

## FEATURES SECTION

# How to effectively use a 2 × 4 appliance

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A mixed dentition treatment can efficiently and effectively be provided using a 2 × 4 appliance. The indications for early treatment are discussed and advantages of fixed appliances over traditionally used removable appliances illustrated using four case reports.

*Key words:* 2 × 4 appliance, mixed dentition, early treatment

## Introduction

Interceptive treatment is usually carried out in order to reduce the severity of a developing malocclusion. This type of treatment is very often indicated and carried out in the mixed dentition, and brings with it unique challenges.

Three of the most common conditions that are referred to a specialist orthodontist for early treatment are that of an anterior crossbite, a posterior crossbite, and delayed eruption of a central incisor due either to impaction or ectopic position.

Timing of orthodontic treatment has always been the subject of much debate over the years, with many variables being studied in depth. Areas investigated include:

- clinical effectiveness<sup>1,2</sup>
- psychological benefits<sup>3</sup>
- influences on the duration and outcome of treatment<sup>4,5</sup>
- cost effectiveness<sup>6</sup>

Evaluations have also been carried out both on the timing of crossbite correction and the impact of missing anterior teeth. White<sup>7</sup> stated that both anterior and posterior crossbites require early correction for functional reasons and the correction of an anterior crossbite is also required for aesthetic reasons. It has been found that dental features were the fourth most common target for teasing, but comments made about teeth were considered to be more hurtful than any other feature especially in the 9–10 year age group.<sup>8</sup>

Ninou and Stephens<sup>9</sup> stated that crossbites with a functional displacement require treatment and that a maxillary fixed appliance is their preferred technique.

Gu<sup>10</sup> found that, in a group of 17 consecutive patients with anterior crossbite, average treatment time was 8½ months using a 2 × 4 appliance and no relapse found at follow-up 1 year later, even though no retainers were used after debond.

Evidence seems to suggest that a short course of orthodontic treatment in the mixed dentition may improve function and aesthetics, reduce the potential for teasing and remain relatively stable once the appliance is removed.

## Considerations for correction of an anterior crossbite

An anterior crossbite is present when one or more of the upper incisors are in linguo-occlusion (reverse overjet). This may involve just a single tooth or could include all four upper incisors. This clinical condition is frequently associated with a displacement on closure or a developing Class III skeletal base relationship.

Crossbite of one or two teeth is usually found in patients with normal facial proportions due to the lack of space for the erupting permanent dentition. The developing tooth buds of the permanent teeth are positioned palatal to their deciduous predecessors. It is rare to find all four upper incisors in linguo-occlusion except in patients who have a Class III skeletal base relationship. It is prudent to warn these patients and their parents about the possibility of future unfavourable growth, and the need for later surgical intervention.

Factors to be taken into consideration include:

- presence or absence of an anterior mandibular displacement
- possible damage that has or might occur to the dentition through excessive tooth wear, or to the supporting periodontal structures
- prevention of establishment of the developing malocclusion
- space availability – this may be rectified by the early removal of both the upper deciduous canines
- the position of the developing permanent canines in relation to the roots of the lateral incisors
- the depth of the overbite

Satisfactory correction of an anterior crossbite is available with a removable appliance if purely tipping movement is required. If bodily movement is required, however, then the control afforded with a simple fixed appliance such as the 2 × 4 appliance is preferred. Also, in the case of rotated teeth, where a removable appliance would be of very limited benefit, fixed appliances allow the labial segment to be fully aligned.

A note of caution must be taken where, by uprighting of incisors, there could be damage due to the proximity of their roots with that of the crown of the developing permanent canine.

A major factor determining whether early correction of an anterior crossbite will be stable is the achievement of a positive overbite. If this can be attained, then the result should require no further retention. A bonded retainer may be placed on the palatal surface of upper incisors if the relapse potential is significant as this maintains the incisors in their corrected position until the occlusion becomes more established. It needs to be borne in mind that this 2 × 4 treatment is not necessarily a definitive course of orthodontic treatment and the patient should always be warned of this.

### Considerations for correction of a posterior crossbite

Posterior crossbites may involve just single teeth or include the entire buccal segment, and can be divided into the following categories:<sup>11</sup>

- unilateral buccal crossbite with displacement
- unilateral buccal crossbite without displacement
- bilateral buccal crossbite
- unilateral lingual crossbite
- bilateral lingual crossbite (scissors bite)

The most important consideration is the aetiology of the posterior crossbite. Factors to take into account include:

- The magnitude of the crossbite —does it involve a single tooth or an entire segment?
- Is there a displacement associated with the crossbite?
- How significant is the skeletal component and will it be possible to compensate for this discrepancy with tooth movement only?

If expansion is indicated at an early stage, then this can be carried out easily and simultaneously by adding a quadhelix to the 2 × 4 appliance.

