

Inadvertent tooth movement with fixed lingual retainers

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Fixed retainers are effective in maintaining the alignment of the anterior teeth more than 90% of the time, but they can produce inadvertent tooth movement that in the most severe instances requires orthodontic retreatment managed with a periodontist. This is different from relapse into crowding when a fixed retainer is lost. These problems arise when the retainer breaks but remains bonded to some or all teeth, or when an intact retainer is distorted by function or was not passive when bonded. In both instances, torque of the affected teeth is the predominant outcome. A fixed retainer made with dead soft wire is the least likely to create torque problems but is the most likely to break. Highly flexible twist wires bonded to all the teeth appear to be the most likely to produce inadvertent tooth movement, but this also can occur with stiffer wires bonded only to the canines. Orthodontists, general dentists, and patients should be aware of possible problems with fixed retainers, especially those with all teeth bonded, because the patient might not notice partial debonding. Regular observations of patients wearing fixed retainers by orthodontists in the short term and family dentists in the long term are needed. (*Am J Orthod Dentofacial Orthop* 2016;149:277-86)

The stability of orthodontic treatment is a major concern to both orthodontists and patients. Several long-term studies have demonstrated a strong tendency for relapse of anterior alignment after orthodontic treatment and retention.¹ For this reason, many orthodontists believe that permanent retention with a fixed retainer is the only way to maintain ideal dental alignment after treatment. Examining patients on 20-year recall, Booth et al² found that periodontal health was better in those whose mandibular fixed retainers bonded only to the canines were still in place than in those whose retainers had been lost or removed, so it appears that permanent retainers are not a risk factor for periodontal problems.

It has been shown that a higher percentage of patients with fixed retainers secured only to the canines will have incisor irregularity at 5 years after treatment than if the retainer wire is bonded to the incisors as

well.^{3,4} This has led to increased use of bonding to all teeth, but problems can arise when this is done. Bonding 6 teeth rather than 2 increases the chance of a bond failure within the first 5 years from approximately 20% to 30%.⁵ A more serious problem is major inadvertent tooth movement created by a lingual retainer, which has been the subject of previous case reports but has been considered highly unusual.^{6,7}

Tooth movement produced by a fixed retainer is different from the mild relapse seen occasionally despite the presence of a retainer, especially since it is almost never in the direction of the pretreatment position of the tooth and therefore is not relapse. This article was inspired by a patient who was referred to the office of the senior author (T.G.S.) in 2013 with surprising and unexpected mandibular anterior tooth movement and periodontal damage despite an intact small-diameter fixed retainer wire bonded to each tooth. Her coordinated periodontic-orthodontic treatment is discussed below. Through word of mouth among a few colleagues, a dozen or so other examples of tooth movement created by a fixed lingual retainer were collected, providing an impression of the unrecognized extent of the problem.

Our objectives in this article were to illustrate examples of inadvertent tooth movement created by fixed lingual retainers, discuss the most likely causes, make recommendations for prevention and retention management, and discuss the periodontist-orthodontist interactions in retreatment to correct severe problems.

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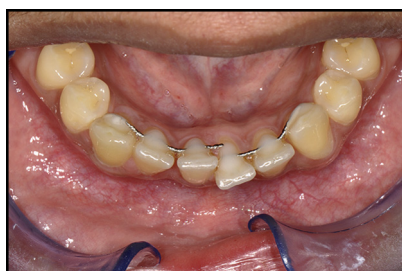


Fig 1. Dead soft wire with breakage between the central incisors, resulting in movement of 2 segments of teeth. Note the torque of the left canine and left central incisor in opposite directions.



Fig 2. Dead soft wire, half missing, with space opening and tooth movement. It is likely that the teeth on the right side were moved by the wire segment on that side before it was ultimately lost.

Examples of retainer-created inadvertent tooth movement

No single fixed retainer type appears to be immune to unexpected and unwanted tooth movement, although tooth movement is more likely when more flexible wires are used.

However, different types of tooth movement and problems are specific to the various retainer designs and wire sizes. This is discussed below relative to the most common fixed retainer types: (1) canine-to-canine plain steel wire (0.025–0.032 in) retained with bonding only to the canines, (2) more flexible 0.032-in spiral wire bonded only to the canines,⁸ (3) smaller diameter (0.0195–0.0215 in) and increasingly flexible spiral wire bonded to each anterior tooth, and (4) dead soft wire of various dimensions bonded to each anterior tooth.

