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Orthodontic tissue remodelling and periodontal healing

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Orthodontic tooth movement is accompanied by tissue remodelling, which can be observed through bone apposition on the side under tension and bone resorption on the side under pressure. Without attachment, it is not possible to obtain this type of tissue transformation.

Orthodontic tooth movement towards an infraosseous lesion does not allow attachment gain and increases the degree of bone damage around proximal teeth. In this situation, it is recommended to treat the lesion with a surgical periodontal regeneration technique before beginning the orthodontic displacement. According to the principle of guided tissue remodelling, a membrane placement leads to the formation of a newly regenerated tissue on the surface of the tooth under pressure. This tissue presents all the potential necessary for the formation of a new connective tissue attachment and leads to bone repair at the end of orthodontic displacement. Today, with the use of enamel matrix derivative, proteins can provide the same results as those obtained with membranes in the treatment of infraosseous defects. Therefore it is possible to use Emdogain® in a pre-orthodontic situation according to the principle of guided tissue remodelling.

Orthodontic tooth movement is accompanied by tissue remodelling, which modifies the morphology of the periodontal tissues. Where there is translation movement, these transformations can be observed through bone apposition on the side under tension and by resorption on the side under pressure. For these movements to be beneficial, it is necessary to observe the fundamental principles of orthodontic tooth movement biology. As a result, the orthodontic forces applied must be controlled to avoid any risk of hyalinisation to the side under pressure and such a treatment may only be undertaken on healthy periodontal tissues. Thus, if periodontal disease is present, periodontal preparation should be associated with the orthodontic treatment to reduce inflammation and control the infection. If infraosseous lesions are observed around the teeth affected by the displacement, particular attention should be paid to residual bone morphology. Whilst the teeth should be displaced in the direction of a defect, recourse to periodontal regeneration techniques could be envisaged to encourage bone remodelling.

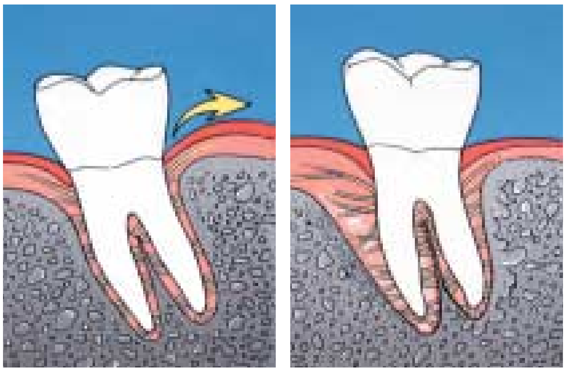

Fig 1 Schematic diagram of periodontal tissue transformation during the course of orthodontic molar uprighting. Desmodontal fibres under tension, inserted in the cement, play a barrier role, thus encouraging bone repair at the end of orthodontic displacement.

Orthodontic uprighting of a mesioverted molar corresponds to a distal translation movement (Fig 1). If the periodontium is healthy, the presence of a connective tissue attachment to the side under tension allows bone repair to be achieved after mineralisation. The supracrestal desmodontal fibres under tension work like a real barrier, encouraging regeneration (Fig 2). In the absence of attachment, it is not possible to obtain this type of tissue transformation. In the classic case of a mesioverted mandibular molar, presenting a deep infraosseous lesion to the mesial side, it is recommended to combine a periodontal treatment with orthodontic displacement with the aim of regenerating the tissues destroyed. If the

Fig 2 Radiographs of a clinical example illustrating the mesial bone mineralisation of a mesioverted molar, at various stages of orthodontic axis correction.

