Periodontic and orthodontic treatment in adults

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The purpose of this article is to provide an update of the interrelationship between periodontics and orthodontics in adults. Specific areas reviewed are the reaction of periodontal tissue to orthodontic forces, the influence of tooth movement on the periodontium, the effect of circumferential supracrestal fiberotomy in preventing orthodontic relapse, the effect of orthodontic treatment on the periodontium, microbiology associated with orthodontic bands, and mucogingival and esthetic considerations. In addition, the relationship between orthodontics and implants (eg, using dental implants for orthodontic anchorage) is discussed. (Am J Orthod Dentofacial Orthop 2002;122:420-8)

The past 2 decades have seen greater focus on dentofacial esthetics in the adult population with an increasing demand for orthodontic treatment in appearance-conscious adults.[1,2] The primary motivating factor in this group of patients has been reported to be a desire to improve dental appearance.[3] Special attention must be given to the periodontal status of adults because they are more likely to have already experienced periodontal disease. Epidemiologic studies show that, although the worldwide prevalence of gingival inflammation is high, advanced periodontal disease affects a small percentage of the population about 8% to 30%.[4,5] There is a greater incidence of periodontal disease in patients with a history of the disease and a greater incidence in certain teeth, especially the maxillary and mandibular molars.[6]

Thus, it is important to identify patients who are susceptible to the more severe manifestations of the disease and to control existing disease before starting a treatment plan involving comprehensive orthodontics. The classic periodontal patient usually presents with the maxillary labial segment showing proclination, irregular spacing, rotation, and overeruption of the dentition. These changes in tooth position might complicate long-term periodontal care by decreasing the ease of plaque control and compromise the esthetics and function of the dentition.

Orthodontic treatment planning for any malocclusion will involve determining the type and the sequence of tooth movements. This could be either adjunctive orthodontic treatment (tooth movement to improve a particular aspect of the occlusion in order to facilitate other dental procedures that are needed to control disease and restore function) or comprehensive orthodontic treatment (treatment to correct the malocclusion). The purpose of this article is to review issues related to periodontics and orthodontics in adults with special emphasis on the periodontally compromised patient.

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PERIODONTAL TISSUE RESPONSE TO TOOTH MOVEMENT

Tooth movement during orthodontic therapy is the result of placing controlled forces on teeth. Table I summarizes the response of the periodontal ligament (PDL) to various magnitudes of orthodontic forces.

Age per se is not a contraindication to orthodontic treatment. In the elderly, the tissue response to orthodontic forces including both cell mobilization and conversion of collagen fibers is much slower than in children and teenagers.[7] This is due to reduced cellular activity and the tissues becoming richer in collagen. In adults, hyalinized zones are formed more easily on the pressure side of an orthodontically moved tooth, and these zones might temporarily prevent the tooth from moving in the intended direction.[8] This delay in tooth movement varies from short, with the application of light forces, to long periods of time, with heavier forces.

The hyalinized zone is eliminated by PDL regeneration that occurs from the reorganization of the area through resorption by the marrow spaces (undermining resorption) and the adjacent areas of unaffected PDL

Table I. Periodontal tissue response to orthodontic force

Force	*Tissue response*
Strong/heavy force (forces far exceeding capillary blood pressure)	PDL on pressure side of tooth is crushed resulting in local ischemia and degeneration of PDL = hyalinization = more delay in tooth movement
Moderate force (forces exceeding capillary blood pressure)	PDL strangulation resulting in delay in bone resorption
Light force (forces less than capillary blood pressure)	PDL ischemia with simultaneous bone resorption and formation = more continuous tooth movement

and alveolar bone. Once the hyalinized zone is removed, teeth can move again. It has been shown that regeneration of the PDL does not occur when inflammation is present in the periodontal tissues.[9] Thus, inflammation must be controlled through periodontal treatment. Furthermore, unlike in children and adolescents, growth and development have ceased in adults and cannot be influenced by orthodontic movements.[10]