Loss of alignment from inadvertent tooth movement is more likely when wires break. This appears to be most likely with smaller diameter dead soft wires (Fig 1), but it also occurs with small flexible spiral wires bonded to each tooth. Breakage can lead to no retention at all when a wire segment is missing or can lead to independent tooth movement produced by a remaining wire segment (Fig 2).

Transverse changes in the position of one or both canines can occur with small wires bonded to each tooth and are seen with both dead soft wires (Fig 3) and flexible spiral wires (Fig 4). Different types of transverse changes occur with larger diameter wires. A stiffer wire produces a more dependent relationship between the canines than does a smaller wire. Twisting of the wire can result in reciprocal movement of the canines and skewing of the arch form (Fig 5). Downward deflection of a relatively stiff wire can produce expansion across the canines (Fig 6).

Torque discrepancies between adjacent incisors are most likely with smaller diameter flexible spiral wires (Fig 7), but these can also occur with dead soft wires

(Fig 8). In some cases, tooth movement is severe enough to cause periodontal damage (Fig 9). We observed no examples of torque discrepancies between adjacent incisors with larger diameter canine-to-canine wires secured to the canines only.

Fixed lingual retainers to prevent reopening of a maxillary central diastema typically have a flexible wire between these teeth only. Both torque and tipping effects can occur over time (Fig 10). It has been suggested that it would be safer to bond across the diastema from the maxillary lateral incisors, but if a problem arises, the extended flexible wire can displace both the central and lateral incisors (Fig 11).⁹

Causes of inadvertent tooth movement

Wire distortion is one of several possible reasons for retainer-caused tooth movement. If the fixed retainer wire is not passive when placed, it introduces an active force when bonded. It is also possible that a truly passive wire could be deformed during bonding. This could happen when pushing on the wire with a hand instrument to adapt it. The use of a carrier for placement should prevent this, but perfect adaptation is less certain.

Wire deformation could occur in the posttreatment period from biting on hard foods or trauma, which would essentially activate the wire as if the orthodontist had bent it. It also is possible that the patient could distort the retainer wire while flossing the teeth; enough force to do that could be generated with dental floss under the wire. Tongue habits probably do not play a role in deforming retainer wires because of the short duration of tongue pressure.¹⁰ Also, resting tongue pressure against the incisors probably does not play a role because the magnitude of resting tongue pressure is far below the pressure needed to bend a wire.¹¹ Fortunately, a force heavy enough to distort a retainer wire usually leads to bonding failure or breakage; wire

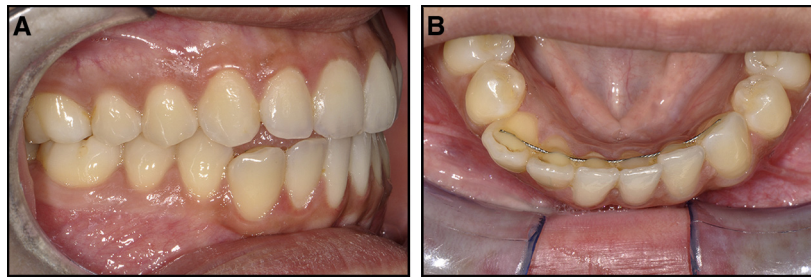


Fig 3. Dead soft wire completely intact, with skewing of the arch form in multiple planes of space, facial tipping of the right canine, and torque of the right lateral incisor and central incisor in opposite directions: **A**, buccal view; **B**, occlusal view.

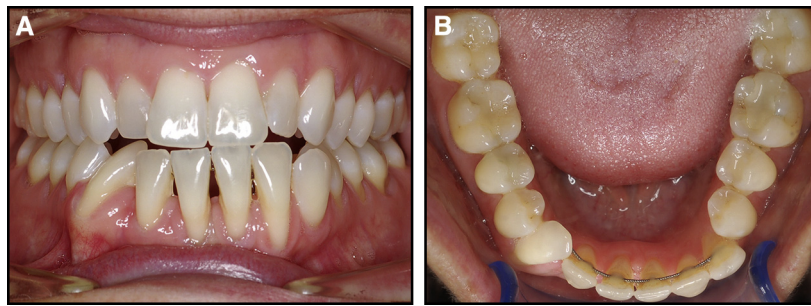


Fig 4. Flexible spiral wire retainer with severe lingual inclination of the mandibular right canine and labial displacement of the mandibular left canine: **A**, frontal view; **B**, occlusal view (courtesy of Dr John Iaculli).

