Infrabony Pockets and Reduced Alveolar Bone Height in Relation to Orthodontic Therapy

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Experimental animal studies have shown that orthodontic movement of teeth into infrabony pockets may be detrimental to the periodontal attachment. After elimination of subgingival plaque infection in the experimental animals, no additional loss of connective tissue attachment occurred. An experimental model has shown that a tooth with normal periodontal support can be orthodontically moved into an area of reduced bone height with maintenance of height of connective tissue attachment level and alveolar bone support. The results from these experimental studies have been tested clinically. (Semin Orthod 1996;2:55-61.) ***Copyright © 1996 by W.B. Saunders Company***

The question of whether orthodontic tooth movement may have deleterious effects on the periodontal tissues has been evaluated in a number of clinical and experimental studies. The results have shown that, provided periodontal health and proper oral hygiene standards are maintained during the phase of orthodontic therapy, no injury, or only clinically insignificant injury to the supporting tissues will occur. However, if the oral hygiene is less effective and periodontal inflammation is present during the orthodontic treatment, the studies have indicated an increased risk for adverse effects on the periodontium. This is important to remember, if orthodontic tooth movements should be performed in areas with infrabony pockets or in areas of reduced height of alveolar bone. This article will discuss relevant studies, together with some clinical applications, to improve our understanding of the advantages as well as the disadvantages of orthodontic treatment in such patients.

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Periodontal Tissue Response to Orthodontic Movement of Teeth With Infrabony Pockets

Experimental studies involving histological analysis have reported that orthodontic forces per se are unlikely to convert gingivitis into a destructive periodontitis.[1,2] The development of destructive periodontal disease, however, may result in the formation of infrabony pockets, ie, angular bony defects with inflamed connective tissues and the dentogingival epithelium located apical to the crest of the alveolar bone.[3]

Thus, it can be stated that orthodontic movement of teeth with healthy periodontal tissues will not cause loss of connective tissue attachment.[4-6] Also in areas with the presence of plaque-induced suprabony lesions, orthodontic forces per se have been shown to be incapable of causing accelerated destruction of the periodontal support.[6,7] This may be explained by the fact that the effect of orthodontic forces is generally confined to that portion of the periodontium which is bordered by hard tissues on both sides, whereas the suprabony connective tissue remains unaffected, because the latter portion will not be compressed between the hard tissues. However, it has also been shown that in buccal sites with gingival inflammation and where the tooth is moved out through the alveolar bone (ie, a buccal bone dehiscence is created), gingival recession and concomitant loss of connective tissue attachment may occur, if the covering soft tissue is thin.[7,8] It is most likely, however, that the causative factor for this destruction is the plaque-induced lesion, rather than the orthodontic trauma, because similar orthodontic movement of teeth with healthy marginal periodontal tissues did not result in attachment loss.[9,10]

The position of the plaque-induced lesion may, however, be shifted from a suprabony to an infrabony position, ie, into the area where orthodontic forces affect the periodontium, when tooth movement directed at tipping or intruding a tooth into the alveolar bone is performed. Under these conditions an enhanced rate of periodontal destruction is evident.[11] Thus, infrabony pockets may be created by orthodontic tipping and/or intruding movements of teeth harboring bacterial plaque. Deepened gingival pockets must be eliminated before any orthodontic tooth movement is started. After the orthodontic treatment, additional surgical pocket elimination is also performed, if necessary.[2]

In patients who have periodontal disease infrabony pockets are frequently found. Whether orthodontic tooth movement in areas with infrabony pockets may have a detrimental effect on the supporting tissues, has been discussed.

Orthodontic elimination of an infrabony pocket by tooth extrusion has shown a maintained relationship between the cemento-enamel junction and the bone crest, ie, the bone followed the tooth during the extrusion movement.[12] In contrast, teeth subjected to extrusion with concomittant fiberotomy, ie, the coronal portion of the fiber attachment was excised, the crestal part of the alveolar bone did not follow the root during extrusion, and consequently, the root movement resulted in an increased distance between the cemento-enamel junction and the alveolar bone crest.[12-15] Because of the orthodontic extrusion, the tooth will be in supraocclusion. Hence, the crown of the tooth will need to be shortened, in some cases followed by endodontic treatment.