In periodontally compromised dentitions, the loss of alveolar bone results in the center of resistance of the involved teeth moving apically, and the net effect is that teeth are more prone to tipping than to moving bodily.[11] Thus, treatment is often limited to different types of tooth alignment. The use of segmental arch mechanics to provide incisor intrusion, with light forces, has been recommended to correct a deep overbite and to level arches in nongrowing patients, instead of molar extrusion.[12] The combination of orthodontic intrusion and periodontal treatment has been shown to improve compromised periodontal conditions, if oral hygiene is maintained and tissues are healthy.[13] However, root resorption of 1 to 3 mm has been associated with intrusion of incisors in adult patients showing marginal bone loss and deep overbite. Therefore, light forces (between 5 and 15 g per tooth) have been recommended when the periodontium is healthy in adults.[14] Re et al,[15] in a 12-year report, showed orthodontic treatment is no longer a contraindication in the therapy of severe adult periodontitis. In such cases, orthodontic treatment might enhance the possibilities of saving and restoring a deteriorated dentition.

Orthodontic movement of endodontically treated teeth is also possible because the response of the PDL, not the pulp, is the key element in such movement.[16] Similarly, light interrupted forces should be used because evidence indicates that such teeth are slightly more prone to root resorption during orthodontic treatment than are teeth with normal vitality.[16]

INFLUENCE OF ORTHODONTIC FORCES ON THE PERIODONTIUM

When moving teeth orthodontically, the entire periodontal attachment apparatus, including the osseous structure, the PDL, and the soft tissue components, moves with the tooth.[17] Based on this principle, orthodontic repositioning of tipped molars has been shown to have beneficial effects on the periodontium. Considerable and predictable morphological alterations to the crestal bone accompany tooth uprighting, even though the connective tissue attachment level remains unchanged along the root surface.[18-20]

Similarly, forced eruption has also been reported to achieve a reduction of probing depths in isolated vertical intrabony defects.[21] Another benefit of forced vertical eruption is in the exposure of tooth structure; this facilitates prosthetic treatment to manage carious or traumatic destruction of clinical crowns and lateral root perforations.[22-24] Studies have also shown that moving teeth into adjacent osseous defects, orthodontic extrusion with and without fiberotomy, and labial tipping of anterior teeth can be successfully accomplished without jeopardizing the periodontal support when there is adequate plaque control.[17,25-31]

Results extrapolated from animal studies in dentitions with reduced periodontia show that, without plaque, orthodontic forces and tooth movements do not induce gingivitis.[9,32,33] In the presence of plaque, however, similar forces can cause angular bone defects, and, with tipping and intruding movements, attachment loss can occur.[9] In regions of healthy reduced periodontal tissue support, orthodontic forces kept within biologic limits do not cause gingival inflammation.[9] The most important factor in the initiation, progression, and recurrence of periodontal disease in a reduced periodontium is microbial plaque.[32,33] Clinical studies have demonstrated that, with adequate plaque control, teeth with reduced periodontal support can undergo successful tooth movement without compromising their periodontal situation.[34,35]

EFFECT OF CIRCUMFERENTIAL SUPRACRESTAL FIBEROTOMY

Tooth repositioning (eg, rotation) is easy to accomplish but often difficult to maintain. Reorganization of PDL fiber complexes, and surrounding collagenous and elastic fibers, occurs after orthodontic tooth movement