### Considerations for correction of impacted/ectopic incisors

Impacted or ectopic incisor teeth can have a very significant effect on the psychological well-being of an individual, especially at a young age. There is also the potential for speech problems to occur. Due to the adverse effect that may be had on the child's social interaction and self-esteem, the problem of the impacted or ectopic incisor should be managed as early as reasonably possible.<sup>12</sup>

The incidence of unerupted maxillary incisors is not known exactly, although the prevalence has been reported as 0.13% in the 5–12 year-old age group.<sup>13</sup> In a referred population, this has been estimated as 2.6%.<sup>14</sup>

Causes of failure of eruption include:

- previous history of trauma
- early extraction of deciduous teeth allowing closure of eruption space or formation of fibrous gingival tissue
- retained deciduous teeth
- supernumerary teeth
- odontomes

Once the cause has been identified and dealt with, it may be that space needs to be created to allow traction to be applied to the affected tooth in order to bring it into the line of the arch.

The major advantages in carrying out this treatment with a 2 × 4 appliance are the ease with which space opening can be controlled with a fixed appliance, and also that the force magnitude and vector can be controlled much more precisely than with a removable appliance.

### Advantages of fixed appliances

- Minimal discomfort
- Reduces need for patient co-operation
- Increase control of tooth movements
- Movement possible in all three planes of space

### Disadvantages of removable appliances

- Appliance rarely worn full time
- Appliance damage/lost appliances
- Difficulty in speech/eating
- Gagging
- Decalcification/caries
- Gingivitis/palatal hyperplasia/fungal infections
- Incorrect activation produces unhelpful changes
- Allow only tipping of teeth

## Timing and length of treatment

Treatment may start as soon as sufficient permanent teeth have erupted and it is felt that the child is co-operative enough to have separators placed, bands cemented and brackets bonded. Placement of the fixed appliance usually only takes a little longer than the time required to fit a removable appliance and may be even carried out at a single visit. Another advantage is that no laboratory facilities are required. Although there needs to be patient co-operation for the placement, adjustment and removal of the appliance, the importance of compliance during active treatment is usually less than that for a removable appliance. It is still essential that the patient is capable of maintaining a high standard of oral health in view of the increased risk of demineralization associated with a fixed appliance.

Treatment carried out in this mixed dentition stage may take as little as a couple of weeks,<sup>15</sup> but in the more difficult cases can take longer. In the majority of cases, however, the end result can be more effectively and efficiently achieved than if a removable appliance was used.

Definitive treatment will probably still be necessary in the permanent dentition, but the complexity and duration of this may be significantly reduced.

## How to use the 2 × 4 appliance

The appliance described is versatile, easy to use and well tolerated by all patients. A series of case reports will follow identifying how versatile the 2 × 4 appliance is and how it can be adapted to treat the previously mentioned problems.

Many of these problems have been treated traditionally with upper removable appliances. However, the authors' belief is that the 2 × 4 appliance, when used correctly, will give a more controlled approach to tooth movement in all three dimensions and a more predictable outcome.

## The 2 × 4 appliance design

The basic 2 × 4 appliance design is as follows:

- bands cemented on both upper first permanent molars
- brackets bonded onto the erupted maxillary incisors
- continuous archwires to provide/maintain good arch form, as well as control of anterior teeth
- supporting stainless steel tubing placed in the long archwire spans between the molars and incisors

The tubing is carefully shaped to the correct arch form and strengthens the long unsupported span of wire between molars and incisors. This protects the archwire from distortion due to occlusal forces, especially in early stages of treatment. The stainless steel tubing should fill the entire length of span unless space is required for the alignment of the anterior segment, in which case the tube is trimmed by 1–2 mm. If space is required by proclination of the incisors, a compressed nickel titanium coil spring is placed into a 2–3 mm gap. A quadhelix can be soldered to molar bands or palatal sheaths welded for provision a removable quadhelix if correction of a posterior crossbite is required simultaneously.

It is also important to anneal the 2 mm of archwire that is left protruding from the molar tubes to allow it to be turned down hard against the tube. This prevents the archwire sliding forward, thus preventing increase of arch length, trauma to the soft tissues or loss of control of the molar teeth