The effect of bodily movement of teeth into infrabony periodontal defects has been evaluated in experimental studies in the monkey[5] and in the dog.[16] If periodontal treatment was performed before the orthodontic tooth movement was started, and the monkeys were subjected to plaque control measures during the entire course of the experiment, no deleterious effect was obtained on the level of the connective tissue attachment.[5] It was reported, that the angular bony defect was eliminated by the orthodontic treatment, but no coronal shift (gain) of the connective tissue attachment was found. Hence, a thin junctional epithelium covered the root surface to a level corresponding to the pretreatment position of the connective tissue attachment.

On the other hand, experiments in dogs have shown that orthodontic therapy involving bodily movement of teeth with inflamed, infrabony pockets may enhance the rate of loss of the connective tissue attachment.[16] In each dog, one premolar was moved away from the angular bony defect and one premolar into and through the angular bony defect (Fig 1). After orthodontic treatment (5 to 6 months), the teeth were stabilized for 2 months. Clinical, radiographic, and histological evaluations showed that it was possible to establish and maintain an infrabony pocket with a subcrestal, plaque-induced inflammatory leason during the entire course of the study. Although the control teeth had maintained their attachment levels, all but one of the orthodontically moved teeth showed additional loss of attachment (Fig 2). The risk for additional attachment loss was particularly evident when the tooth was moved into the infrabony pocket.

In conclusion, experimental studies in monkeys and dogs have shown that orthodontic movement of teeth into infrabony pockets may be detrimental for the periodontal attachment. After elimination of the subgingival plaque infection, no additional loss of connective tissue attachment occurred. The consequence from these experimental results is that elimination of plaque-induced lesions must precede the orthodontic treatment. This hypothesis has been tested in a series of patients with infrabony pockets resulting from periodontal disease (Fig 3).[2] Clinical and radiographic observations have shown, that orthodontic treatment can be successfully performed in such cases, provided that periodontal treatment directed at the elimination of the plaque-induced lesion precedes the initiation of orthodontic therapy, and that proper oral hygiene is maintained during the course of orthodontic treatment.

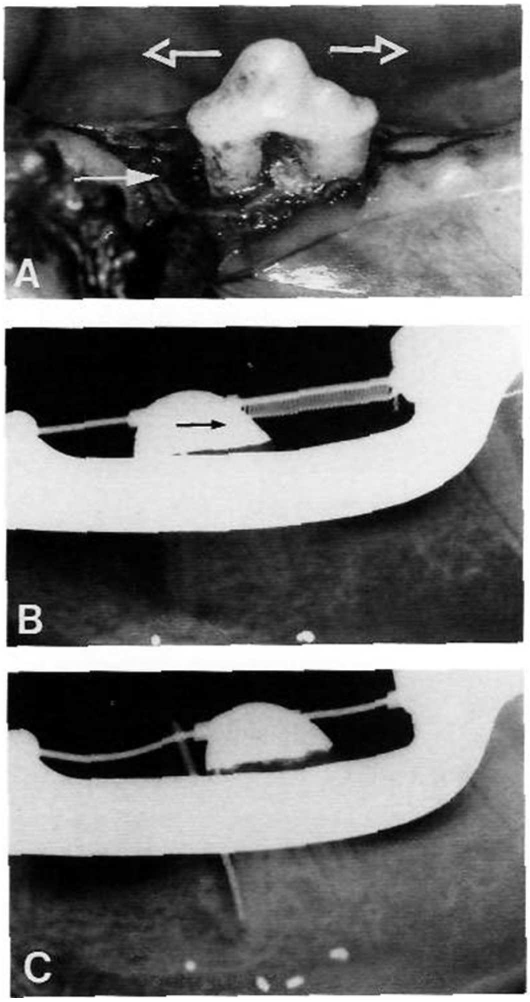

Figure 1. Clinical appearance (A) of the two to three walled angular bony defect (arrow), extending to a level corresponding to about 50% of the root length. A notch was prepared at the bottom of the angular defect. The tooth was then moved away from, or into and through the defect (open arrows). Radiographs obtained at the start of the orthodontic tooth movement (B) and at termination of the experimental period (C). Arrow indicates the direction of tooth movement, ie, away from the defect. The displacement of the tooth is related to the titanium pins, inserted in the buccal cortical bone. (Figs 1 (B-C) reprinted with permission.[16])

Periodontal Tissue Response to Orthodontic Movement of Teeth into Edentulous Areas with Reduced Bone Height

In patients with partially edentulous dentitions, because of congenitally absent or the extraction of teeth, orthodontic treatment often has to be performed. By positioning the teeth toward, or into, the edentulous area, improved esthetic and functional results may be gained.[18-20] In many of these individuals there is a reduced alveolar bone height.