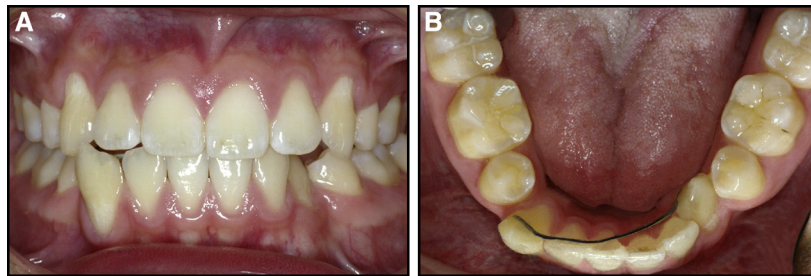


Fig 5. Canine-to-canine wire still secured at both ends, skewing of arch form, and torque in opposite directions of the canines: **A**, frontal view; **B**, occlusal view (courtesy of Dr Rick Booth).

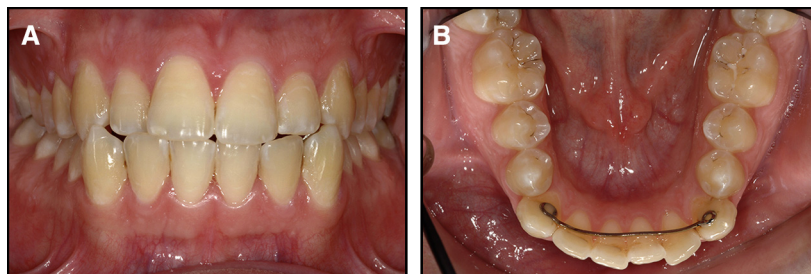


Fig 6. Canine-to-canine wire deflected downward at the incisors (probably from biting force), resulting in expansion across the canines: **A**, frontal view; **B**, occlusal view.

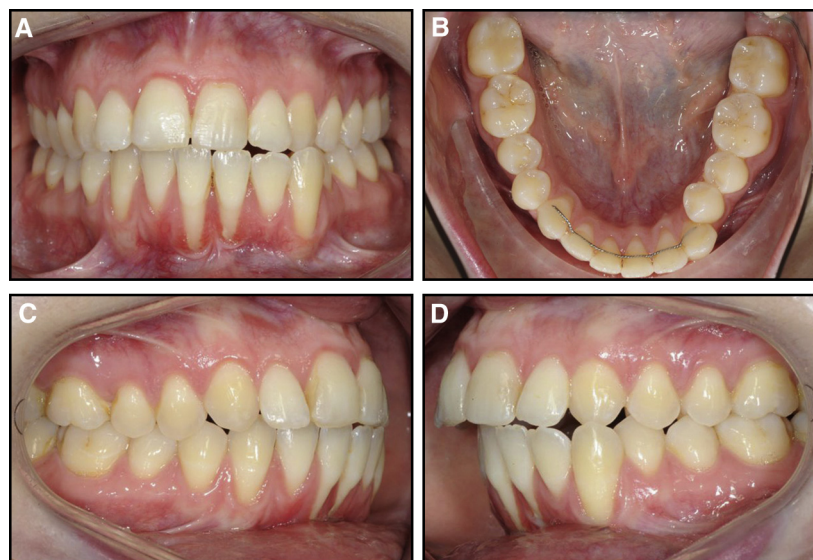


Fig 7. Flexible spiral wire retainer with torque discrepancy between the left and right incisors: **A**, frontal view; **B**, occlusal view. Displacement of the mandibular left canine only in a labial direction: **C** and **D**, buccal views (courtesy of Dr Anne-Marie Renkema).