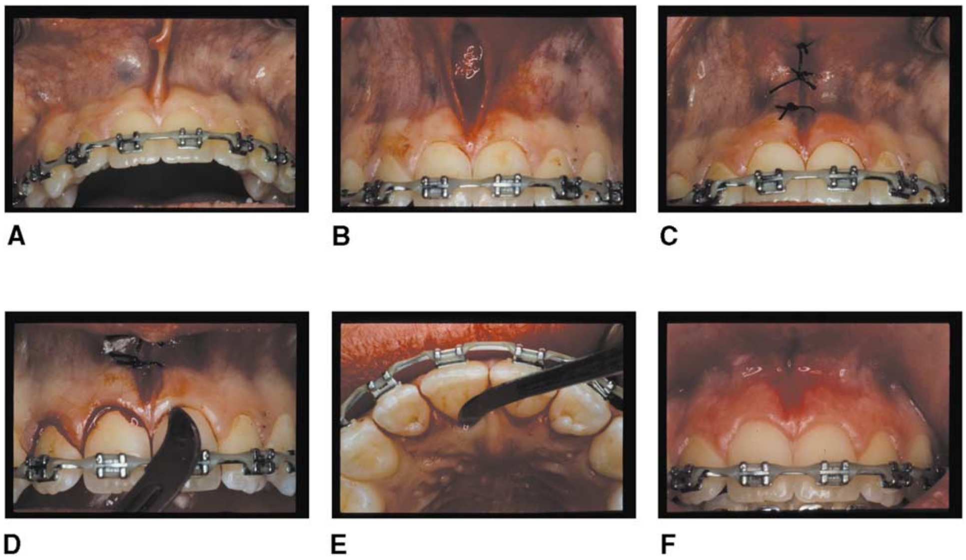

Fig 1. Frenectomy and circumferential supracrestal fiberotomy after orthodontic treatment (courtesy of Dr Robert O'Neal, University of Washington, Seattle): **A**, thick frenum between central incisors at end of orthodontic treatment; **B,** frenectomy was performed with scalpel; **C**, frenum was removed and site closed with 3 interrupted sutures; **D**, buccal view of circumferential supracrestal fiberotomy with #12 blade; **E**, lingual view of circumferential supracrestal fiberotomy with #12 blade; **F**, results after 2 weeks of healing.

to accommodate the new tooth positions. Sharpey's fibers of the newly formed bundle bone, supra-alveolar and transseptal fibers, and the principal fibers of the PDL (oblique fibers) undergo rearrangement even after a retention period of 4 to 6 months.[36,37] Hence, the retention period should continue part-time for at least 12 months to allow time for remodeling these periodontal tissue fibers.

Edwards[38] successfully used circumferential supracrestal fiberotomy (CSF) to treat 12 postorthodontically rotated teeth. A long-term prospective study of the CSF procedure in reducing dental relapse after tooth movement was published later.[39] A total of 320 consecutively treated control and CSF subjects were recorded at approximately 4 and 6 years after active treatment and again at 12 and 14 years after active treatment. The statistical differences between the mean relapses of the 2 groups were highly significant at both time intervals. It is estimated that CSF reduced the mean relapse by almost 30%. No significant increase in sulcus depth or signs of gingival recession on the labial or lingual aspects of the CSF group of teeth were noted.

It has been reported that most relapse after orthodontic treatment occurred during the first 5 hours after the appliance was removed.[36] CSF surgery should be performed toward the end of the finishing phase of active orthodontic treatment to minimize this relapse caused by the network of elastic supracrestal gingival fibers (Fig 1). Such orthodontically treated malaligned teeth would by then have been held in their new positions for several months to accommodate the reorientation of the PDL fibers and the crestal transseptal fibers. In addition, it has been demonstrated that repeated use of CSF during forced eruption for clinical crown lengthening of a tooth can prevent the coronal displacement of the gingiva and the attachment apparatus.[31] This can reduce the need for additional recontouring of gingival and osseous tissue after completing orthodontic movement of the tooth.

EFFECTS OF ORTHODONTIC TREATMENT ON PERIODONTAL TISSUES

The main short-term effects of orthodontic bands on the periodontium are gingivitis and gingival enlargement. Gingival enlargement occurs after placement of a fixed appliance. This condition rapidly improves within 48 hours after the appliance is removed.[40] The increase in probing depth during orthodontic treatment has also been attributed to this enlargement.[41-43] Because this gingival enlargement is also seen in patients with good oral hygiene, mechanical irritation caused by the band or cement, in addition to trapped plaque, can be implicated.[41,44] When such iatrogenic irritations are

inevitable, the risk of loss of attachment can be anticipated.[43]

In patients with no periodontal disease and with good oral hygiene, including adults with reduced but healthy periodontia, proper orthodontic treatment causes no significant long-term effects on periodontal attachment and bone levels.[34,35,45-47] However, in adults with active periodontitis (plaque-infected deep pockets evidenced by bleeding on probing), orthodontic tooth movement might accelerate the disease process, even with good oral hygiene.[9,47,48]