Orthodontic forces, induced for bodily tooth movement, will result in different reactions in the periodontal tissues on the pressure and on the tension sides. Bone resorption occurs on the pressure side as a consequence of trauma-induced reactions within the periodontal ligament tissue, whereas on the tension side a continuous bone apposition will be seen resulting in a maintained width of the periodontal ligament.[21]

The tissue changes occurring on the pressure side during orthodontic tooth movement are confined to the infrabony area of the root, ie, the area of supporting bone where the periodontal ligament will be compressed between the two hard tissues. Hence, orthodontic tooth movement will not induce reactions in the supracrestal area resulting in loss of connective tissue attachment.[7,9,10] The applied forces will lead to demineralization of the supporting bone, which in turn allows the tooth to move in the direction of the force. No bone remineralization is observed adjacent to a tooth that has been moved out through the bony plate, ie, when an alveolar bone dehiscence has been created.[7,8,9] However, when such a tooth is moved back into the alveolar bone housing, bone apposition will take place in the area of the previous dehiscence.[9,10,22,23] The results of these studies indicated that the soft tissue, facial to a produced bone dehiscence, contains a bone matrix with the capacity to remineralize following repositioning of the tooth into the alveolar process. It may thus be speculated, that genetic factors controlling the dimensions of the alveolar process may be the reason for the lack of remineralization of the bone matrix buccal to a tooth which has been moved buccally out of the alveolar housing on the buccal side of the dental arch.

Hence, based on the findings in the studies referred to, it could be anticipated that, as long as orthodontic tooth movement is performed within the genetically determined boundaries of the jaw, the tooth will maintain the original height of the supporting apparatus, ie, its connective tissue attachment level and its alveolar bone height. An experimental model in a beagle dog