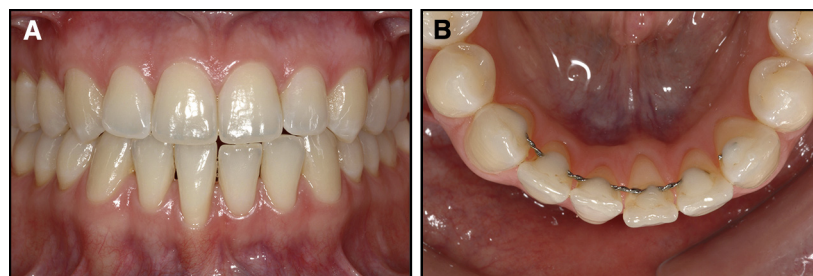


Fig 8. Dead soft wire with lingual root torque of one central incisor and facial root torque of the other, after fracture of the wire between the left lateral incisor and canine: **A**, frontal view; **B**, occlusal view.

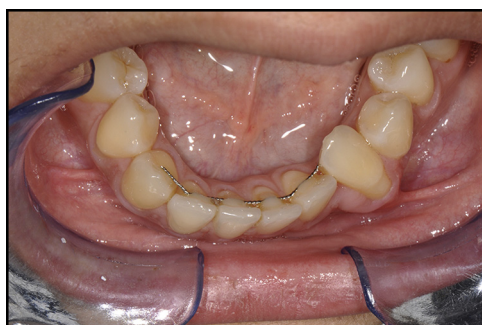


Fig 9. Occlusal view of a flexible spiral wire retainer with bond failure on the mandibular right canine, but with a severely lingually inclined mandibular left canine and facial attachment loss.

deformation without debonding does not seem to be the cause of most unexpected tooth movement.

Deformation of fixed retainer wires is least likely with thick steel wires. Booth et al² suggested that a smaller 0.025-in (vs 0.032 in) stainless steel wire may flex more than the heavier wire but would be better able to accept some shock without bond failures. However, if any canine-to-canine wire becomes deformed without resulting in a bond failure, there is a good chance that the canines will move, and the incisors might also be affected.

A possibility for tooth movement with multistranded twisted retainer wires is a change in the mechanical properties of the wire, either inherent or acquired in the fabrication process. It is not hard to imagine



Fig 10. Flexible spiral wire to retain a maxillary midline diastema with slow displacement and rotational movement of the central incisors: **A**, immediately after placement; **B**, 4 years later; **C**, 8 years later.

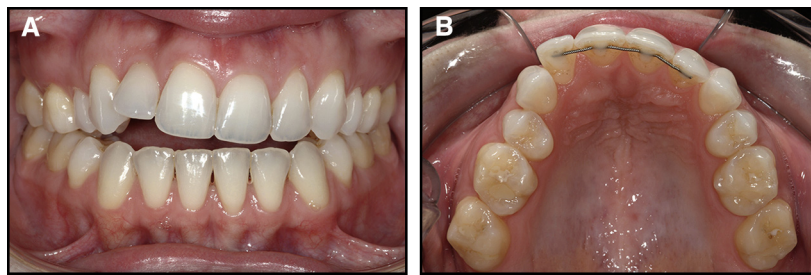


Fig 11. Flexible spiral wire bonded to all 4 maxillary incisors, with intrusion, rotation, and tipping to the right of the central incisors and the right lateral incisor: **A**, frontal view; **B**, occlusal view.



Fig 12. Spiral wire retainer (0.032 in) with bonding to the central incisors and the canines; it is more likely than a retainer bonded only to the canines to remain in position if 1 bond breaks.

“untwisting” of a spiral wire causing a torque discrepancy between adjacent teeth. When a twisted wire is cut, if there is internal tension, the end of the wire tends to splay out as some untwisting occurs. A wire like that certainly should not be used to fabricate a fixed retainer. Finally, if any tooth moves while it is secured to another, the dependent relationship between them can result in a reciprocal change.

Prevention of inadvertent tooth movement

Prevention of inadvertent tooth movement has 2 aspects: careful fabrication of the retainer wire so that it is passive when bonded into position, and regular observation of retainer integrity by either the orthodontist or the family dentist.