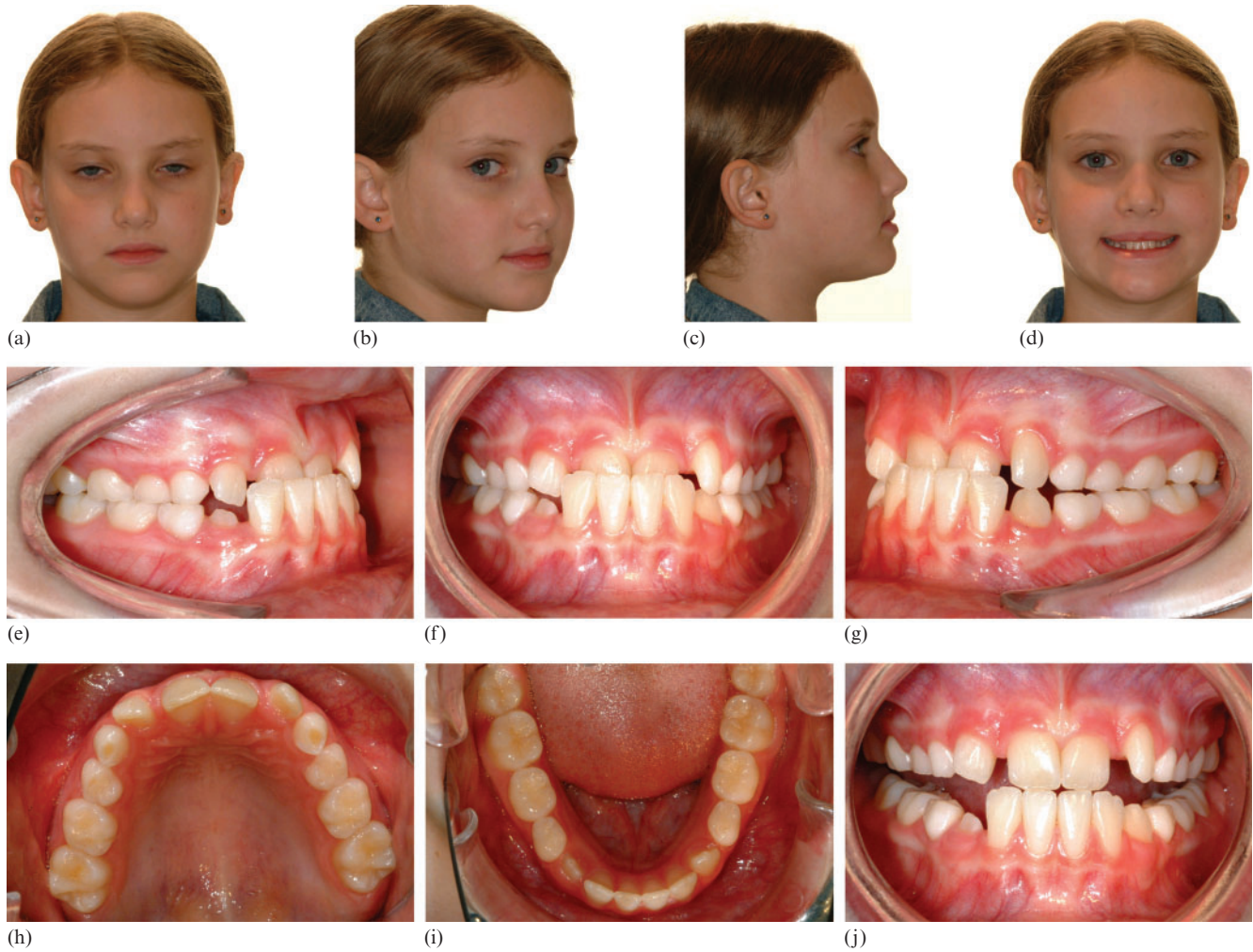
Progression through flexible 0.016-inch nickel titanium to rigid stainless steel wires is often very rapid as only the incisors are included.

## Case studies

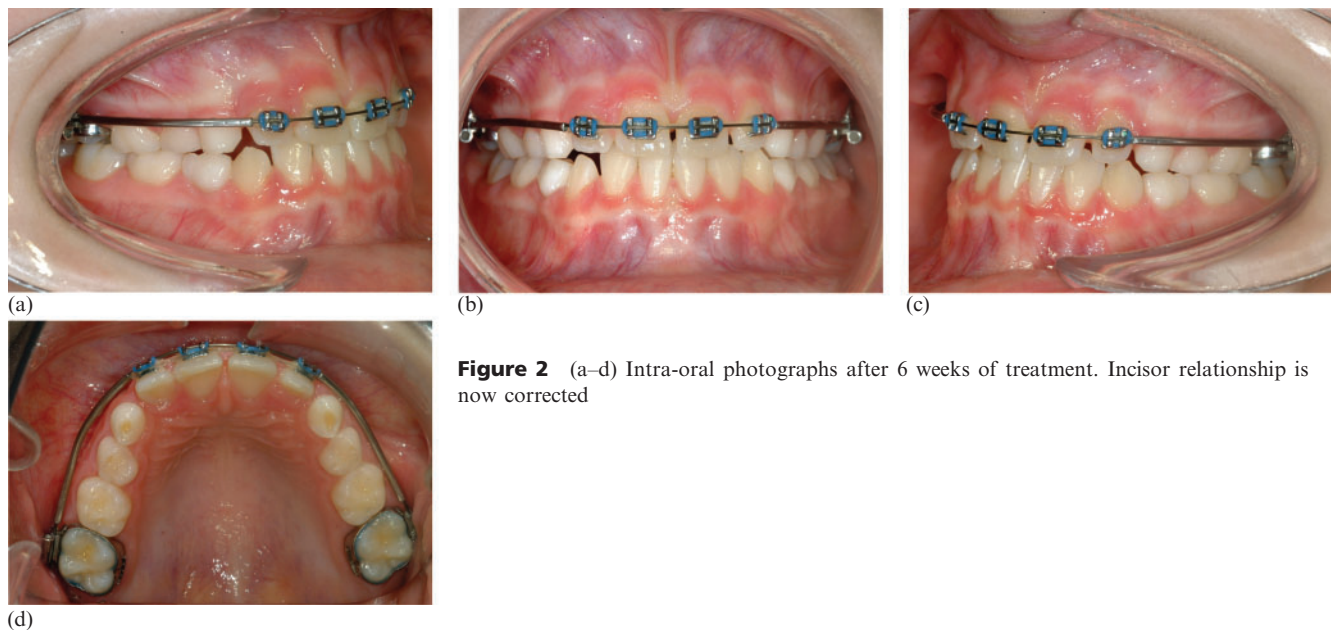
### *Case 1: rapid correction of retroclined central incisors*