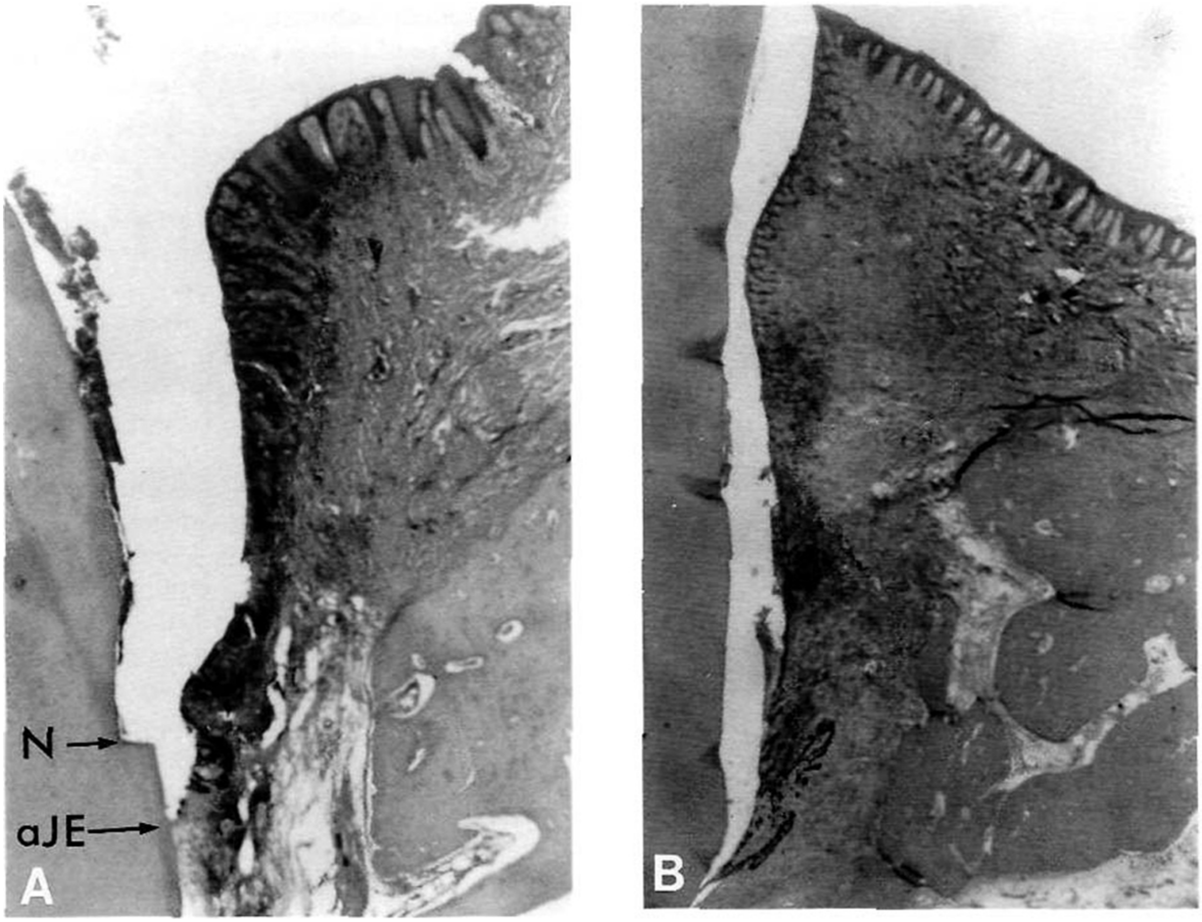

Figure 2. Specimens from a tooth orthodontically moved into (A) and away from (B) the infrabony pocket, showing presence of an inflammatory cell infiltrate in the connective tissue adjacent to the pocket epithelium. The termination of the dentogingival epithelium (aJE) apical to the notch (N) indicates additional loss of connective tissue attachment, when the tooth is moved into the defect. (Fig 2(A) reprinted with permission.[16])

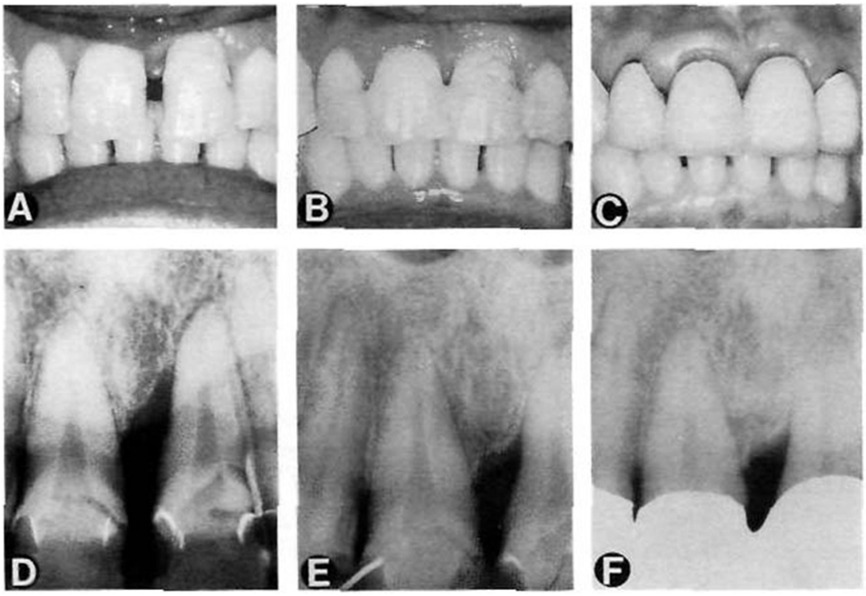

Figure 3. A 40-year-old woman had had periodontal treatment for the infrabony pocket mesial to the maxillary left central incisor (A and D). Proper oral hygiene was maintained, and the spaces in the anterior segment were closed by means of a fixed appliance using very light forces. Semipermanent retention performed 6 months later. A further control 6 months later showed improvement of the bony defect (B and E). Permanent retention then was carried out. Posttreatment control 5 years later (C and F). Note the improvement of the bony defect. (Reprinted with permission.[21])

was designed to test this hypothesis by orthodontically moving teeth into edentulous areas with reduced bone height (Fig 4).[24] None of the teeth whether moved orthodontically or not, showed loss of connective tissue attachment (Figs 5 and 6). Hence, at all teeth, the most apical cells of the junctional epithelium were located at the cemento-enamel junction (CEJ). The newly established periodontal ligament exhibited a normal width, both on the pressure and on the tension side of the displaced teeth.

On the tension side both the original height and width of the supporting bone were fully maintained. On the pressure side, supporting alveolar bone was also present, extending far coronal to the surrounding, experimentally created bone level, but not reaching the complete height as the original supporting bone. It is obvious when analyzing the histological sections, that the supporting bone on the pressure side, not visualized in the radiograph, was much thinner than the original bone. The histological picture of the bone tissue in the coronal portion of the root showed a high number of cells in contrast to the compact appearance of the more apically located bone (Fig 6). The explanation for this finding can only be speculated on.