When bending a wire with any degree of flexibility is required (ie, anything except a dead soft wire), we highly recommend fabrication on a working model. This provides better adaptation to the lingual surfaces of the anterior teeth than can be obtained with intraoral fabrication and decreases the chance of placing an active fixed retainer. The use of a carrier to position the wire during bonding already has been mentioned as a way to avoid distorting it with finger pressure.

Dead soft wire can be adapted to the teeth with finger pressure so that it is contoured tightly against the lingual surface. This is easier with a working model but can be done intraorally. The interdental wire does not stick out from the teeth and is therefore less susceptible to deformation from occlusal forces. Dead soft wire is an ideal choice for patients with complex anatomy of the lingual surfaces. It is not as likely as

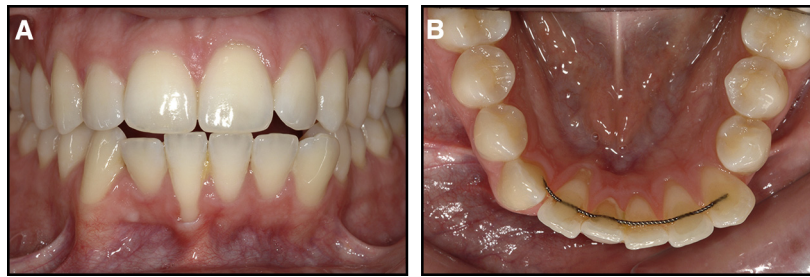


Fig 13. Flexible spiral wire retainer bonded to the canines and incisors, with gingival recession and attachment loss, severe torque discrepancy between the central incisors, and transverse movement and torque of both canines. Both the periodontal problems and the severity of tooth movement were indications for coordinated periodontic-orthodontic retreatment: **A**, frontal view; **B**, occlusal view.

flexible spiral wire to store energy or become activated in placement, but it is the wire that is most likely to break, and as we have shown, distortion created during breakage can move teeth.

With a larger wire of intermediate flexibility (eg, 0.025-in in rather than 0.032-in steel or a version of 0.032-in spiral wire with less internal tension than Zachrisson's original retainer wire⁸), bonding to the canines and central but not lateral incisors provides resistance to distortion and breakage while still allowing movement of the lateral incisors during function (Fig 12). If a bond fails in one location, the patient is generally aware of it, but it does not result in wire deformation. This prompts the patient to call the office for a repair soon after the incident. When a traditional canine-to-canine retainer suffers a bond failure at one canine, the patient is more likely to remove the wire. Bond failure of a single tooth when all 6 anterior teeth have been bonded is much more likely to go unnoticed, and this can result in tooth movement before it is detected.

Patients with fixed retainers should be seen regularly in the initial retention period by the orthodontist responsible for placement—perhaps for the first 2 years, when bond failure rates are greatest. The bond failure rate is lower in the 3- to 5-year posttreatment period.⁵ After 2 years, it would seem most practical for the patient's general dentist to inspect the fixed retainer at regular dental checkups every 6 to 12 months. Patients should be instructed to immediately call their orthodontist for an appointment if they notice tooth movement or a bond failure.

A removable retainer for nighttime wear that fits over the fixed retainer can also be provided for additional protection against inadvertent tooth movement, as well as debonding or breakage. This can be as simple as a vacuum-formed retainer made on a model with

the undercuts beneath the wire blocked out. Most importantly, early detection of tooth movement, debonding, or wire breakage prevents the types of failures illustrated in this article.

Coordinated orthodontic-periodontic retreatment of a patient with periodontal damage

A 28-year-old woman (mentioned above, whose problems inspired this article) was referred by her general dentist to the senior author because he noticed tooth movement and periodontal damage in the area of her fixed mandibular retainer. She had completed orthodontic treatment more than 15 years earlier with the placement of a 0.0195-in flexible spiral wire retainer bonded to all mandibular anterior teeth. She reported that she saw her orthodontist regularly during the first year after treatment but had not seen him since.

The clinical examination showed an intact fixed retainer and no wire breakage (Fig 13). Gingival recession was noted on the labial aspect of the mandibular right central incisor and the lingual aspect of the adjacent lateral incisor. There was a significant torque difference between these teeth in the direction of the recession. The mandibular left canine was buccally displaced, whereas the right canine was lingually inclined. Three-dimensional radiographs confirmed the loss of facial bone over the mandibular right canine and to a lesser extent over the right central incisor. The right lateral incisor root was also torqued out of the bone on the lingual aspect (Fig 14).