A nine-year-old girl was referred by her dentist regarding both upper central incisors, which were in crossbite. She presented with a Class I incisor relationship on a Skeletal I base in the mixed dentition. The upper labial segment was spaced with the lower being well aligned. She had a premature contact on the central incisors with a resultant 2 mm anterior displacement on full closure (Figure 1a–j).

Bands were placed on both upper first molars and brackets were bonded to all the upper incisors with an initial aligning wire of 0.016 inch nickel titanium being placed. At the next visit, 5 weeks later, the overjet had been corrected. A 0.016 inch stainless steel wire was then placed with powerchain for a further 4 weeks to close any residual space and the patient was debonded (Figure 2a–d). Total treatment time was 9 weeks. No retainer was indicated and the result was stable 4 months later (Figure 3a,b).



**Figure 1** (a–d) Pretreatment extra-oral photographs. (e–i) Pretreatment intra-oral photographs in maximum intercuspation. (j) Pretreatment intra-oral photograph on initial contact



**Figure 2** (a–d) Intra-oral photographs after 6 weeks of treatment. Incisor relationship is now corrected



(a)



(b)

**Figure 3** (a,b) Post-treatment photographs after 4 months showing stable result

### *Case 2: correction of impacted teeth*

An 8 year-old boy was referred by his GDP regarding the delayed eruption of the upper left central incisor due to the presence of supernumerary tooth. He presented with a Class I incisor relationship on a Skeletal I base with well-aligned upper and lower arches (Figure 4a–i). The supernumerary was removed and the central incisor bonded to a gold chain using a closed technique under a general anaesthetic (Figure 5a).

Brackets were bonded to the three erupted incisors and bands were cemented onto both upper first molars with an initial aligning wire of 0.016 inch nickel titanium. The wire sequence progressed through a 0.018 × 0.025 inch nickel titanium to a 0.019 × 0.025 inch stainless steel working arch wire. This was then used as a base wire coupled with a piggyback 0.016 inch nickel titanium wire applying traction to the unerupted central incisor via the gold chain (Figure 5b). Once the incisor was through a bracket was placed and 0.016 inch nickel titanium archwire fully engaged. The archwire was then stepped up to a 0.018 inch stainless steel wire with powerchain to close any residual spacing prior to debond. The incisor was self-retaining. Total active orthodontic treatment time was 10 months (Figure 6a–d).

### *Case 3: rotated and irregular incisors*

A 5 year-old boy was initially referred by his GDP for the removal of two supernumerary teeth present in the upper midline. He presented in the early mixed dentition. The supernumerary teeth were removed and the patient reviewed 1 year later when he

presented with a very irregular and rotated upper incisors (Figure 7a–i). A course of 2 × 4 appliance therapy was prescribed.

Initially, all four incisors were bonded with bands place on both upper first permanent molars and an initial aligning wire of 0.012 inch nickel titanium due to the severe rotations associated with the upper incisors. Progression was via a 0.016 inch nickel titanium achwire to a 0.018 × 0.025 inch nickel titanium archwire with a working archwire of 0.019 × 0.025 inch stainless steel (Figure 8a–d). Powerchain was used for a single visit to close any remaining anterior spacing. Once a positive overjet and overbite were established the appliance was removed, and a palatally-bonded retainer cemented. Total active orthodontic treatment time was thirteen months (Figure 9a–c).

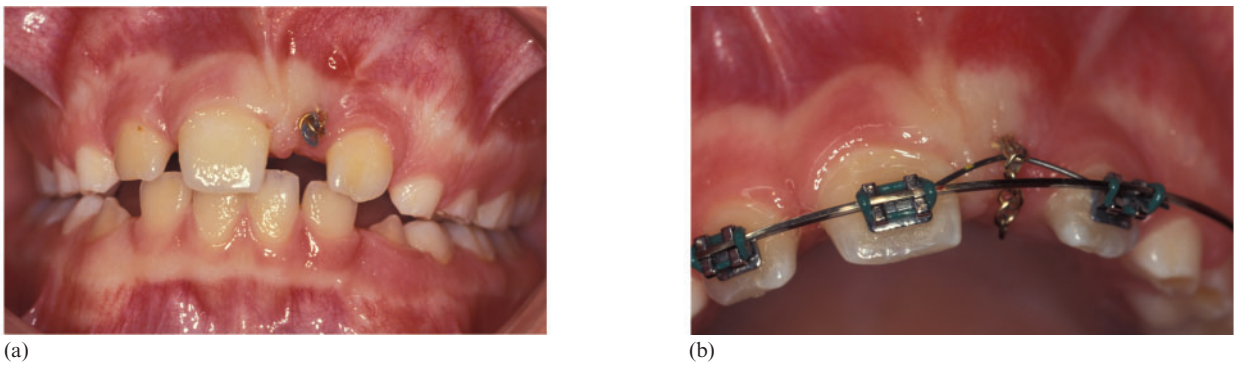
### *Case 4: unilateral crossbite with central incisors in crossbite and stable long-term result*