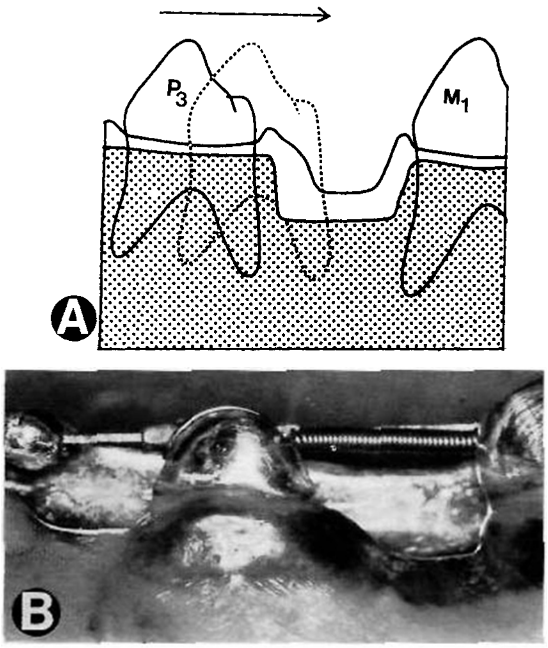

Figure 4. Schematic drawing (A) and clinical photograph (B) illustrating the bodily movement of the third premolar into the area with reduced alveolar bone height. (Fig 4(A) reprinted with permission.[24])

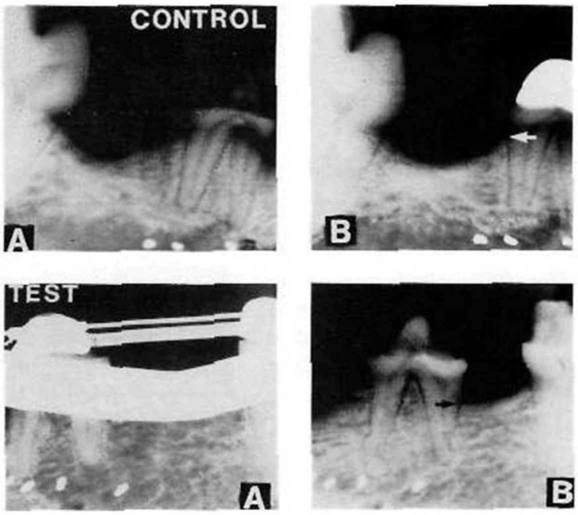

Figure 5. Radiographs obtained at the start of the orthodontic movement (A) and at the termination of the experiment (B) of a test tooth and the contralateral control tooth. Note the difference in radiographic bone height (arrows). Titanium pins indicate the displacement of the test tooth. (Reprinted with permission.[24])

Following similar tooth movement in a facial direction outside the boundaries of the jaw, no bone remineralization will be found.[7,10] In contrast to the heavy forces used when moving teeth out buccally through the bony plate, only very light forces were applied when moving the teeth bodily into the area with reduced bone height. The use of light forces may explain that, only the inorganic component of the alveolar bone was lost, as a consequence of the biological response to the orthodontic force, and that the organic component was maintained which was likely to result in remineralization of bone. The interesting finding, that the newly formed bone on the pressure side shows resorption on the surface near the root and apposition on the opposite side of the thin bone plate, may also be explained by the piezoelectrical theory. The changes that occur in alveolar bone during tooth movement have been interpreted to be related to a piezoelectrical effect through strain-generated potentials, arising as a result of mechanically induced deformation of collagen or hydroxyapatite crystals.[25]

In conclusion, an experimental model has shown that a tooth with normal periodontal support can be orthodontically moved into an area of reduced bone height with maintained height of the supporting apparatus, ie, main-

