of missing teeth.

Abstract

Retention may be particularly challenging after the correction of specific malocclusion features, such as tooth rotations, open bite and expansion, which are all inherently unstable. In this article, some indications for active retention are reviewed by highlighting a variety of clinical techniques and appliances. Active retention is discussed in relation to preservation of tooth alignment and in the three planes of space: sagittal, vertical and transverse. In some situations, an active retention regimen may be helpful to minimise or counteract relapse after orthodontic treatment and to improve patient satisfaction during the typically lengthy post-treatment period.

Introduction

The challenge of preventing unwanted tooth movement following orthodontic treatment is well known to every experienced orthodontist. While much of our literature has focused on preventing relapse of alignment, undesired changes also occur in the anteroposterior, vertical and transverse dimensions. For stabilisation of alignment, we often prescribe bonded retainers on the anterior teeth, removable wire and acrylic retainers, or vacuum-formed retainers. Usually, we would consider these retention devices to be passive, as they are only intended to maintain alignment. However, we may also choose to employ retainers with features that will help prevent anticipated relapse, or address relapse once it has been observed. We might consider these types of retainers to be active retainers, either 'proactive' or 'reactive', respectively. The physiologic recovery of the periodontal structures, the persistence of deleterious oral habits, neuromuscular imbalance and continued facial growth all contribute to the complexity of retaining orthodontic correction.[1] Anticipation of relapse tendencies and the use of proactive retention strategies should be routinely considered, especially for malocclusions that are known to be particularly unstable, such as anterior open bites and maxillary constriction.[2,3]

In this article, we review some indications for active retention, highlighting a variety of clinical techniques and appliances. We first discuss active retention in relation to alignment and then address active retention in the three planes of space: sagittal, vertical and transverse. We also present examples of alterations to retainer design in special situations, such as replacement of missing teeth.

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Alignment

Relapse of anterior tooth alignment is the most common problem following the completion of orthodontic treatment. Removable or fixed retainers may be used in the maintenance of alignment of anterior teeth, but only 30–50% of patients demonstrate satisfactory alignment after ten years.[4] There are currently insufficient data regarding the best retention regimen to maintain the alignment of anterior teeth. A prospective randomised controlled trial compared the effectiveness of vacuum-formed and bonded retainers for 18 months after the removal of orthodontic appliances.[5] Within the first six months, relapse was found to be more likely to occur with vacuum-formed retainers when compared to fixed retainers, although the observed relapse was minimal.[5] After the first six months, no significant differences were noted between these two different retention methods.[5]

Patients often notice minor relapse of alignment of the anterior teeth, usually in the lower arch. There are many methods that can be utilised to 'reactively' recover from this type of relapse, including spring retainers, positioners, reset or modified vacuum-formed retainers, a series of clear aligners, a short period with fixed appliances, or bonded active retainers (Fig. 1). The latter, however, need to be carefully monitored over time to prevent unwanted side effects, even when they are no longer active.[6]

Positioners have historically been used for achieving the final posterior alignment and occlusal relationships of the teeth, allowing orthodontic appliances to be removed