Two retrospective studies in adults concluded that no significant damage to the periodontium occurred after orthodontic therapy.[46,49] Recently, Quirynen et al,[50] in a 4-to-10-year retrospective study, reported that orthodontic extrusion of impacted front teeth did not jeopardize their periodontal health.[50] In another 2-year postorthodontic study, 30 women who had multibanded therapy were compared with 30 age-matched controls. It was found that the orthodontically treated patients had a higher prevalence of root resorption (17% vs 2%), although there was a lower prevalence of mucogingival defects (5% vs 12%). This root resorption was most common in the maxillary incisors followed by the mandibular incisors.[51] Root resorption is a side effect of orthodontic treatment; it is usually minor, about 1 to 1.5 mm.[52] Owman-Moll and Kurol[53] examined the risk factors for root resorption, including root morphology, gingivitis, allergy, nail-biting, and medication. They indicated that only allergy showed an increased risk of root resorption, but it did not reach a statistically significant level. Levander and Malmgren[54] further determined that the maxillary central incisor with a remaining total root length of less than 9 mm had a higher risk of increasing tooth mobility.[54]

In a cross-sectional study, radiographic crestal bone levels in 104 adults, who had completed orthodontic therapy at least 10 years previously, were shown to be no different from 76 matched control subjects.[55] However, another study in adolescents indicated that up to 10% of the 38 children had significant loss of attachment (mean, 1-2 mm) in 2 years.[56] In a recent study, 267 adults who had severe periodontal disease with pathologic migration of the anterior teeth had combined orthodontic-periodontal treatment. Before orthodontic treatment began, 129 of them had surgical periodontal treatment (modified Widman flap), and the rest had nonsurgical treatment with hand instruments or ultrasonic devices. They were followed for varying periods (2 to 12 years) after the end of treatment. The results of this study suggest that orthodontic treatment is not a contraindication in the therapy of severe adult periodontitis, and, in such cases, it might improve the possibilities of saving and restoring a deteriorated dentition.[15]

Table II. Effects of orthodontic treatment on the periodontium

Term	*Effect*
Short	Gingivitis and gingival enlargement No attachment loss Effects are reversible
Long	Root resorption (1.0-1.5 mm) Attachment loss in areas of active periodontitis Effects are often irreversible

In adults, it thus appears that, apart from root resorption, orthodontic treatment has minimal detrimental effects on the health of the periodontium in both the short and long terms. This is summarized in Table II.

MICROBIOLOGY ASSOCIATED WITH ORTHODONTIC BANDS

Plaque is a primary etiologic factor in gingivitis.[57] The patient's inability to clean adequately around orthodontic devices promotes plaque accumulation, thus leading to gingival inflammation. An overall increase in salivary bacterial counts, especially *Lactobacillus*, has been shown after orthodontic band placement.[58] Similarly, 2-fold and 3-fold increases in both clinical indexes and numbers of motile organisms have been reported at sites 6 months after appliance placement,[59] as well as early increases in anaerobes and *Prevotella intermedia*, and a decrease in facultative anaerobes.[60,61] This shift in the subgingival microflora to a periopathogenic population is similar to the microflora at periodontally diseased sites.[62]

Studies comparing the microbiologic and periodontal responses in adolescents and adults show that adults appear to be at no greater risk than are adolescents to develop periodontal disease after orthodontic treatment.[35,59]

MUCOGINGIVAL AND ESTHETIC CONSIDERATIONS

The position in which a tooth erupts through the alveolar process and its eventual position in relation to the buccolingual dimension of the alveolar process influence the amount of gingiva that will be established around the tooth.[63] In the past, it was thought that a minimum 2 mm of gingiva, corresponding to 1 mm of attached gingiva, was necessary to maintain gingival health.[64] However, later studies showed that minimal bands of gingiva could be maintained in periodontal