An 8 year-old girl was referred by her GDP who was concerned about both upper central incisors being in crossbite. She presented with a Class III incisor relationship on a Skeletal III base in the mixed dentition with an anterior and displacement to the left of the mandible after initial contact (Figure 10a–i).

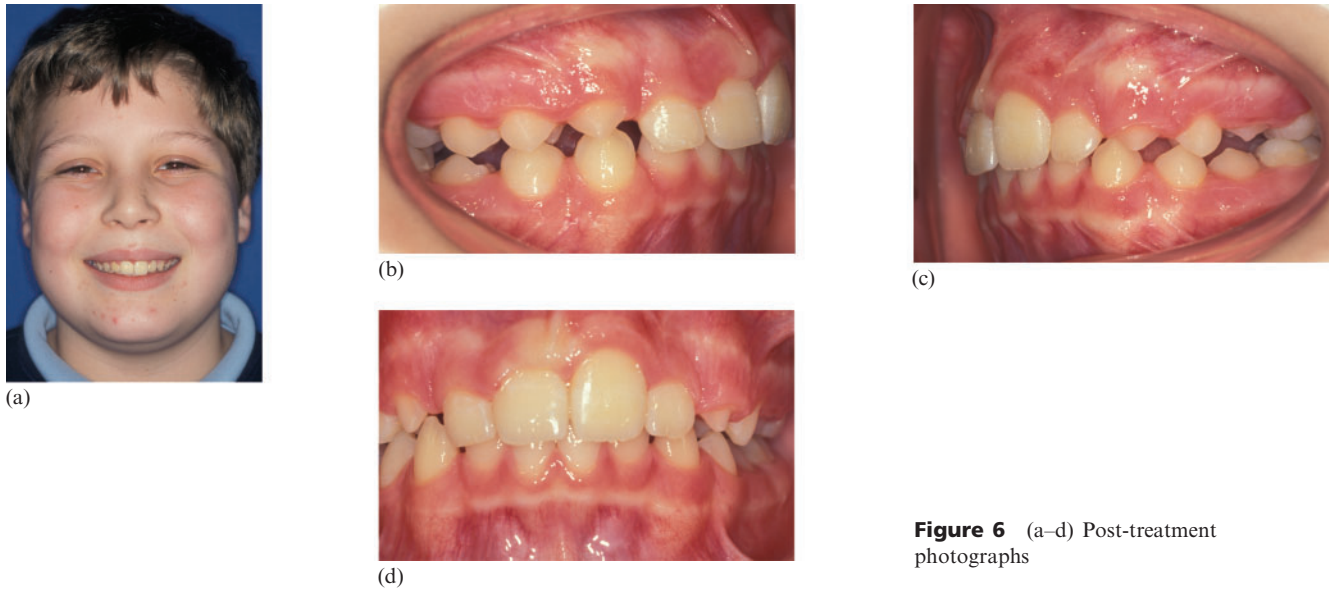
All four upper incisors were bonded, the upper first molars banded with a soldered quadhelix, which was activated, and an initial aligning wire of 0.016 inch nickel titanium placed (Fig. 11a–e). Rapid correction of the incisor relationship occurred and the patient was debonded after 5 months of treatment. She was kept under review with the occlusion remaining stable 3 years later (Figure 12a–e).