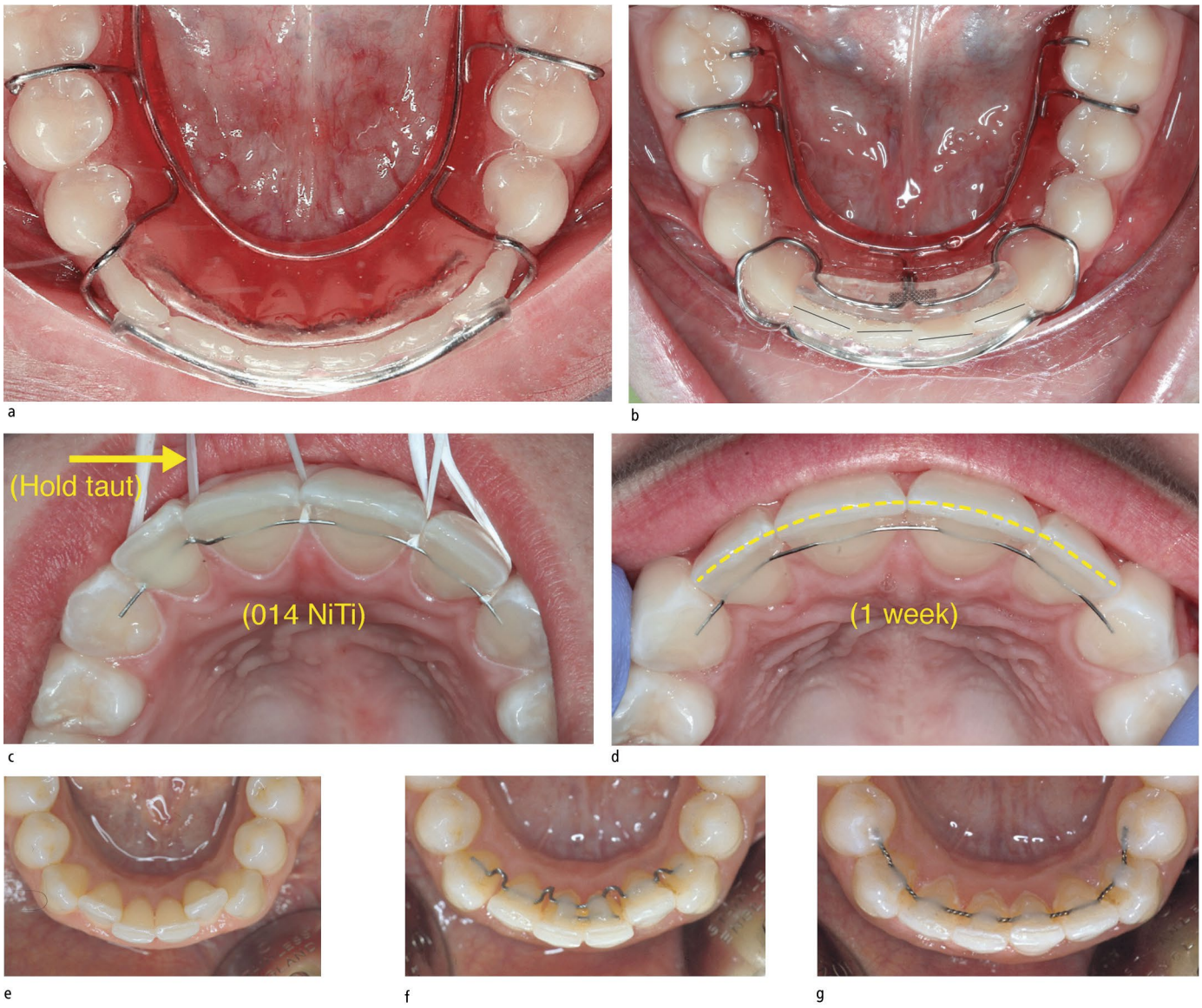

Fig. 1 Misalignment of upper and lower incisors can be proactively or reactively retained using a) passive retainers, b) spring retainers, or c, d, e, f, g) bonded active lingual retainers. Images 1e, 1f and 1g are courtesy of Dr Marino Musilli, Salerno, Italy

sooner.[7] While positioners do improve the final occlusion, they may not lead to increased occlusal contacts.[7] Also, the amount of tooth movement that can be incorporated into one positioner is limited and compliance is often challenging. Positioners have largely been replaced with a short series of commercial or in-office aligners after the removal of fixed appliances.

A novel method for addressing minor relapse in the alignment of the anterior teeth involves bonding a segmented, active 0.014" nickel-titanium wire to the lingual surfaces of these teeth.[8] This technique has been shown to resolve crowding in one week to three months, after which point the nickel-titanium wire is replaced with a passive bonded lingual wire retainer.

Active lingual retainers may also be used in carefully selected cases to address moderate crowding (Figures 1e, 1f and 1g)9

Another technique to recover from minor anterior relapse is to utilise a vacuum-formed retainer that has been cut on the incisal edge from canine to canine.[10] This technique allows the vacuum-formed retainer to have more flexibility and to gradually re-align the anterior teeth, similar to a spring Hawley retainer.

Patients who present with spacing may tend to have spaces reopen in the short term, although they typically close eventually.[11] For these cases, the labial surfaces of the anterior teeth may be reduced slightly on the stone models before fabrication of the retainer, in order to provide a light force to maintain space closure.[11]

The sagittal plane

Anteroposterior occlusal correction can be undertaken in the mixed dentition, as phase one of a two-phase treatment, or in the permanent dentition, during a single phase of comprehensive treatment. There has been considerable debate surrounding the relative merits of class II correction with these approaches, with systematic reviews of randomised controlled trials reporting that two-phased regimens are no more effective and are less efficient than single-phased approaches.[12] However, a two-phased approach for class II patients may be beneficial in terms of reducing dental trauma and reducing psychosocial issues, such as teasing.[13]