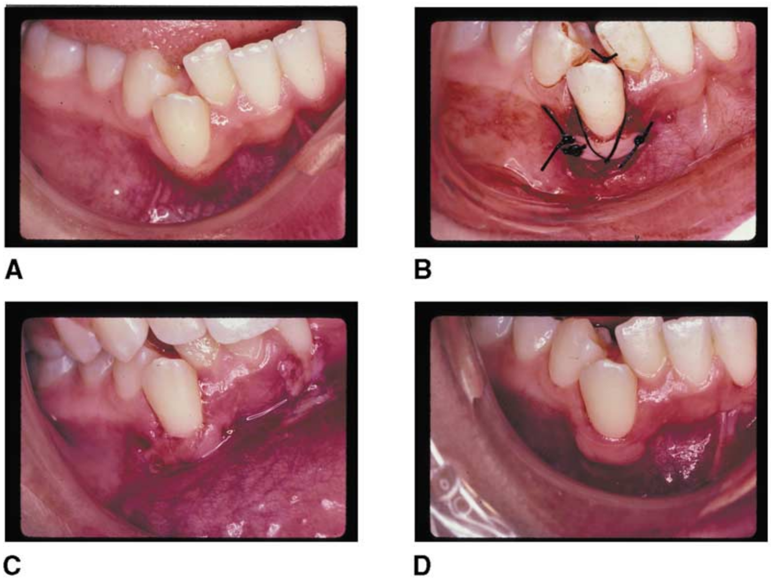

Fig 2. Gingival graft in 15-year-old girl planning to have orthodontic treatment: **A**, mandibular right canine had minimal and thin keratinized gingiva; **B**, free gingival graft placed and secured with sutures; **C**, after healing for 1 week; **D**, 6 months of healing showed gain of 3 mm root coverage.

health without progressive recession if traumatic toothbrushing and inflammation were controlled.[65-68]

A retrospective study of orthodontically treated adults showed a low prevalence of mucogingival defects (5%).[51] Other clinical studies have shown that a narrow band of gingiva can withstand the stress caused by orthodontic forces.[69,70] Results from an experimental study indicate that as long as the tooth is moved within the envelope of the alveolar process, the risk of harmful side effects on the marginal soft tissue is minimal.[71] Gingival augmentation might be considered when facial tooth movement with thin keratinized gingiva (Fig 2) could cause alveolar bone dehiscences with resultant marginal tissue recession.[72-74] Mucogingival interceptive surgeries, including double pedicle grafts, apically positioned flaps, and free gingival grafts, have been shown to be effective approaches to conserving the keratinized buccal gingiva of ectopically erupting premolars over 7 years.[75] No difference was noted among the 3 procedures.

Northway and Meade[76] reported that surgically assisted rapid maxillary expansion produced more acceptable long-term buccal gingival conditions. However, Carmen et al[77] reported twice the incidence of gingival recession of maxillary premolars and molars in surgically assisted rapid maxillary expansion when compared with orthopedic expansion. Nonetheless, both treatments achieved the goal of transverse diameter maxillary expansion.

Patients with 3 unesthetic situations—gingival margin discrepancies, missing papilla, and gummy smile—might present for orthodontic treatment.[78] Discrepancies in gingival margin heights can be due to ectopic initial eruption of the tooth and resolved by surgical or orthodontic means, depending on the underlying cause of the defects. The sulcus depth and the clinical crown height of the teeth in question are considered.

Missing papillae might be due to several factors, including advanced periodontal disease with loss or cratering of interdental alveolar crest giving rise to the loss of papilla. The esthetics in this situation might be improved with a combination of enameloplasty, tooth movement, and selective cosmetic bonding.

The gummy smile (Fig 3), or the excessive display of gingiva on smiling, is usually due to vertical maxillary excess, delayed apical migration of the gingival margins, or overeruption of the maxillary anterior teeth, in an otherwise normal vertical maxillary development (Class II Division 2 malocclusions).

In adult patients with vertical maxillary excess, orthognathic surgery is necessary to correct a gummy smile. In patients with delayed apical migration of gingival margins, usually seen between 12 and 15 years of age, the timing of gingival surgery (before or after orthodontic appliances are removed) depends on the wear at the incisal edges of the central and lateral teeth.