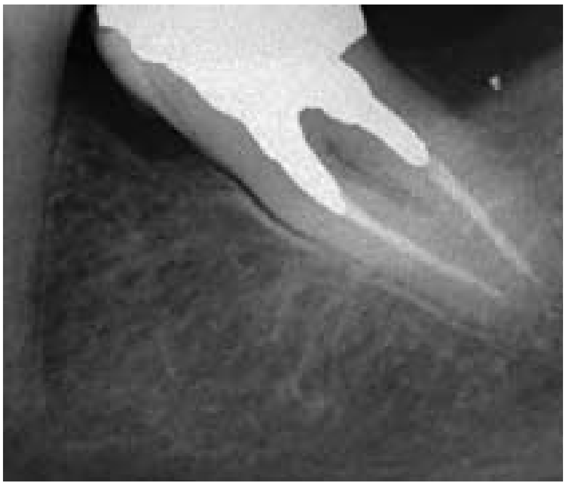

Fig 2a Initial radiograph showing the axis of the mesioverted 37.

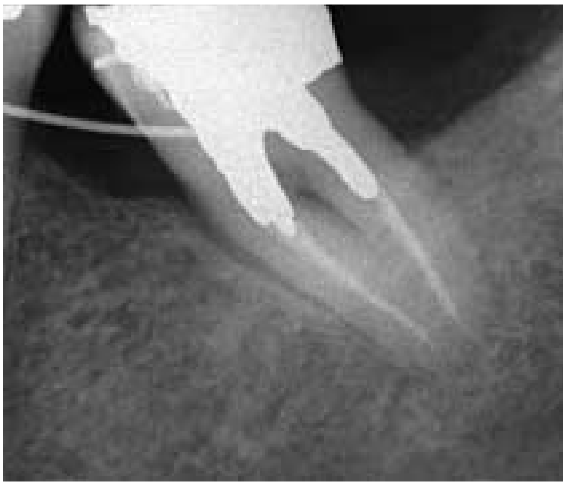

Fig 2b Radiograph at the start of orthodontic displacement showing the ligament thickening on the side under tension.

Fig 2c Radiograph at the end of orthodontic displacement, showing the absence of mineralised bone on the mesial side of the molar.

Fig 2d Radiograph after 6 months of setting and the fitting of a 35–37 bridge, showing the image of bone repair and mineralisation to the side under tension.

Fig 3 Clinical example of treatment of an infraosseous lesion treated with the placement of a membrane according to the principles of guided tissue regeneration, after orthodontic correction of the axis of the tooth concerned.

Fig 3a Initial retroalveolar radiograph showing a deep infraosseous lesion to the mesial side of the mesioverted 47.

Fig 3b Initial clinical situation.

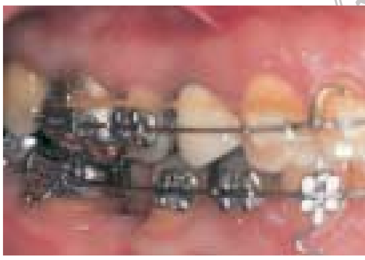

Fig 3c Orthodontic appliance in place, having allowed the correction of the axis of 47, as part of the treatment of a secondary malocclusion.

Fig 3d and 3e Labial and lingual view of mesial bone defect to 47 after raising a mucoperiosteal flap and debridement of the lesion.

Fig 3f Retroalveolar radiograph at end of orthodontics. The absence of ligaments on the side under tension has not allowed bone apposition on the mesial side of 47. The infraosseous lesion must be treated at this stage by a guided tissue regeneration procedure.

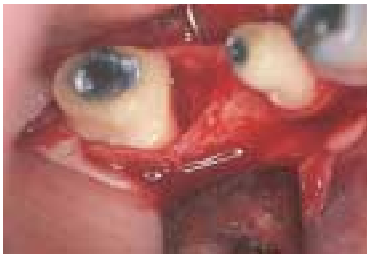

Fig 3g Occlusal view of the bone defect.

Fig 3h Occlusal view after positioning of resorbable membrane.

Fig 3i Suture technique to cover the membrane.

Fig 3j and 3k Final clinical result after putting a bridge in place.

