The Toothbrush and Gingival Traumatic Injury*

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THIS PAPER EXPLORES, by means of clinical observation, toothbrush misuse and its relationship to gingival recession/clefting. The morphology of the lesions created is correlated with the vigor, duration, frequency and direction of the toothbrush abuse. In addition, histologic observations of biopsied tissue from different types of clefts and recessions are used as a basis for discussion of the possible pathogenesis of this type of lesion.

Gingival recession has been related separately and collectively to inflammation,[1-3] malalignment of teeth,[4-7] toothbrushing,[5,8,9] factitious injuries,[10,11] muscle pull,[12-14] orthodontic tooth movement[15-18] and iatrogenesis.[2]

In his classical paper "The Toothbrush: Its Use and Abuse," Hirschfeld[12] discussed toothbrush misuse as an etiological factor in gingival injuries. He dealt with arch form, toothbrush technique, excessive force and brush design, relating them all to the problem. Gorman,[5] in studying the etiology of gingival recession, concluded that tooth malalignment and toothbrushing are indeed the most common factors associated with gingival recession. Sangnes and Gjermo[19] have confirmed that different types of traumatic injuries may result in a variety of gingival lesions.

In 1948 Bass[20] showed that severe lesions can be produced on the gingiva of dogs by severe toothbrushing. He generally concluded that a soft brush with rounded bristle ends did not cause damage whereas a brush with thicker unrounded bristles did cause irritations. Breitenmoser, in 1979,[9] in studying the damaging effect of toothbrush bristle-end form on the gingiva concluded that, with standardized brushing forces, cut bristle ends were more damaging than rounded ends. Interestingly, the toothbrushing technique used in this study was the Bass method.

In their study on the incidence of gingival recession O'Leary et al.[21] showed an increase in recession that was correlated with lower plaque scores achieved with improved home care. This was thought to be due to a reduction in inflammatory gingival enlargement. It is also possible that some of the change may be attributed to toothbrush trauma. According to Sangnes,[22] Waerhaug in 1967 pointed out that pockets generally associated with gingival recession are shallow. These findings have also been corroborated in therapeutic studies,[23,24] and it is likely that they may be connected to toothbrush misuse.

There still appears to be little information regarding toothbrush trauma and the resultant gingival lesions. This paper will attempt to add to the body of information with the presentation of:

1. A series of clinical cases relating toothbrush misuse to various types of gingival injuries and lesions.
2. Histological observations made on tissue biopsies taken from the gingiva surrounding such lesions.
3. Thoughts on the pathogenesis of cleft/recessions related to toothbrush trauma.

CLINICAL CASE REPORTS

Case Report No. 1—Figure 1. This report concerns a 23-year-old female who, soon after beginning secretarial work in a periodontal office, became aware of tenderness in her marginal gingiva around the mandibular bicuspids bilaterally. She admitted to intensified force and frequency of toothbrushing, related to office influences. The brushing technique used was a horizontal scrub method using a medium nylon brush. Clinical examination revealed a very early loss of marginal gingiva in the first mandibular right bicuspid gingival area (Fig. 1A), and a very early marginal laceration in the contralateral homologous area (Fig. 1B). This case indicates that gingival recession related to toothbrush trauma can be diagnosed very early.

Case Report No. 2—Figure 2. An 18-year-old female complained of frequently recurring "ulcerations" in her marginal gingiva. The patient admitted to excessively frequent daily toothbrushing, using a firm nylon toothbrush with both a horizontal and vertical scrub stroke. Examination revealed acute gingival trauma with associated recession on the maxillary left lateral incisor and laceration of the marginal gingiva of the mandibular left cuspid (Fig. 2A). Altering the brushing tech-

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nique, type of brush and frequency of brushing resulted in spontaneous healing but with residual recession on the lateral incisor (Fig. 2B) as compared to the right lateral incisor (Fig. 2C).