The goals of retreatment were to bring the teeth back to normal positions of both crowns and roots, and to stimulate the formation of new bone in the areas of recession and root exposure. Coordinated periodontal surgery and orthodontic treatment was necessary to accomplish these.

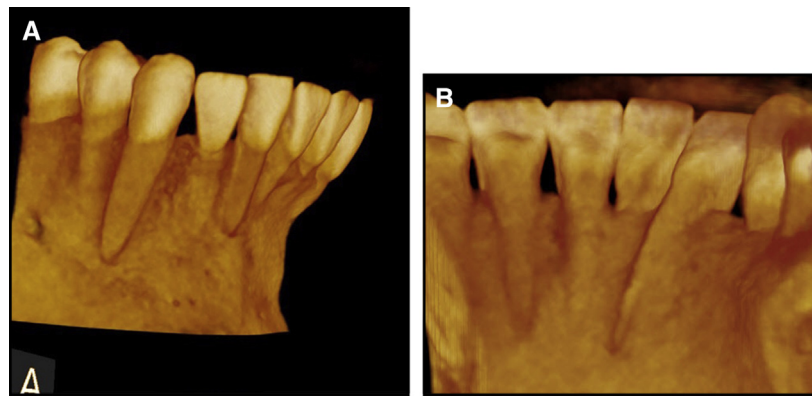


Fig 14. Three-dimensional images of fenestrations on: **A**, the facial and **B**, the lingual aspects of the incisor roots, immediately after removal of the fixed lingual retainer.

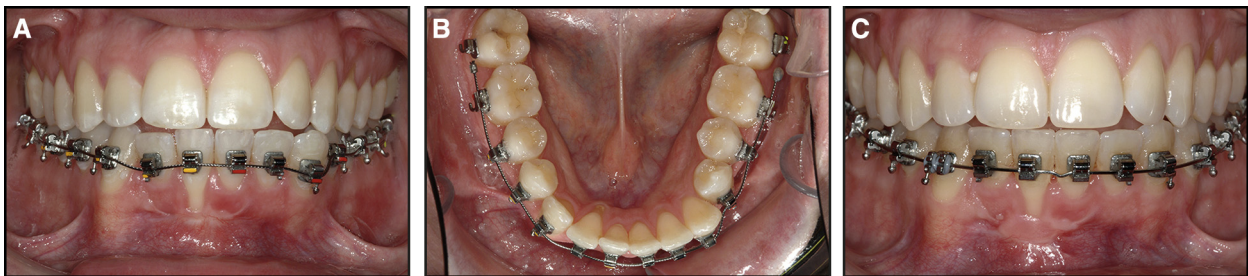


Fig 15. Initial alignment before soft tissue grafting of the mandibular right central incisor area: **A**, frontal view; **B**, occlusal view; **C**, 2 weeks after soft tissue grafting, the initial periodontal surgery.

The bonded retainer was removed, and fixed appliances were placed (Fig 15), limited to the mandibular arch only at the patient's request. A connective tissue graft was placed on the facial aspect of the mandibular right central incisor in a first-stage periodontal procedure. A second periodontal procedure was done 2 months later (Fig 16). It included deliberate vertical bone scoring to initiate a regional acceleratory phenomenon, along with significant facial and lingual bone grafting for correction of the fenestrations. Significant improvement in the torque discrepancies between the teeth was then achieved with full-dimension archwires and their expressions over time (Fig 17). Judicious interproximal reduction was followed by space closure to broaden the contacts and eliminate unesthetic black triangles. Alignment and arch form were also corrected before debonding (Fig 18). Before and after 3-dimensional images (Fig 19) highlight the addition of bone on the facial surface of the mandibular right canine and the improvement in root positions of the anterior teeth. The mild

anterior open bite was not corrected because elongation of the mandibular incisors was considered imprudent.

This time, the patient preferred a removable retainer.