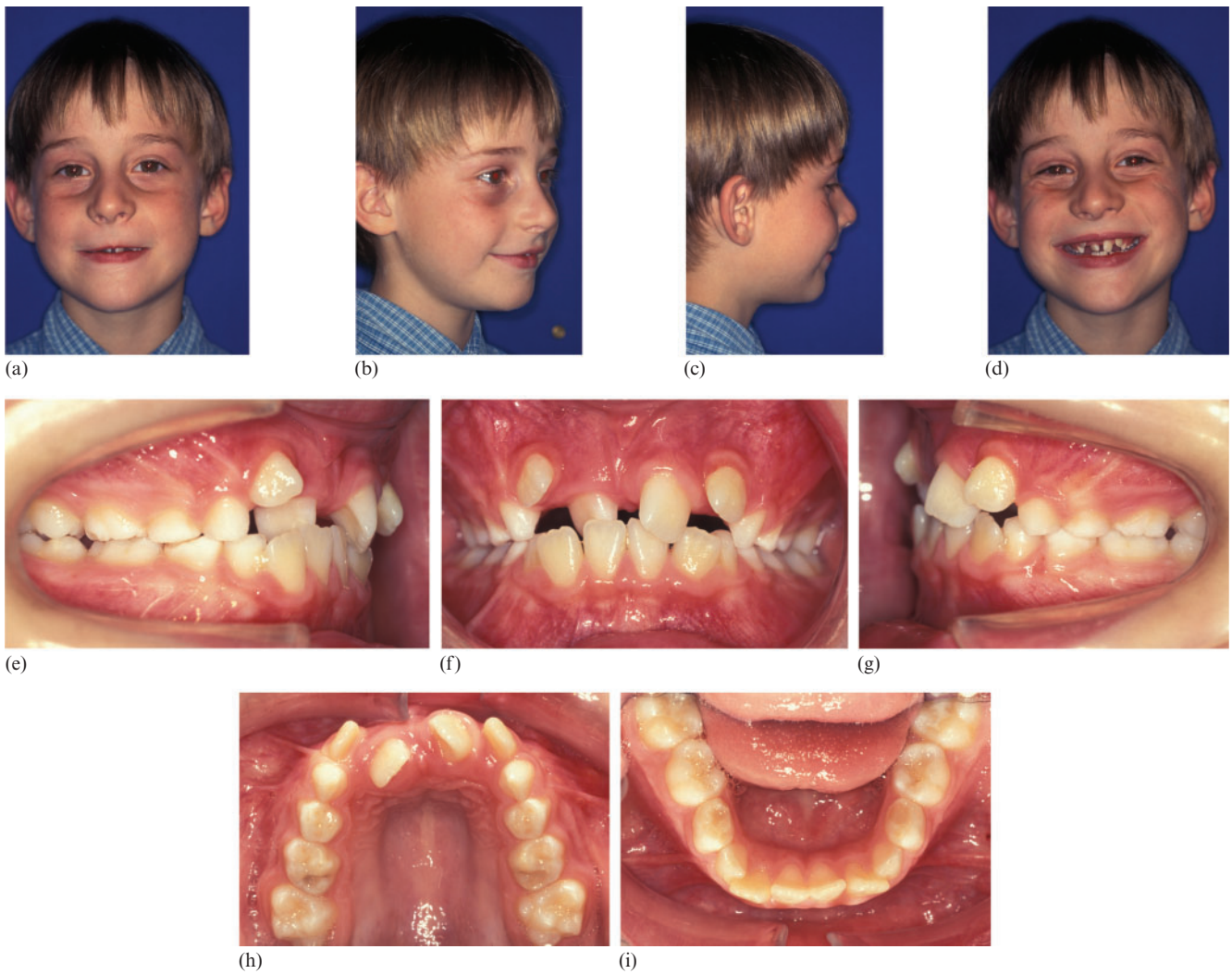
**Figure 4** (a–d) Pretreatment extra-oral photographs. (e–i) Pretreatment intra-oral photographs



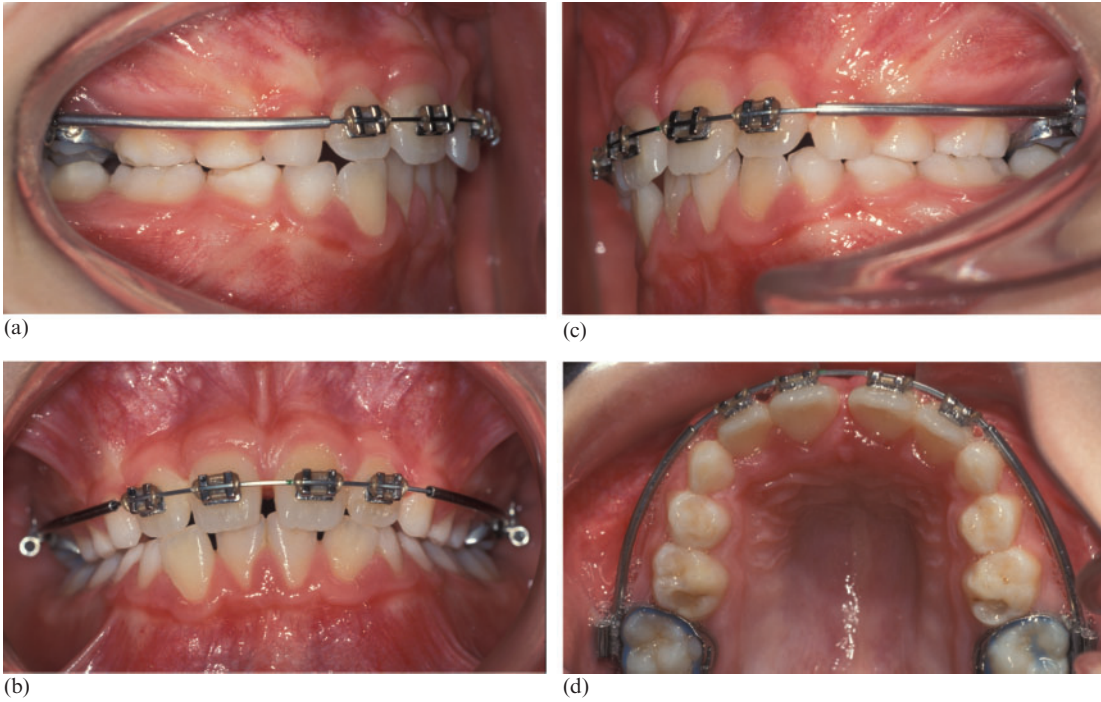
**Figure 5** (a) Upper left central after exposure and bonding. (b) 'Piggyback' technique to align incisor