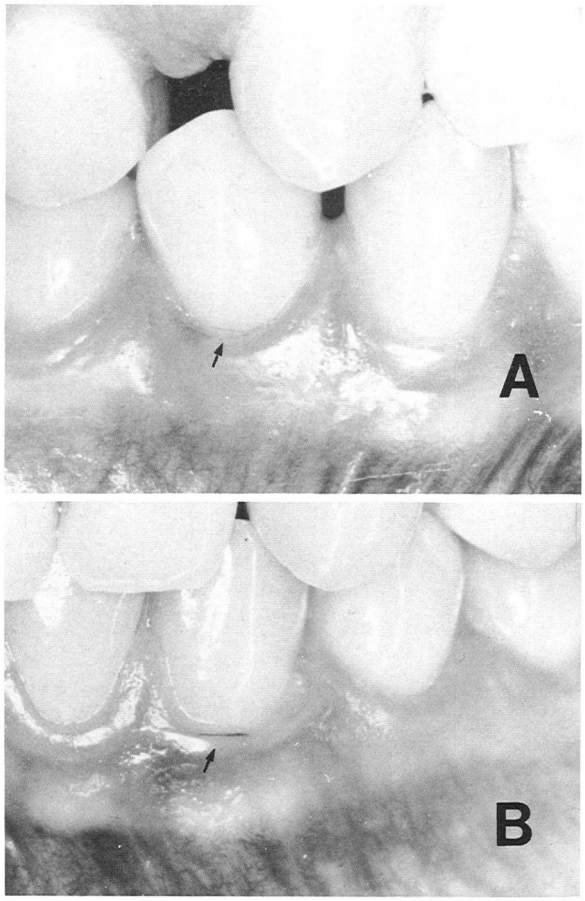

Figure 1. **A,** *note recent traumatic marginal gingival loss Tooth No. 28.* **B,** *note very early traumatic laceration of gingival margin Tooth No. 22.*

Case Report No. 3—Figure 3. This pattern of traumatic gingival injury and recession, in a 42-year-old male, was discovered during an initial periodontal examination. The patient had previously used a horizontal scrubbing stroke with a firm toothbrush but had in recent months used a soft nylon toothbrush and a vertical brushing stroke. Clinical examination revealed a broad recession in the mandibular left cuspid and bicuspid regions which was probably related to his previous brushing technique. The bicuspid marginal gingiva also revealed a recent vertical laceration with early clefting, associated with the changeover to an excessive vertical stroke (Fig. 3A). Observation of the patient's technique indicated the cause and effect as illustrated in the posed photograph (Fig. 3B).

Case Report No. 4—Figure 4. This 29-year-old female patient was referred by her dentist for treatment of the gingival clefts and recession associated with the maxillary right lateral incisor and cuspid teeth (Figs. 4A and B). The patient admitted to very rigorous use of a soft nylon multitufted toothbrush with a combination of a circular and an oblique scrub technique. The latter is illustrated in the posed photographs (Figs. 4A and B)—note the change in direction of the brushing stroke and the relation to the morphology and direction of the gingival clefts.

Case Report No. 5—Figure 5. This 30-year-old male patient was conscious of a "yellow" coloration of his teeth which he was almost obsessively trying to remove by vigorous horizontal toothbrushing with a firm toothbrush. On being informed of the danger of using a firm brush he had, in recent years, changed to a soft nylon