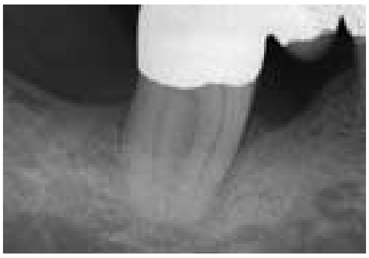

Fig 3l Radiograph after 9 months' healing. The bone repair can be seen on the mesial side of the tooth.

movement is evidenced by distal translation with the effect of moving the tooth concerned away from the bone defect, this periodontal repair phase may follow the orthodontics (Fig 3).

Inversely, when a tooth must be displaced in the direction of an infraosseous lesion, the periodontal treatment phase must precede the orthodontics. In fact, the nature of the attachment to the side under

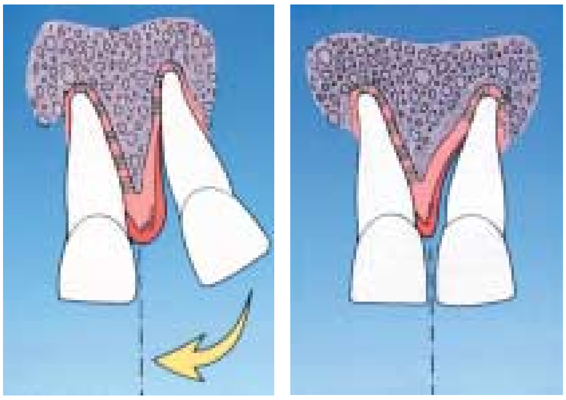

Fig 4 Schematic representation of the periodontal situation of a tooth under orthodontic displacement towards a lesion. Without periodontal treatment prior to the orthodontic displacement, no attachment gain can be obtained, and the orthodontics brings a risk of accentuating the bone damage.

pressure also influences the final result. In practice, we know that orthodontic displacement of a tooth in the direction of a periodontal lesion risks accentuating the degree of bone damage (Fig 4). Several experimental studies in animals[1,2] have shown that displacement of a tooth presenting a loss of attachment does not allow attachment to be achieved. In the example of the closure of a secondary diastema, displacement of a tooth in the direction of a lesion without periodontal preparation risks aggravating bone damage around the proximal teeth (Fig 5).

Knowledge gained concerning periodontal healing shows that treatment by blind curettage or by surgical debridement of a damaged tooth leads, in the best case, to the formation of a long epithelial attachment. Still considering the example of the closure of a secondary diastema, displacement of a tooth in the direction of a lesion previously treated with blind curettage or surgical debridement, does not enable the periodontal situation of the proximal teeth to be improved, and the repair associated with this type of treatment does not lead to bone formation (Fig 6). This type of result may be clinically observed with the performance of surgical re-entries at the end of orthodontic displacement (Fig 7).

When such a movement is indicated, it is therefore recommended to make use of a surgical periodontal regeneration technique before embarking on the orthodontic displacement. According to the

Fig 5 Clinical example illustrating periodontal tissue transformations upon orthodontic displacement of a tooth towards a periodontal lesion.

Fig 5a Initial clinical situation before treatment.

Fig 5b Clinical view of the anterior mandibular region showing a considerable loss of attachment around 41, the extraction of which has been chosen.

Fig 5c Pre-operative view after extraction of 41 showing the size of the bone defect at this place.

Fig 5d Final clinical situation after fitting of orthodontic mechanisms.

Fig 5e Clinical view after orthodontics of the anterior mandibular region showing the loss of attachment around 31.