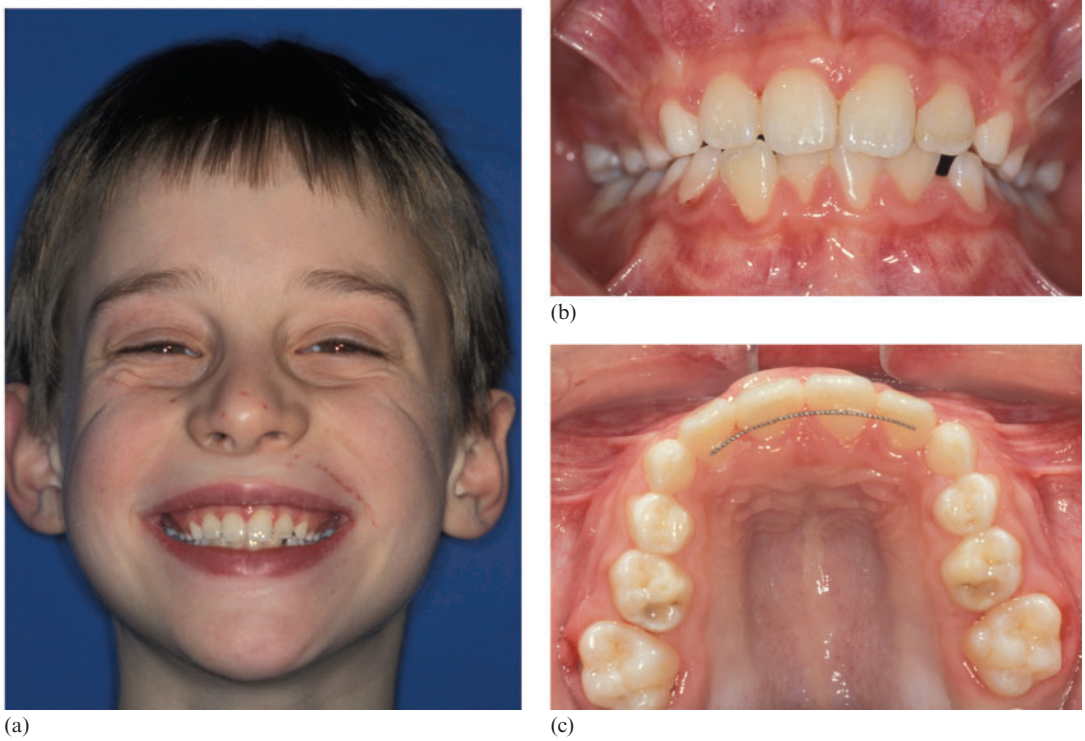
**Figure 6** (a-d) Post-treatment photographs