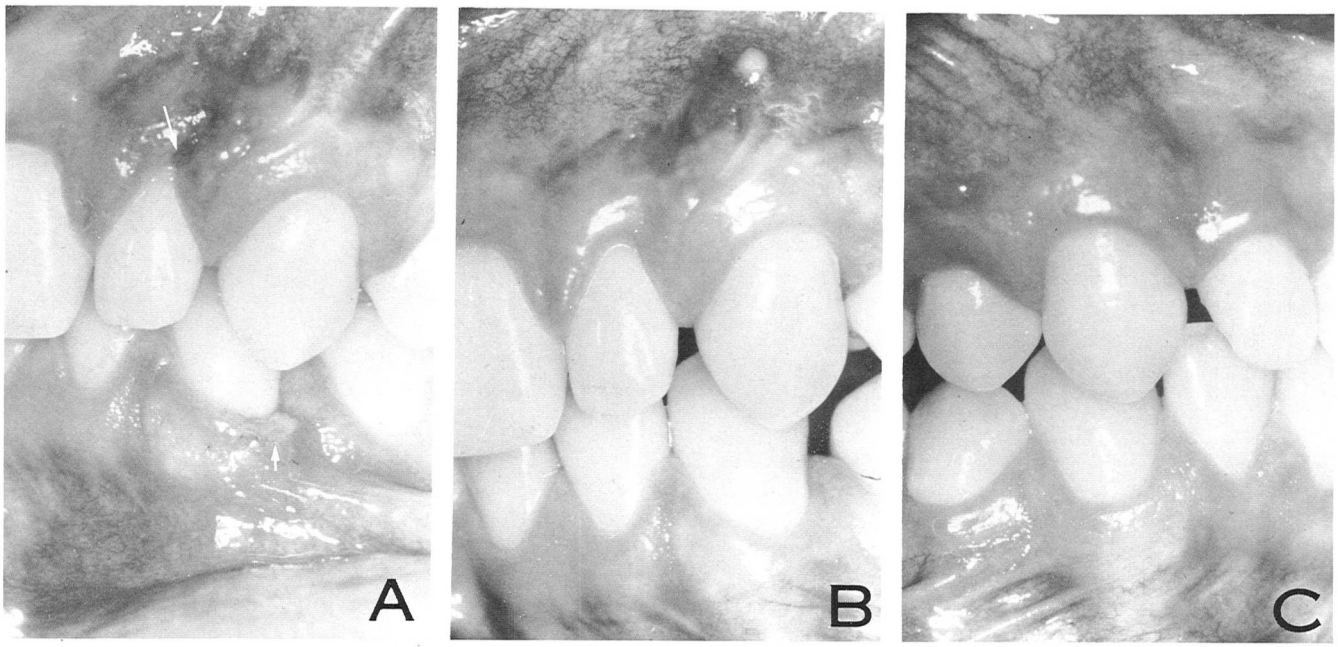

Figure 2. **A,** *traumatic injury to marginal gingiva of Tooth No. 10 with cleft/recession formation (arrow). Note traumatic injury associated with marginal gingiva of Tooth No. 22 (arrow).* **B,** *repair of injured tissue in marginal gingiva of teeth seen in previous illustration.* **C,** *right maxillary lateral incisor shows no recession.*

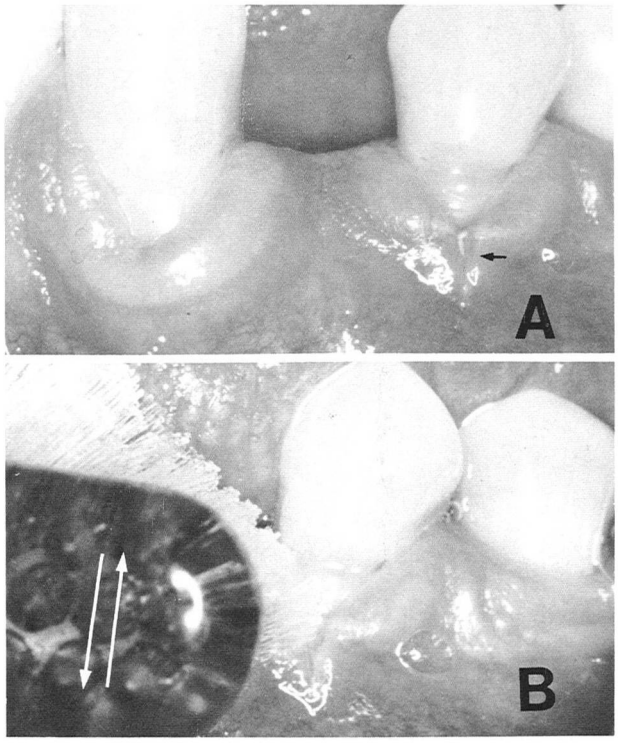

Figure 3. A, *note recession and early cleft formation in marginal gingiva of Tooth No. 21 (arrow).* **B,** *posed photograph illustrating brush action (arrows) and bristles in cleft area.*