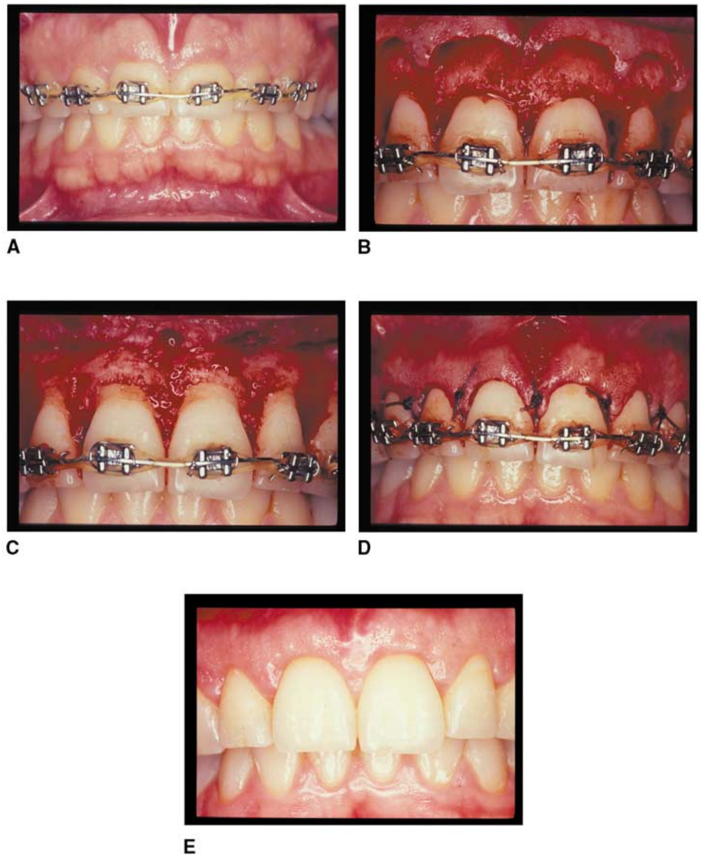

Fig 3. Correction of gummy smile in patient who just completed orthodontic treatment: **A**, unesthetic maxillary labial frenum and gummy smile due to altered passive eruption (no bone loss or probing pocket depths ≥3 mm were noted); bone sounding confirmed epithelial attachment was on enamel, and osseous crests approximated cementoenamel junctions of all anterior teeth; **B**, apically positioned flaps with ostectomy were performed to correct problem; osseous crest was approximated at level of cementoenamel junctions; frenectomy was also performed to correct aberrant frenum; **C**, bone removal was performed with end-cutting diamond burs and hand instruments to provide 1.5 to 2.0 mm between crestal bone and cementoenamel junctions (for biologic width); **D**, flap was repositioned and sutured; **E**, improvement of gingival contours and esthetic appearance 6 months after surgery.

Finally, in patients with overeruption of the maxillary anteriors with normal vertical maxillary development, orthodontic therapy involving intrusion of the overerupted incisors is the treatment of choice.

IMPLANTS AND ORTHODONTICS

The advantages of implants for orthodontic anchorage have been recognized over the last decade.[79-83] Studies have shown the potential of implants for orthodontic anchorage in preprosthetic tooth alignment,[84-87] retracting and realigning malpositioned teeth,[88-90] closing edentulous spaces,[91-93] correcting midline and anterior tooth spacing,[88] reestablishing proper anteroposterior and mediolateral positions for malposed molar abutments,[89,94] intruding or extruding teeth,[88,94-96] correcting a reverse occlusal relationship,[86,91,97] correcting an anterior open occlusal relationship,[84] protracting an arch or the entire dentition, and providing stabilization for teeth with reduced bone support.[88]

Acquiring adequate support for orthodontic tooth movement is a major challenge in adult orthodontic treatment, especially in areas of partial edentulism and limited amounts of alveolar bone support. In addition, severely periodontally compromised teeth might experience further periodontal breakdown and might eventually be lost during treatment. In such situations, the option of removing these teeth and using implants for

the needed orthodontic anchorage has become a clinical reality. Implant-orthodontic anchorage has become a valid treatment option for patients in whom conventional orthodontic treatment might not be indicated because of lack of proper anchorage (eg, a periodontally compromised dentition that offers inadequate anchorage for the necessary tooth movement).

SUMMARY

Periodontal disease and its sequelae often lead to unesthetic and functional problems, either alone or with other restorative problems. Adult orthodontic therapy has a role in providing complete rehabilitation in terms of both appearance and function with a satisfactory long-term prognosis if the patient is reasonably motivated and responds well to initial periodontal therapy. Periodontal health is essential for any form of dental treatment. Good oral hygiene at home and professional maintenance visits are important during and after active orthodontic treatment.

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