Fig 5f Surgical re-entry after orthodontics showing a worsening of bone loss around 31, following orthodontic displacement of the tooth towards the bone defect.

principle of guided tissue remodelling[4], the implementation of the technique of GTR (guided tissue regeneration) using a membrane, before orthodontic displacement, enables the periodontium to be preserved and the result optimised. In fact, the presence on the surface of the displaced tooth under pressure of a newly regenerated tissue, presenting all the potential necessary for the formation of a new connective tissue attachment, leads to bone repair at the end of orthodontic displacement (Fig 8). From an experimental study in animals, it has been possible to demonstrate histologically that the application of this principle encourages the formation of cement and the appearance of desmodontal fibres functionally oriented along the radicular surfaces involved[5]. As with the principle of GTR, it is the formation of this new connective tissue attachment, from the residual desmodontal cells, which provides secondary encouragement for bone repair. The effectiveness of this method has been confirmed by several clinical models published in the literature[3,5], and the results obtained have been clinically observed with the performance of surgical re-entries at the end of orthodontic displacement (Fig 9).

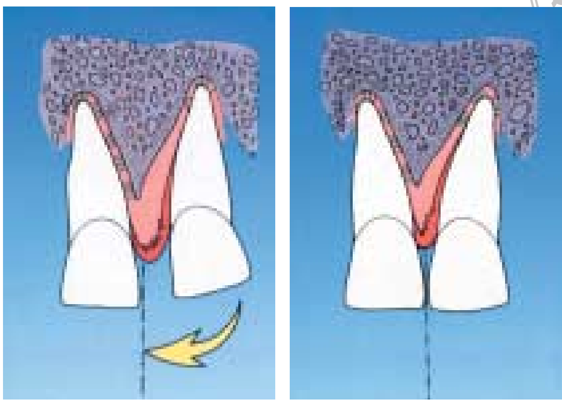

Fig 6 Schematic representation of the periodontal situation of a tooth under orthodontic displacement towards a lesion, previously treated by non-surgical or surgical debridement. In favourable cases, periodontal healing leads to the formation of a long epithelial attachment. After orthodontic treatment, this type of healing does not result in bone regeneration.

This method may also be applied to the treatment of bone lesions associated with root proximity when extraction of a tooth is indicated. The positioning of a membrane at the extraction site allows the secondary displacement of the proximal teeth towards