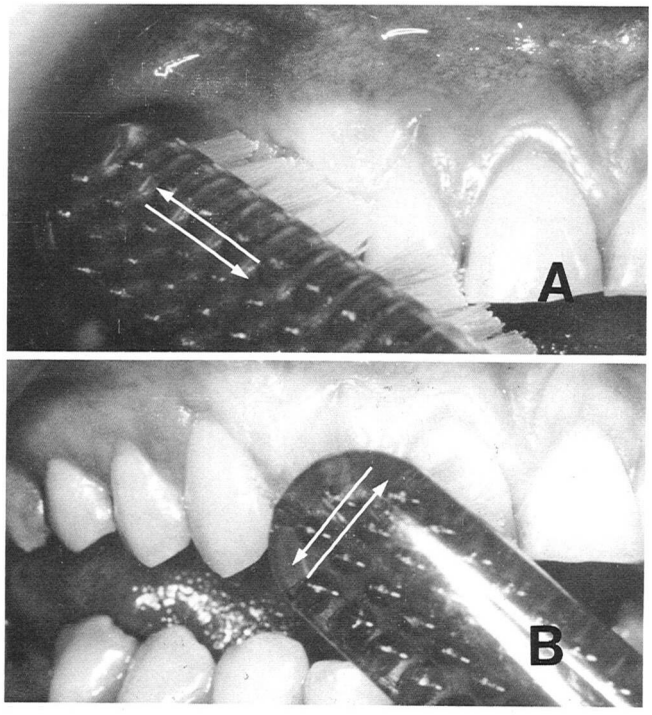

Figure 4. A, *cleft recession associated with Tooth No. 7—mesially inclined direction of cleft. Toothbrush posed indicating direction of brushing in the cuspid region (arrows).* **B,** *note distal inclination of cleft associated with Tooth No. 6. Toothbrush posed in lateral incisor area indicating direction of brushing action (arrows).*

toothbrush. However, the vigor, frequency and technique of his toothbrushing had not changed. Note the marked, generalized, broad type of recession, deep den-

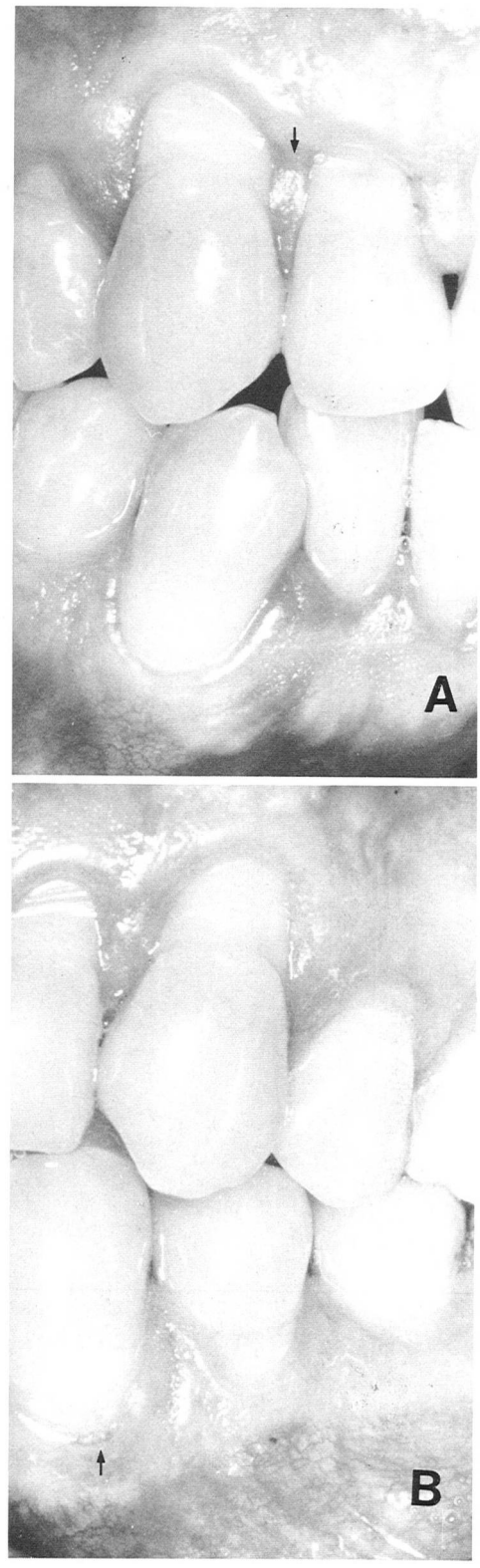

Figure 5. A, *severe recession in maxillary cuspid—lateral incisor region. Note toothbrush abrasion and notching of gingival papilla between teeth numbered 6 and 7 (arrow).* **B,** *severe recession on contralateral side. Note early injury of marginal gingiva of Tooth No. 22 (arrow).*

tal abrasion and "notched" interproximal papilla where the toothbrush bristles were now able to reach (Fig. 5A). The marginal gingiva of the mandibular canine tooth on the contralateral side exhibits an early trau-