CONCLUSIONS

1. Passive and securely bonded fixed anterior retainers are an effective way to prevent posttreatment relapse but require regular supervision.
2. Small-diameter flexible spiral wires bonded to each tooth pose the greatest risk for creating significant inadvertent tooth movement and resulting complications.
3. Early detection of bonding failures, wire breakage, and tooth movement created by the retainer is critical in preventing major problems.
4. A patient with a fixed retainer should be seen regularly by the general dentist if not by the orthodontist, and the orthodontist should accept responsibility for dealing with problems if they arise.

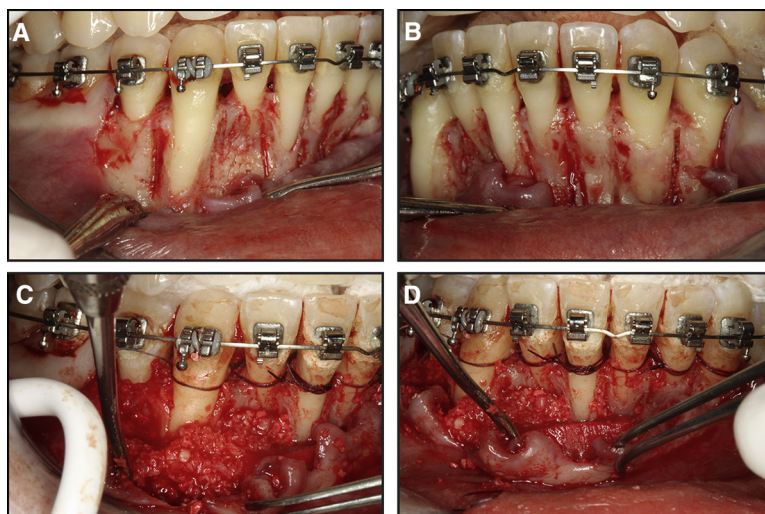


Fig 16. The second periodontal surgical procedure, 2 months after soft tissue grafting: **A** and **B**, this included application of bone morphogenetic protein, intentional bone injury to cause a regional acceleratory phenomenon, and **C** and **D**, the application of a bone graft slurry to correct fenestrations in the alveolar bone (courtesy of Dr Colin Richman).

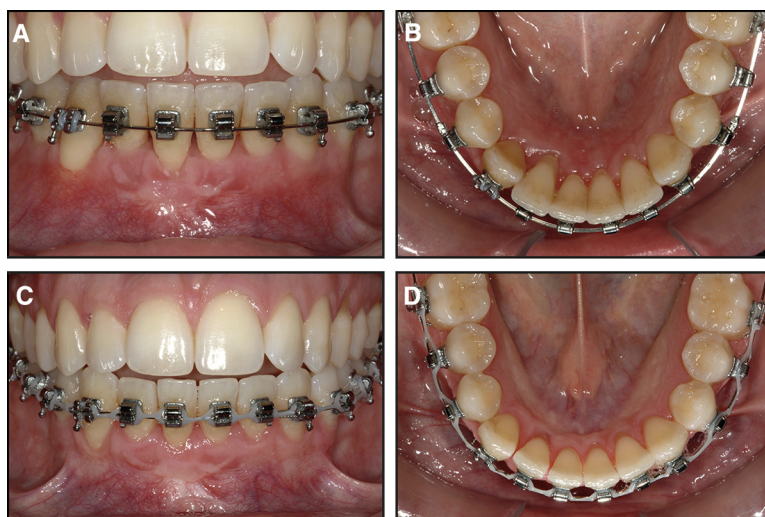


Fig 17. Progress of treatment: **A** and **B**, healing after second surgery; **C** and **D**, improvement of root torque a few months later.

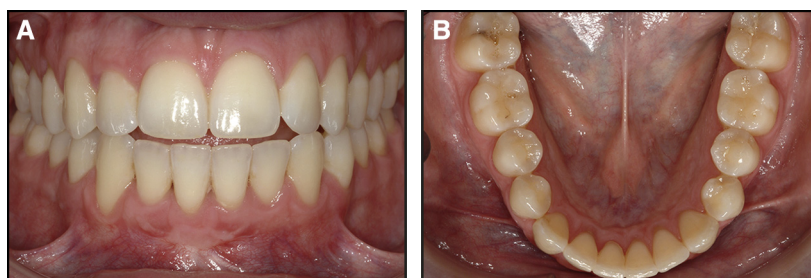


Fig 18. Final images after debonding: **A**, frontal view; **B**, occlusal view. Further tooth movement to correct the mild anterior open bite was considered not to be in the patient's best interest.