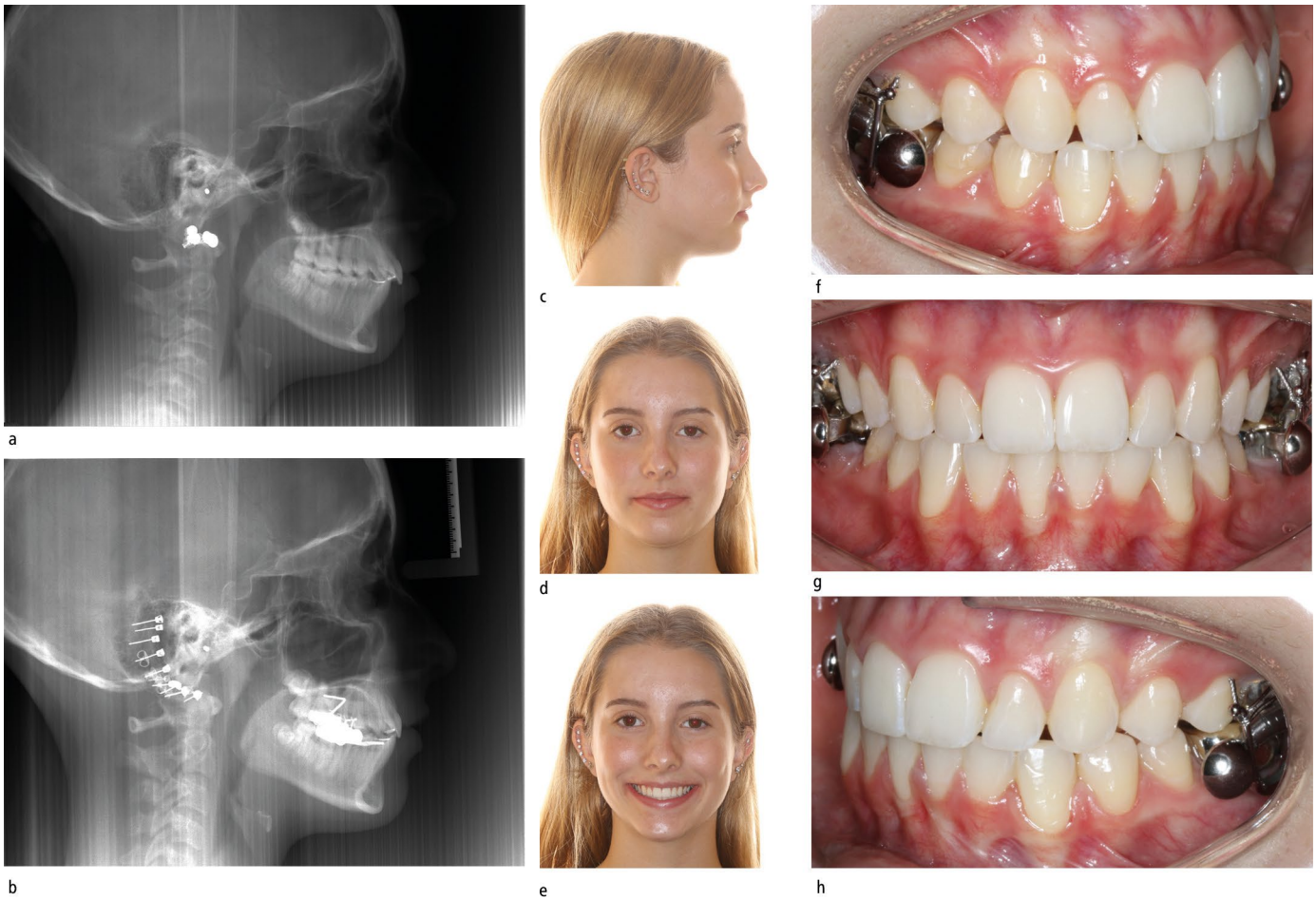

Fig. 2 A functional appliance can be used at the end of treatment, in the absence of braces, to provide non-compliant correction of remaining overjet. Example of 'MARA' used during retention in conjunction with upper and lower canine-to-canine fixed lingual wires

Two-phased approaches do, however, increase the burden of care and may benefit from an intermediate period of proactive retention between the early class II correction and comprehensive treatment. Specifically, retention of class II correction can be accomplished with several strategies such as part-time use of removable appliances. A functional appliance, such as the Herbst appliance or the Mandibular Anterior Repositioning Appliance (MARA), can be used at the end of treatment, in the absence of braces, to provide non-compliant correction of remaining overjet. These 'Herbst or MARA retainers' are used in conjunction with upper and lower canine-to-canine fixed lingual wires for approximately six months after debonding (Fig. 2).

The stability of class II correction at the occlusal level has been studied over prolonged periods and in conjunction with a range of treatment approaches, including functional appliance therapy and orthodontic camouflage. Overall, the stability of class II correction appears to be very good, with a systematic review involving 20 primary studies reporting relapse of 1.2 mm in buccal segment relationships over a 50-month period based on treatment-induced changes of 5.1 mm.[14] Similarly, relapse of 1.8 mm in overjet was observed over 63 months (based on a 6.5 mm reduction during treatment).[14] Furthermore, 86% of overjet correction was retained 32 years following treatment in one study, with the majority of relapse presenting in the first six years post-treatment with only minor changes thereafter.[15]

Stability of class II correction has been linked to compliance with retention regimes, the absence of habits, favourable growth and proper occlusal interdigitation, although the latter association has not been proven convincingly.[16] It would be intuitive to expect that patients with more severe class II skeletal patterns may be more susceptible to post-treatment change. Therefore, proactive retention might be considered for these patients after the completion of comprehensive therapy, especially if class II mechanics were employed until the end of treatment and the patient still has considerable growth potential.[17] These options are similar to those described between phase one and phase two treatment, as well as class II elastics in conjunction with vacuum-formed retainers.