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matic laceration despite the patient's "having taken more care with brushing" recently (Fig. 5B).

Case Report No. 6. This case report concerns a 32-year-old male who insisted that he had a strong need to brush very vigorously, with a medium bristle brush; otherwise, his teeth "did not feel clean." He had always used a vertical scrubbing stroke while brushing for lengthy periods three or four times daily. Clinical examination revealed a generalized pattern of severe clefting with one area of severe acute traumatic ulceration in the marginal gingiva of a mandibular right first bicuspid (Figs. 6A and B). The patient admitted to frequent painful areas which did not, however, prevent him from continuing with his excessive brushing. Note the prominence of the roots in Fig. 6B.

Case Report No. 7. A 24-year-old dental receptionist noticed a gingival fenestration associated with the mandibular right central incisor following the use of a new toothbrush (Fig. 7A). The patient was using a soft nylon toothbrush with a circular brushing motion. Within a week the fenestration had progressed to a gingival recession (Fig. 7B).

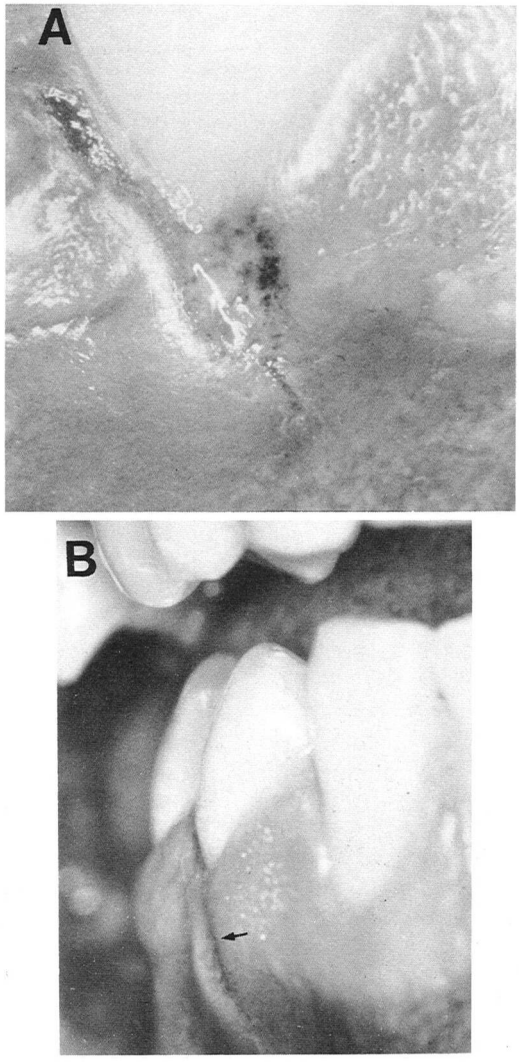

Figure 6. A, *severe obliquely directed injury to marginal gingiva of Tooth No. 28.* **B,** *view of injury (arrow) illustrating the prominent roots in the affected area.*

