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 bone 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.
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 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.

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.
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...
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\textsuperscript{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
principle of guided tissue remodelling⁴, 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 involved⁵. 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 literature³,⁵, and the results obtained have been clinically observed with the performance of surgical re-entries at the end of orthodontic displacement (Fig 9).

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...
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. 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 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.

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.
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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.

References