Similar approaches have been advocated to retain anteroposterior correction in class III patients. For example, continued use of class III functional appliances is sometimes recommended in order to preserve the skeletal changes achieved with protraction face mask therapy.[18] The long-term effectiveness of protraction, however, remains controversial, as some of the changes are dento-alveolar in nature and patients may outgrow the correction during adolescence.[19]

As with class II patients, a proactive retention strategy for class III patients is class III elastics attached to vacuum-formed

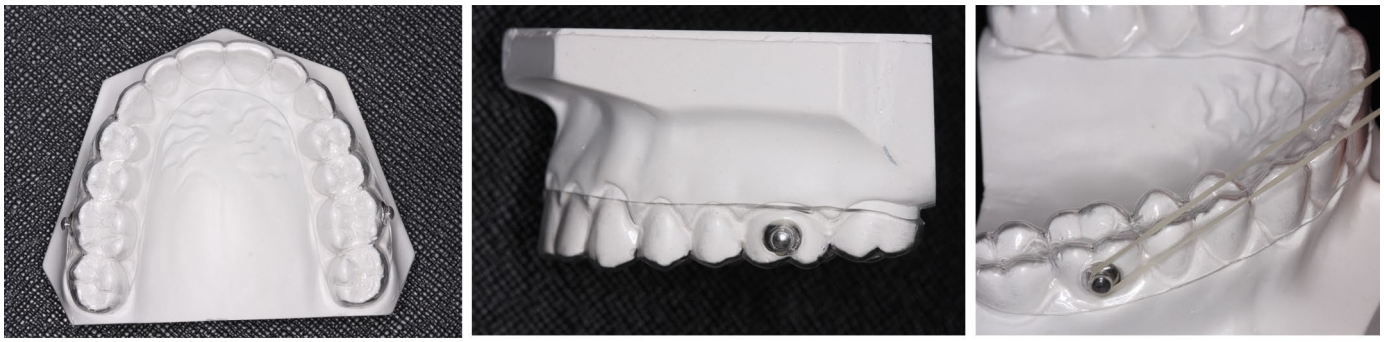

Fig. 3 Vacuum-formed retainer with bonded steel buttons to allow elastic wear for proactive retention of class III malocclusion

retainers (Fig. 3). Night-time wear may be challenging, as the appliances often dislodge under the direct pull of elastics. In these situations, bonded resin or steel buttons for the elastics may be considered, rather than attaching the elastics directly to the retainers.

The vertical plane: open bite malocclusions

Anterior open bite (AOB) is considered one of the more difficult malocclusions to treat and retain, and the stability of AOB correction has been the focus of a great deal of interest among orthodontists. Over the decades, numerous techniques and mechanics have been suggested to treat open bites, and more recently, aligners and temporary anchorage devices (TADs) have been introduced as treatment options. A survey conducted in the US reported that the prevalence of AOB in white children was 3.5%, while its prevalence in children of African ancestry was as high as 16.5%.[20] Despite its relatively low prevalence, orthodontic demand for the treatment of AOB is high. It has been estimated that up to 17% of patients presenting for orthodontic treatment have an AOB.[21] Depending on the severity of the AOB, it can be associated with significant functional, speech and psychological effects.[22,23]

Closure of AOB can be difficult to achieve and high rates of relapse are of primary concern.[2,24] Four broad treatment strategies can be considered: 1) observation or advice on early habit cessation (such as digit habits); 2) interceptive habit cessation treatment;

Fig. 4 Following closure of an anterior open bite, or following the observation of relapse, composite resin buttons may be bonded to the labial surfaces of maxillary and mandibular anterior teeth to permit wear of vertical elastics. Images courtesy of Dr Tae-Woo Kim, Seoul National University, South Korea