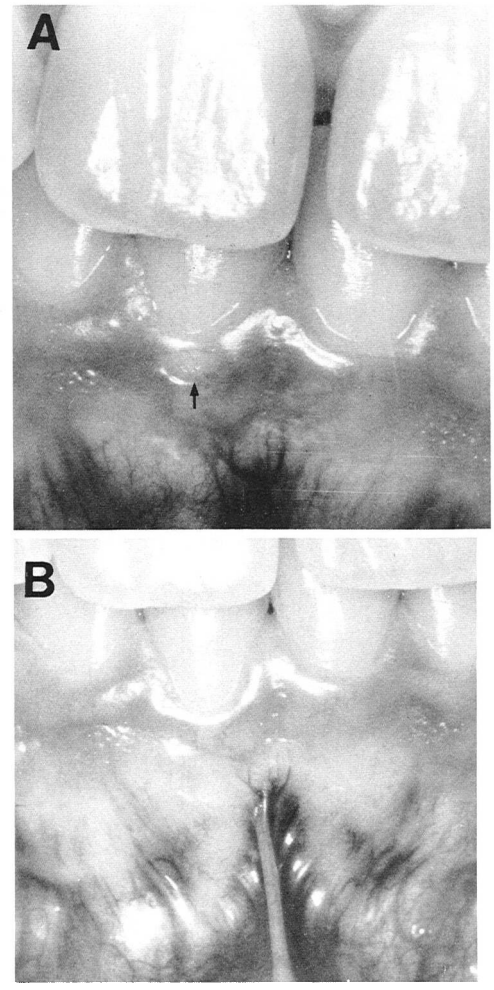

Figure 7. A, *fenestration in marginal gingiva of Tooth No. 25.* **B,** *progression of fenestration to recession.*

Histologic Observations of Biopsied Gingival Lesions

Gingiva with Long Standing Clefts. The oral epithelium associated with the clefts is generally acanthotic and penetrates toward the dentogingival epithelium which is also proliferative (Fig. 8A). An inflammatory exudate is prominent in the lamina propria between the dentogingival and oral epithelia. In other sections (Fig. 8B) coalescence of oral and dentogingival epithelia can be seen. The epithelium is hyperplastic and paler-staining subjacent to the clefts. It is parakeratotic lateral to the clefts. The connective tissue subjacent to the cleft also contains inflammatory exudate. Progressive sections reveal separated epithelium and cleft formation in various stages of completeness (Fig. 8C). The same epithelial and connective tissue changes previously noted are present. Diagram I indicates approximate levels of histological sections shown.

Gingiva with Acute Toothbrush-Induced Injuries. The biopsied tissue revealed injured gingiva with actively proliferating and acanthotic oral epithelium (Fig. 9A). The epithelium exhibited intra- and extra-cellular edema. Between the proliferating epithelium surround-