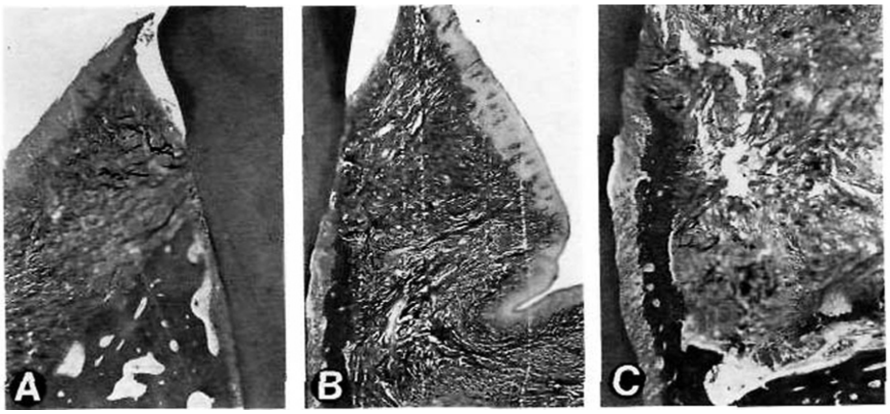

Figure 6. Specimens from the control (A) and the test tooth (B and C magnification), shown in Figure 5. The thin bone along the pressure side of the test tooth is not visualized in the radiograph. (Reprinted with permission.[24])

tained connective tissue attachment level and in all essentials maintained alveolar bone support. These experimental results have been tested in partially edentulous patients with normal periodontal tissue support, located adjacent to an edentulous area with reduced bone volume. Teeth have been orthodontically moved into such an area and used for a fixed partial denture (Fig 7).[17] The results of these clinical follow-up studies are encouraging, provided that bodily tooth movements with light orthodontic forces are used, and proper oral hygiene is maintained.

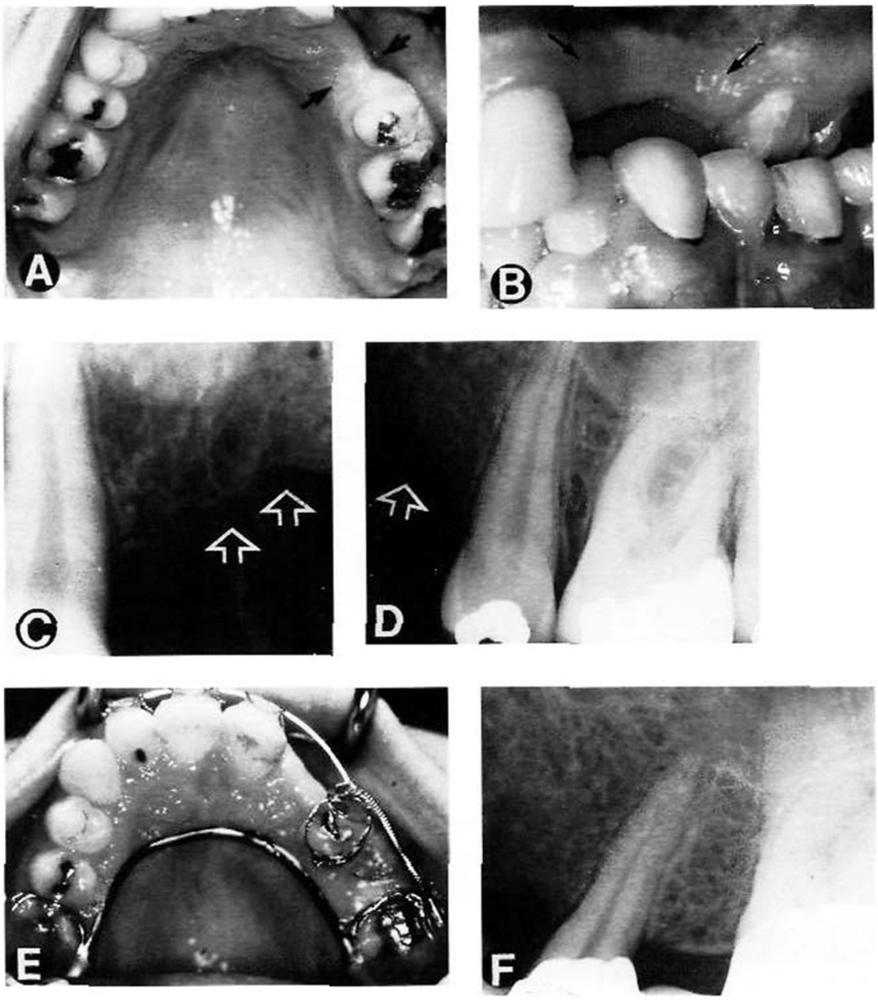

Figure 7. A 25-year-old man partially edentulous because of trauma. Marked bone loss in the left maxillary alveolar process (A, B, C, and D) (indicated by arrows). The second premolar was moved bodily one cusp width into the area with reduced bone support (E). After a treatment period of 12 months, a prosthetic bridge was constructed. Note the regaining of alveolar bone (F). (Reprinted with permission.[21])

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