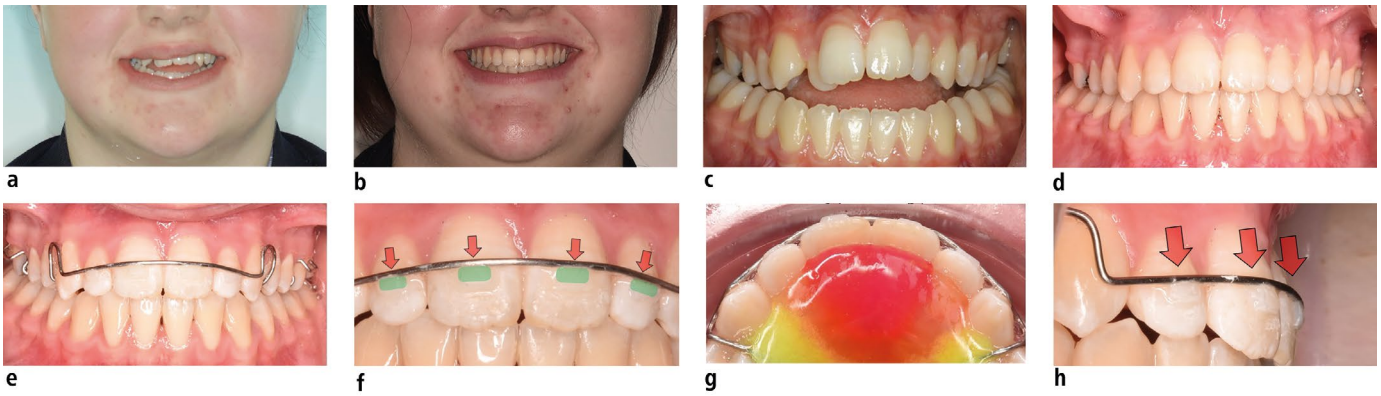

Fig. 5 Patients with severe open bite may refuse surgery and request compromised treatment. a, b, c, d) This patient was treated by a combination of posterior intrusion, anterior extrusion and maxillary expansion, which are at high risk of relapse. e) Proactive retention is achieved using a Hawley retainer, f, g) with the labial bow in slight contact with sharp-edged attachments bonded on the upper incisors to contrast their tendency to re-intrude. h) The proactive retention can be easily converted to reactive retention if the open bite returns, by slight modification of the labial bow loop, so that a light extrusive force is applied. Images courtesy of Dr Gracie Nichols, DClinDent student, University of Otago

3) dento-alveolar tooth movement with orthodontic appliances and/or mini-screws; and 4) orthodontic treatment in conjunction with orthognathic surgery.[25,26] A counter-clockwise rotation of the mandible is associated with TAD-supported molar intrusion.[27] The use of maxillary and mandibular TADs seems to be more effective than upper arch intrusion only.[27] By eliminating mandibular molar eruption while maxillary molar intrusion is in progress, a more reliable and successful counter-clockwise rotation of the mandible and open bite closure can be achieved.

The definition of stability for different malocclusions varies between investigators.[28] Millimetric units can be used to appraise AOB stability – changes greater than 2 mm are considered clinically significant, while changes greater than 4 mm are considered highly clinically significant.[29] Whatever method is used to assess treatment results over time, the maintenance of positive overlap between the maxillary and mandibular incisors is the goal.

The identification of aetiological factors (such as tongue posture, mouth breathing, condylar resorption etc) can be very helpful in developing active retention strategies. However, identification of aetiological factors can be difficult and the aetiology of the open bite could be multifactorial. Furthermore, the pattern of craniofacial growth may contribute to relapse of open bite.

For retention of AOB malocclusions, fixed retainers may be extended to first premolars in both arches. Although fixed maxillary retainers have not been shown to reduce post-treatment irregularities in alignment, anecdotal data support their use in patients with an open bite. When a relapse tendency is noticed in patients with AOB, one approach is to bond composite resin buttons to the labial surfaces of maxillary lateral incisors and canines, as well as mandibular canines, to allow vertical elastic wear (Fig. 4). If this method is used to maintain a positive overbite (an example of proactive retention), elastics can be used at night-time only. If relapse is noticed, full-time use of elastics can be recommended to increase the overbite (reactive retention). Resin buttons can also be used as a stop with a labial bow to counteract the tendency of extruded incisors to re-intrude (proactive retention), or to slightly extrude the incisors if they have already undergone some vertical relapse (reactive retention) (Fig. 5).

If TADs have been used to intrude posterior teeth, they may be left in place following cessation of active treatment. Once vacuum-formed retainers are fabricated, the patient can be advised to wear elastics to the TADs at night-time to maintain open bite closure. The TADs can be left in place for a period of 6–12 months after completion of treatment to ensure the stability of results. Good stability of implant-supported molar intrusion in long-face individuals has been reported.[30]

In general, aligners and vacuum-formed retainers are associated with bite deepening, and as such, vacuum-formed retainers are a good choice to retain open bites. The mechanism of action is thought to be that heavier occlusal forces are being directed to the posterior teeth, due to the occlusal coverage for the retainers. A simple method to increase this effect is to add an additional layer of material over the posterior teeth (Fig. 6d). The additional thickness will augment the intrusive force on the posterior teeth, which may further aid in maintenance of a positive overbite.

Positioners have historically been used by some practitioners immediately after the removal of orthodontic appliances to help the teeth settle into more ideal positions. The main effect of tooth positioners is in first-order alignment, but they have also been shown to deepen the bite.[7]

The vertical plane: deep bite malocclusions

In contrast, a deep bite is the excessive overlap of the incisors and is more common than open bites, being responsible for 92.5% of vertical dimension problems.[31] Deep bite malocclusions are associated with an increase in anterior alveolar bone height and a decrease in the posterior bone height.[32]

The two most important skeletal factors associated with increased overbites are the mandibular plane and gonial angle.[33] Regarding the dental components, a deep curve of Spee and increased eruption of upper incisors are the most common features behind deep bite malocclusions.[34,35] The optimal treatment approach is dependent on the tooth display at rest and while smiling.