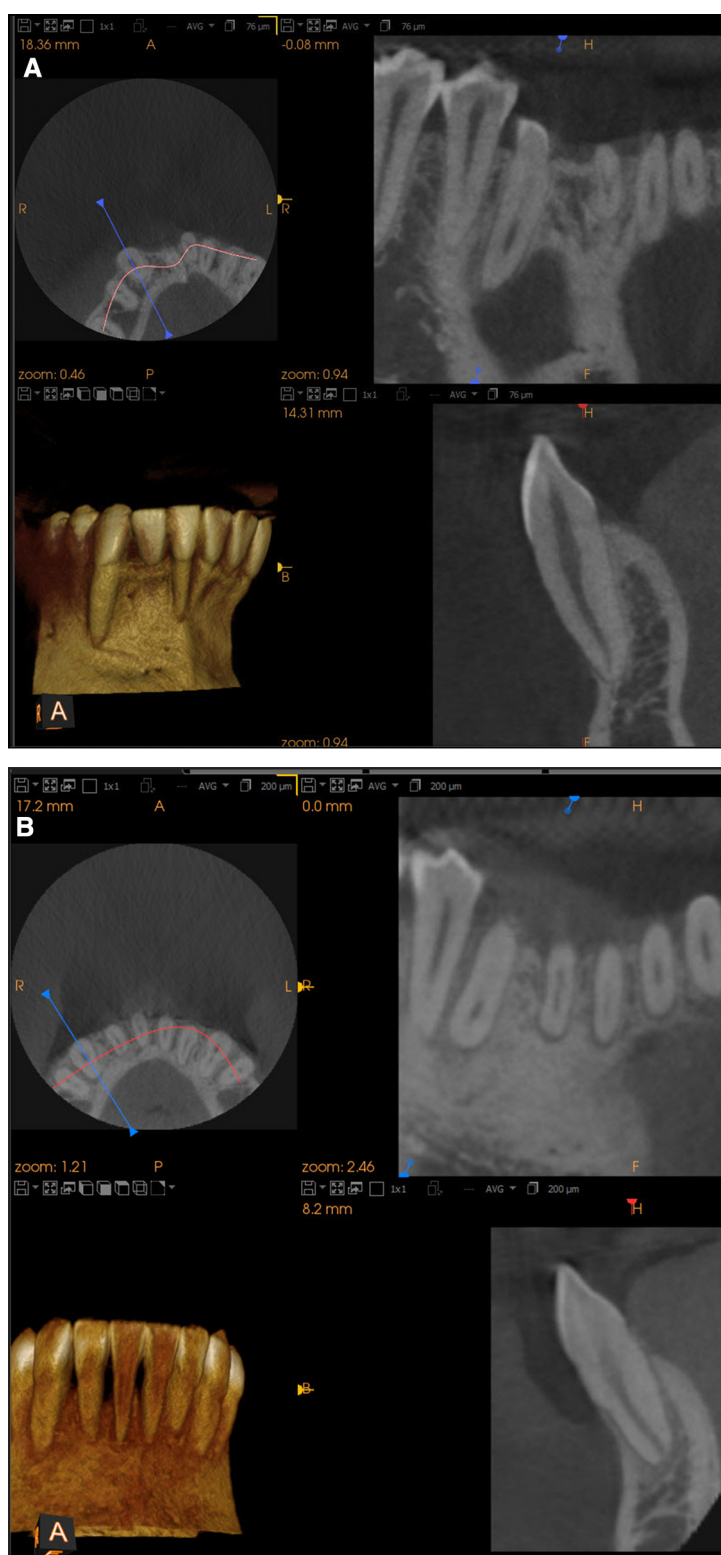


Fig 19. A, Pretreatment and B, posttreatment 3-dimensional images. Note the improvement in root positions and (in the lower right images) the bone formation on the facial aspect of the right canine.

5. Interaction with a periodontist using bone-induction procedures is needed for retreatment of patients with severely displaced teeth.

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