**Figure 7** (a-d) Pretreatment extra-oral photographs. (e-i) Pretreatment intra-oral photographs



**Figure 8** (a–d) Intra-oral photographs after alignment of incisors

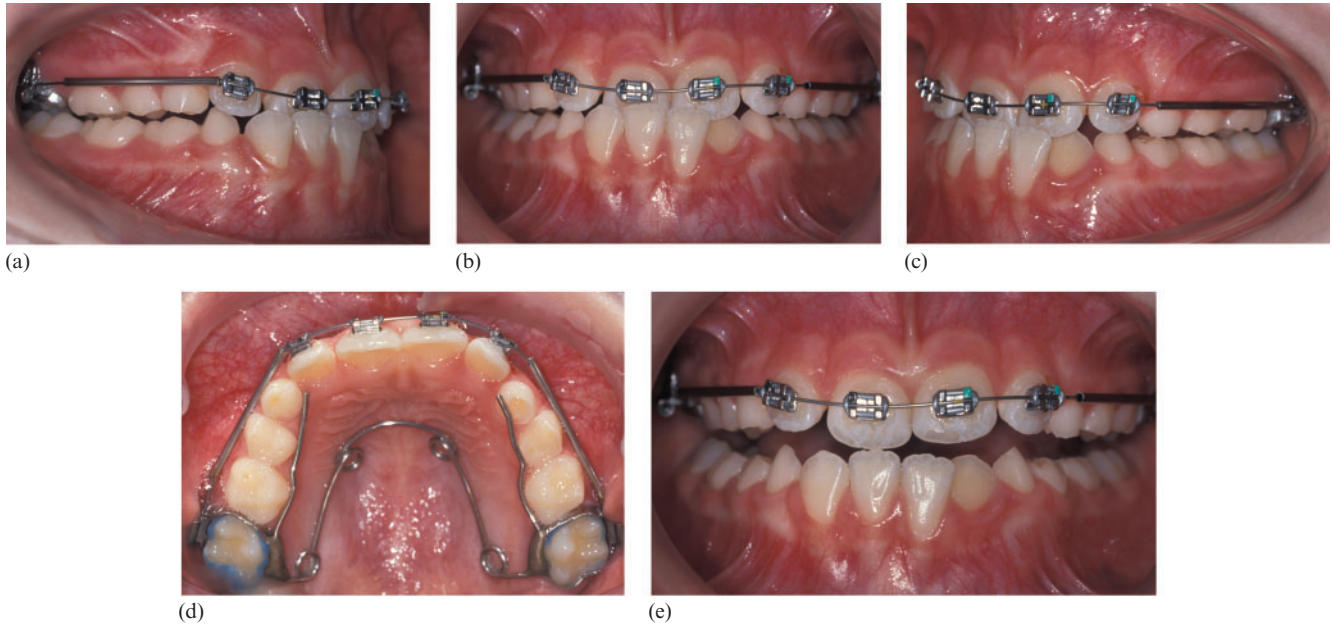


**Figure 9** (a,b) Post-treatment photographs. (c) Palatal bonded retainer





**Figure 10** (a,–d) Pretreatment extra-oral photographs. (e–i) Pretreatment intra-oral photographs



**Figure 11** (a–e) Intra-oral photographs after alignment of incisors and arch expansion



**Figure 12** (a–e) Intra-oral photographs three years after treatment

### Conclusion

The four case reports described clearly demonstrate the versatility of using the 2 × 4 appliance. Even though there may be slightly more chairside time required to fit the appliance, there is no laboratory cost involved as

with a removable appliance. The advantages over this type of appliance are significant and include:

- bodily movement of teeth if spaces needs to be created for an instanding incisor or recreated for an impacted late erupting incisor

- torque of the incisor roots palatally to decrease the chance of relapse, as well as maximize the aesthetic result
- efficient and effective derotation of incisors

The functional improvement coupled with the obvious psychological benefit gives this simple and easily placed appliance a significant advantage over the traditional method of treating these potentially challenging mixed dentition problems.

## References

1. O'Brien K, Wright J, Conboy F, *et al.* Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomised, controlled trial. Part 1: Dental and skeletal effects. *Am J Orthod Dentofac Orthop* 2003; **124**: 234–243.
2. Tulloch JFC, Philips C, Koch G, Proffit WR. The effect of early intervention on skeletal pattern in class II malocclusion: a randomised clinical trial. *Am J Orthod Dentofac Orthop* 1997; **111**: 391–400.
3. O'Brien K, Wright J, Conboy F, *et al.* Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomised, controlled trial. Part 2: psychosocial effects. *Am J Orthod Dentofac Orthop* 2003; **124**: 488–494.
4. Tulloch JFC, Proffit WR, Philips C. Influences on the outcome of early treatment for class II malocclusion: a randomised clinical trial. *Am J Orthod Dentofac Orthop* 1997; **111**: 533–542.
5. Turbill EA, Richmond S, Wright JL. The time-factor in orthodontics: what influences the duration of treatments in National Health Service practices? *Commun Dent Oral Epidemiol* 2001; **29**: 62–72.
6. Koroluk LD, Tulloch JF, Phillips C. Incisor trauma and early treatment for Class II division 1 malocclusion. *Am J Orthod Dentofac Orthop* 2003; **123**: 117–125.
7. White L. Early orthodontic intervention. *Am J Orthod Dentofac Orthop* 1998; **113**: 24–28.
8. Shaw WC, Meek SC, Jones DS. Nicknames, teasing, harassment and the salience of dental features among school children. *Br J Orthod* 1980; **7**: 75–80.
9. Ninou S, Stephens C. The early treatment of posterior crossbites: a review of continuing controversies. *Dent Update* 1994; **21**: 420–426.
10. Gu Y, Rabie AB, Hagg U. Treatment effects of simple fixed appliance and reverse headgear in correction of anterior crossbites. *Am J Orthod Dentofac Orthop* 2000; **117**: 691–699.
11. Mitchell L. *An Introduction to Orthodontics*, 2nd edn. New York: Oxford University Press, 2001.
12. Shaw WC, O'Brien KD, Richmond S, Brook PH. Quality control in orthodontics: risk/benefit considerations. *Br Dent J* 1991; **170**: 33–37.
13. MacPhee CG. The incidence of erupted supernumerary teeth in consecutive series of 4000 school children. *Br Dent J* 1935; **58**: 59–60.
14. DiBiase DD. Midline supernumeraries and eruption of maxillary central incisors. *Transactions of the BSSO* 1968–69: 83–88.
15. Skeggs RM, Sandler PJ. Rapid correction of anterior crossbite using a fixed appliance: a case report. *Dent Update* 2002; **29**: 299–302.