Deep bite malocclusions have been shown to be more stable than open bites in a systematic review and most of the orthodontic correction is maintained in the long term.[36] In a long-term study on deep bite patients, in which relapse was defined as an increase in incisor overlap

to 50% or greater, only 10% of the study population displayed relapse when followed for an average of 11.9 years.[37] Although there is little data regarding methods of retention in deep bite cases, extraction does not seem to be a key factor in the stability of the results. According to a Cochrane review conducted in 2017, there is little evidence-based literature regarding the efficacy of extraction versus non–extraction orthodontic treatment in resolving deep bite malocclusion in class II division 2 cases.[38]

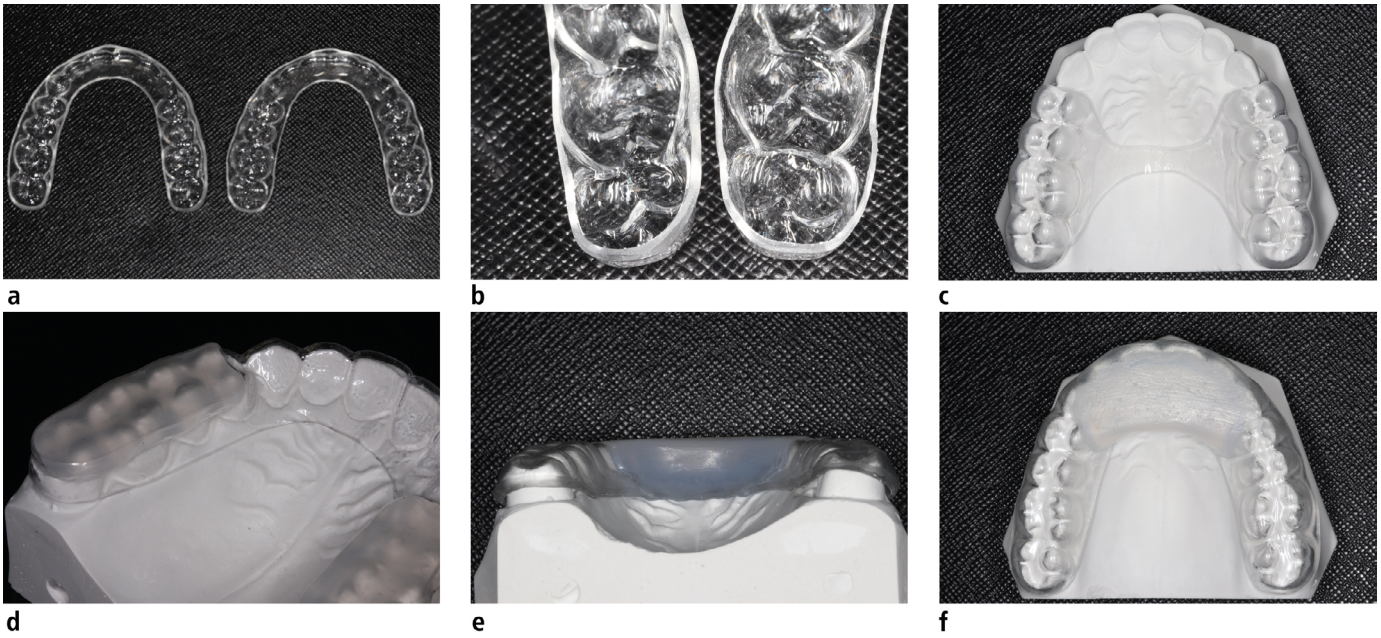

Fig. 6 Modifications to vacuum-formed retainers can be made to proactively retain more unstable forms of correction. Variation in retainer material or thickness may assist in maintaining significant increases in transverse dimensions, with retainer blanks ranging in dimension – a) 1 mm; b) 1.5 mm. c) Similarly, modifications can be made in order to maintain transverse correction by including posterior teeth only in the retainer, particularly during the transition from mixed to permanent dentition. In terms of maintaining vertical change, bite planes can be added in the d) posterior or e, f) anterior regions to control the relative vertical movement of anterior and posterior segments, in order to promote maintenance of correction of increased and reduced overbite, respectively