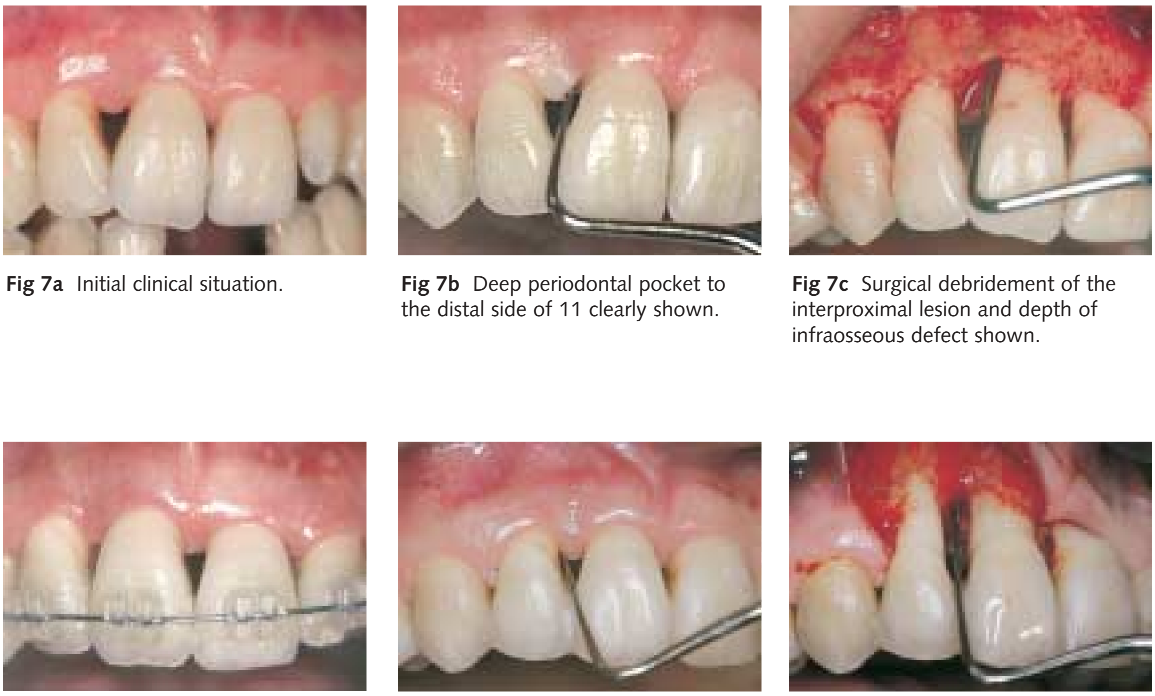

Fig 7a Initial clinical situation.

Fig 7b Deep periodontal pocket to the distal side of 11 clearly shown.

Fig 7c Surgical debridement of the interproximal lesion and depth of infraosseous defect shown.

Fig 7 Clinical example illustrating periodontal tissue transformations upon orthodontic displacement of a tooth towards a periodontal lesion previously treated by surgical debridement.

Fig 7d Clinical view at the end of orthodontic treatment.

Fig 7e Probe depth to the mesial side of 12 at the end of orthodontics.

Fig 7f Surgical re-entry at the end of orthodontics and aggravated bone loss in the interproximal space shown.

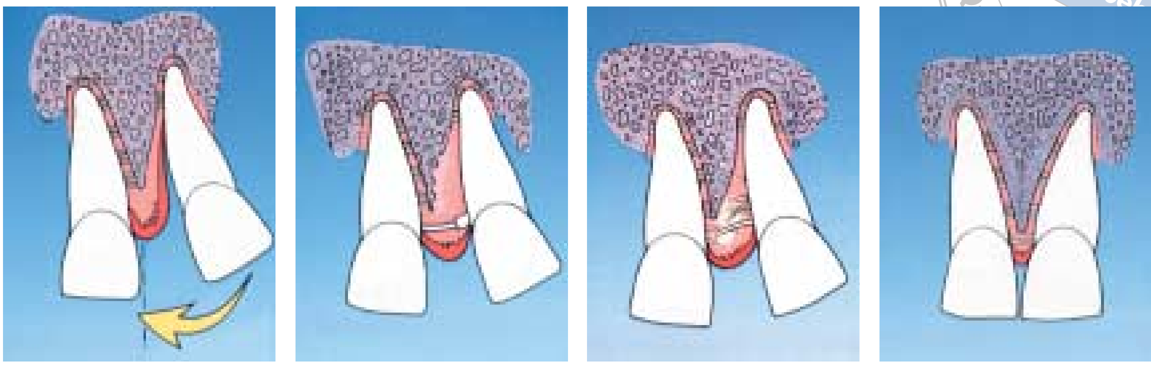

Fig 8 Schematic representation illustrating the principle of guided tissue remodelling. The placement of a membrane before orthodontics allows formation of a new conjunctive tissue attachment to be obtained according to the principle of guided tissue regeneration. This type of healing results in repair at the end of orthodontic displacement.

newly regenerated tissue, thus allowing the formation of a new connective tissue attachment on the proximal surfaces of the displaced teeth and encouraging the secondary bone repair (Fig 10).

Today, in the treatment of infraosseous defects, the use of proteins derived from the enamel matrix (Emdogain®) gives results comparable to those obtained by the use of membranes[6]. The application of an Emdogain® gel on a root surface, previously surfaced and then conditioned with Prefgel®, encourages the formation of a new connective tissue attachment and bone repair. From these data, it seems possible to use proteins derived from the enamel matrix in a pre-orthodontic situation according to the principle of guided tissue remodelling. By following the same protocol with the same operative sequences, it is possible today to replace the placement of a membrane with the application of an Emdogain® gel on the root surface of a tooth displaced orthodontically towards an infraosseous

Fig 9 Example illustrating the principle of guided tissue remodelling in the case of a bone defect associated with secondary migration.