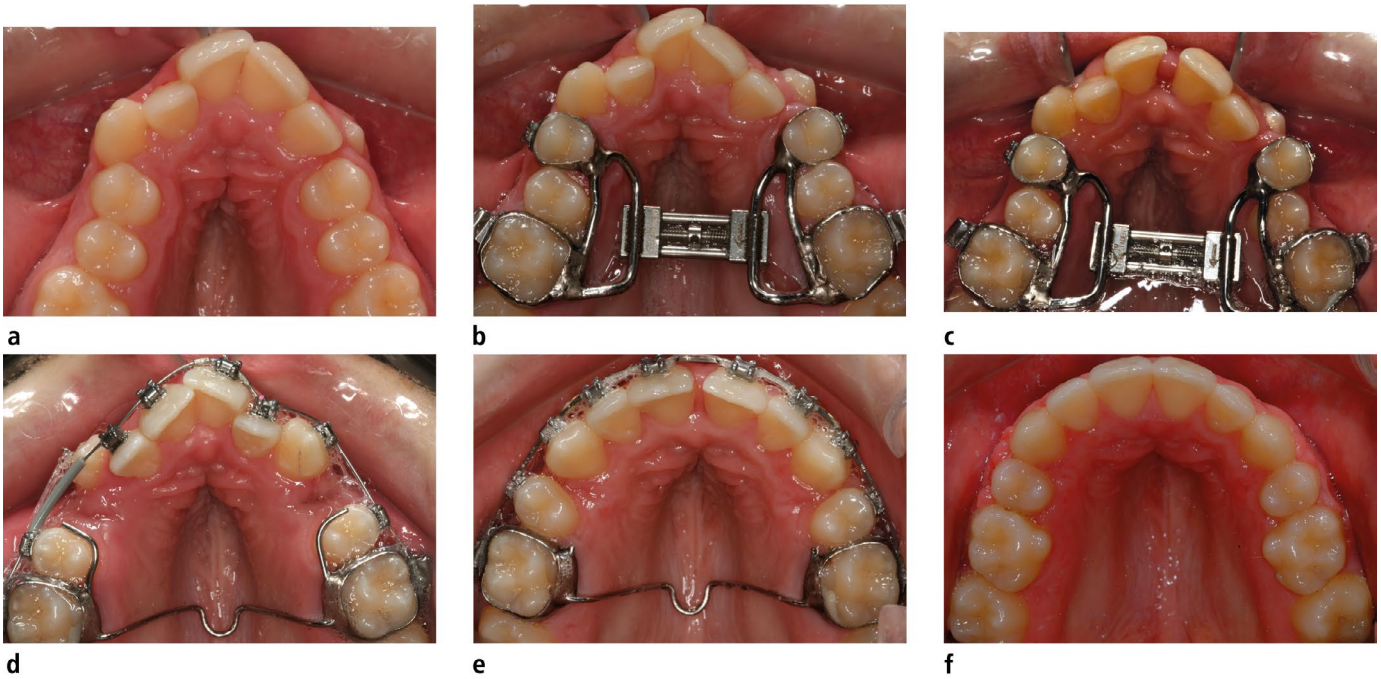

Fig. 7 Transverse expansion is known to be particularly unstable. a, b, c) Following active expansion, a rapid palatal expander (RPE) can be left in situ to maintain transverse dimensional change. This approach is acceptable if the transition to the multi-bracket phase is relatively seamless, with the RPE maintained for a period of approximately three months. d, e) However, in view of the associated bulk and need to perform independent movement of premolars relative to the maxillary molars, the RPE can be substituted for a rigid transpalatal arch. The palatal arch can incorporate mesial extension in order to preserve inter-premolar width changes before streamlining once rigid wires are in place. f) In view of the extent of expansion and transverse change obtained, assertive forms of retention will be required to obtain long-term stability

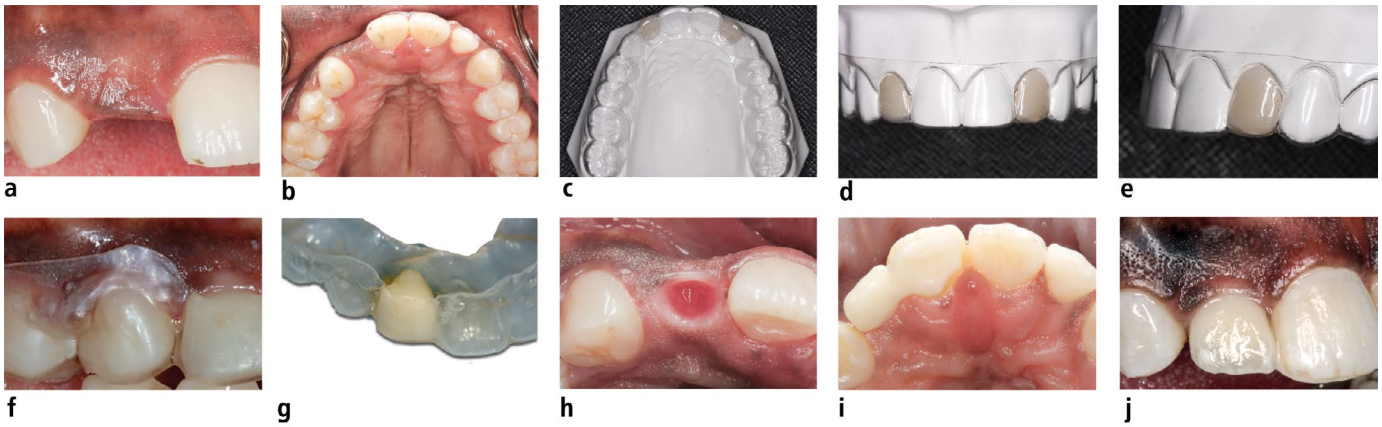

Fig. 8 a, b) Prosthetic replacement of the developmentally absent maxillary right lateral incisor was planned following orthodontics. c, d, e, f) A vacuum-formed retainer was fabricated with a prosthetic incisor to restore the aesthetics as an interim measure. g, h) The pontic was modified with additional resin-based adhesive to alter the gingival contour. i, j) This was worn over a four-month period to optimise the emergence profile for the subsequent adhesive bridge

Orthodontists have historically been less concerned about deep bite malocclusions in comparison to AOB, due to its lower tendency for relapse. Anterior bite planes associated with Hawley or vacuum-formed retainers (Figures 6e and 6f) may assist in maintaining the deep bite correction.

Transverse

The dentition is believed to be in a position of muscular balance supported by the periodontal ligament, alveolar bone and the gingivae.[39] Resting soft tissue pressures as well as metabolic activity within the periodontal membrane are the primary determinants of tooth position and arch form.[39,40] While intended alterations in arch form, dimensions and length may be required to achieve occlusal objectives, including correction of maxillary arch constriction and transverse inter-arch discrepancy, these changes may require prolonged and proactive retention due to the high potential for relapse (Fig. 7).[41] Resolution of crowding without interproximal reduction or extractions will usually result in incisor proclination and transverse expansion to varying degrees.[42]

While specific mechanics can predictably produce desired expansion, subtle arch form and dimensional changes also occur with conventional edgewise mechanics irrespective of the treatment protocol.[43] Maxillary inter-molar width changes of 2.8 mm were demonstrated in a study involving participants treated with fixed appliances without extraction.[44] While this magnitude of change is relatively minor, it is known to be unstable. Clearly, more significant transverse changes can be produced with alternatives, including both surgical and non-surgical rapid palatal expansion. These approaches are typically indicated in the presence of marked transverse issues and may necessitate proactive approaches to retention either following comprehensive treatment over a prolonged period or as an intermediate phase before comprehensive treatment.[3] The latter may be required either if expansion has been undertaken as a phase one approach in the mixed dentition or in the later mixed or permanent dentition as a prelude to comprehensive treatment. These retainers must be rigid enough to withstand the tendency for relapse from both the skeletal and dento-alveolar changes that were achieved during treatment (Figures 6a, 6b and 6c). As such, acrylic (Hawley-type) retainers have traditionally been advocated. These retainers may include expansion screws or springs for active retention. Excellent fit of the acrylic along the palatal surface of the expanded teeth is critical, and patients should be informed of both the importance of compliance and of the need to be seen by their practitioner if the retainer does not fit. The increasing versatility of vacuum-formed materials may offer a viable, user-friendly alternative, although there has been relatively little comparative research on this to date.

Retention of transverse changes in the mandibular arch generally receives little attention. The curve of Wilson and Monson's sphere should ideally be considered. To aid in preventing relapse, increases in these planes should be stabilised; for example, by providing a vacuum-formed retainer rather than an anterior fixed retainer only. In special cases in which there has been significant constriction or adjustment in the torque of the mandibular molars during treatment, the Wilson bar may be considered as an active retainer.

Tooth replacement during retention

Alteration to retainer designs may also be required in a variety of scenarios; for example, due to prosthodontic or periodontal requirements. In particular, absence of teeth places an onus on maintaining aesthetics both during and after treatment. As such, modifications can be made to retainers to incorporate prosthetic acrylic teeth during the pre-prosthetic retention period (Figures 8c, 8d and 8e). These pontics can also be altered in order to sculpt the gingival architecture to enhance the emergence profile of the definitive restoration Figures Please replace 'Fig. 8a' with (Figures 8i and 8j). Alternatively, fixed retainer designs replicating adhesive bridgework, referred to as Maryland bridge-like retainers, can be added during treatment as an interim measure to enhance the appearance once the edentulous space has been optimised, while other treatment objectives are achieved, or at the end of treatment as a temporary restorative retainer. Cantilevered resin-bonded bridges are generally preferred over fixed-fixed designs.[45,46]

Conclusions

Many clinicians use a standard treatment protocol and they may also employ a standard retention protocol. However, each patient presents with unique factors that may decrease or increase their propensity for relapse. Therefore, clinicians should identify these factors and appropriate retention strategies

should be designed to counteract them. Active retention may be indicated to maintain alignment or correction in any of the three planes of space. Hopefully, this will help to minimise relapse after orthodontic treatment, and if relapse does occur, reactive retention techniques can be utilised. Both are helpful to increase clinical efficiency and improve patient satisfaction during the typically lengthy post-treatment period.

Conflict of interest

The authors declare no conflicts of interest.

Acknowledgements

Sepideh Torkan and Fiona Firth contributed equally to this paper.

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