Fig 9a Initial clinical situation.

Fig 9b Pre-operative view of 21 after lifting of a mucoperiosteal flap, and showing a circumferential infraosseous defect.

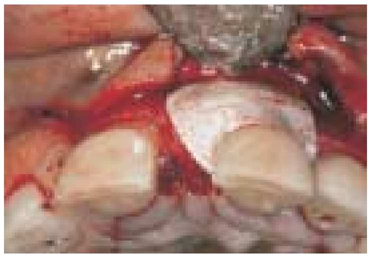

Fig 9c Occlusal view of the non-resorbable Gore-Tex membrane put in place.

Fig 9d Occlusal view after placement of the membrane at 5 weeks. The area of the infraosseous defect is occupied by newly regenerated tissue.

Fig 9e Clinical view after 4 weeks of healing and fitting of orthodontic appliance.

Fig 9f Surgical re-entry at the end of orthodontic displacement. Note the total closure of the diastema and the bone repair obtained around 21.

defect. The effectiveness of this method has been confirmed from a clinical model, and the results obtained have been clinically observed, once more, with the performance of a surgical re-entry at the end of orthodontic displacement (Fig 11).

In the same way, an experimental study in animals has shown that the application of an Emdogain® gel, at the experimental site, reduces the loss of attachment by encouraging the formation of a new connective tissue attachment, and that this type of healing around an orthodontically displaced tooth improves the conditions for tissue remodelling[7]. Although this study seems very convincing, and the case reports published in the literature appear to be very demonstrative, the reproducibility of all these pre-orthodontic periodontal regeneration methods remains to be demonstrated by clinical studies. The use of these combined techniques offers conservative solutions for the most compromised teeth where the progression of a periodontal lesion is accompanied by pathological migration. To be rewarded with success, the instructions must be clearly set out, and the technical principles followed rigorously. The surgical treatment phase must be preceded by a peri-

Fig 10 Clinical example illustrating the application of the principle of guided tissue remodelling in the treatment of a lesion associated with the presence of root proximities.

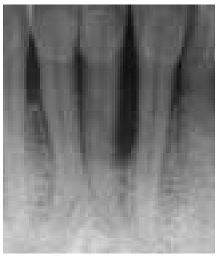

Fig 10a Initial radiograph.

Fig 10b and 10c Clinical views after extraction of 31. Note the bone loss on the medial sides of the adjacent teeth and the destruction of the labial cortex at the extraction site.

Fig 10d Placement of a non-resorbable membrane on the extraction site, in direct contact with the adjacent teeth.

Fig 10e Following removal of the membrane at 8 weeks, the whole space is occupied by newly regenerated tissue.

Fig 10f Clinical post-operative view after activation of mechanisms.

Fig 10g Final clinical situation.

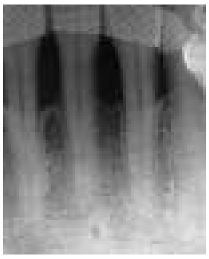

Fig 10h Final radiograph. Note the presence in the image of lamina dura the length of the root surfaces previously exposed, which is characteristic of a new connective tissue attachment.

Fig 11 Clinical example illustrating the application of the principle of guided tissue remodelling with the use of enamel matrix derived proteins (Emdogain®), before orthodontics, in the case of a bone defect associated with secondary migration.

Fig 11a Initial clinical situation.

Fig 11b Large bone defect shown to be present at 11 before being displaced orthodontically.

Fig 11c Prefgel® application.

Fig 11d Emdogain® gel application.

Fig 11e Suture technique.

Fig 11f Clinical situation at end of orthodontics.

odontal preparation allowing inflammation to be reduced and infection to be controlled. Meanwhile, the orthodontic phase must follow all the biomechanical principles of tooth displacement on reduced periodontium.

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