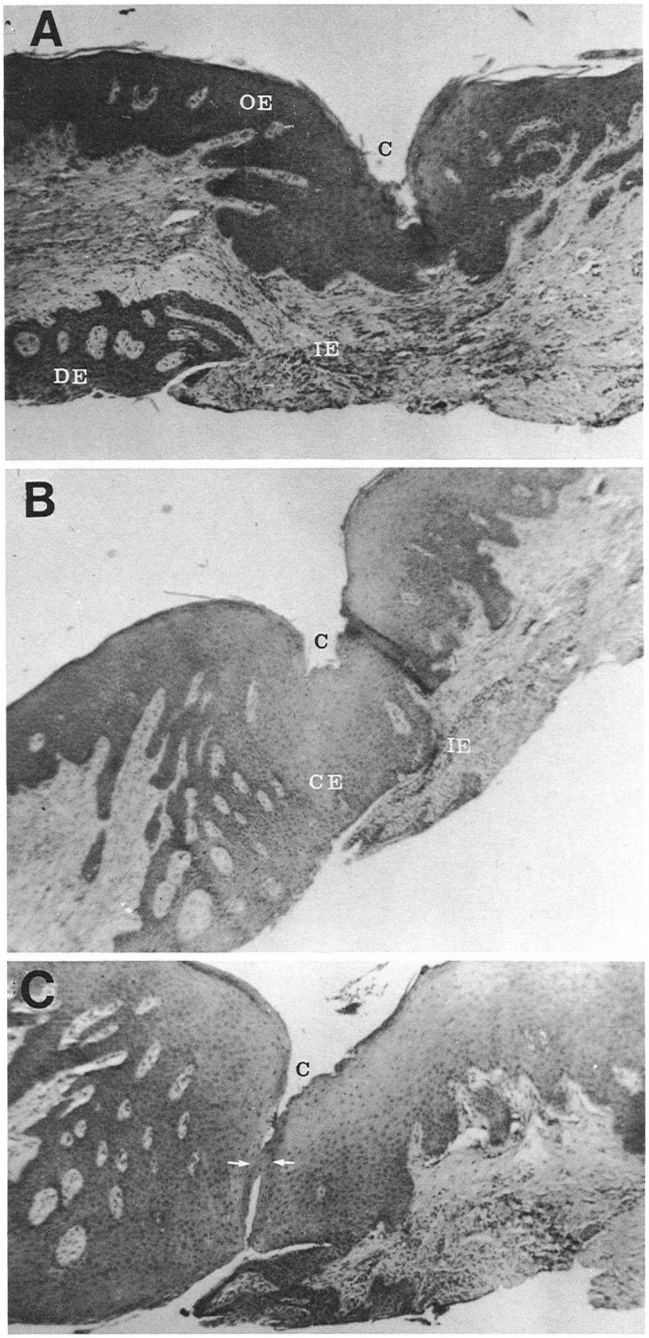

Figure 8. *Photomicrographs of long standing cleft.* **A,** *cleft* (C), *proliferating oral epithelium* (OE) *and dentogingival epithelium* (DE), *inflammatory exudate* (IE). **B,** *cleft* (C), *coalesced epithelia* (CE), *inflammatory exudate* (IE). **C,** *cleft* (C), *remaining epithelial bridge (arrows); note the acanthosis and parakeratosis in these sections (H & E, magnification × 100).*

ing the wounds may be found necrotic tissue containing desquamated epithelial cells, extravasated blood cells and fibrin exudate. In other sections (Fig. 9B), the proliferating acanthotic epithelium extended towards and over the connective tissue exposed by the traumatic ulcer. The epithelium showed the same changes previously described, and the subjacent connective tissue was markedly inflamed. Diagram II indicates the approximate levels of histological sections shown.

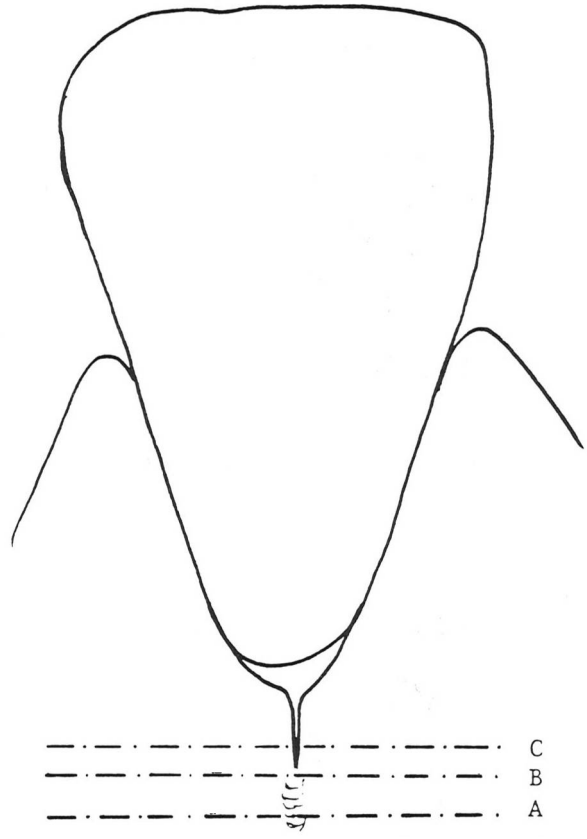

Diagram I: *Diagrammatic illustration indicating areas from which histologic sections were taken for Figure 8.* A, B, *and* C *correspond respectively to photomicrographs* A, B, *and* C *in Figure 8.*

Gingiva with Broad Recession. In gingiva from broad recession areas, the dentogingival epithelia was seen penetrating the lamina propria (Fig. 10A), which also contained perivascular inflammatory exudate. It appeared that epithelial penetration continued until it almost completely occupied the connective tissue cone between the two epithelial layers (Fig. 10B). Diagram III indicates the approximate levels of histological sections shown.

DISCUSSION

The clinical cases discussed tend to confirm, and even strengthen, the conviction that toothbrush abuse is related to gingival recession and clefting. Our observations seem to confirm that the method of brushing, type of brush, direction, frequency and magnitude all appear to be important factors and may even be related to the morphology of gingival lesion.[5,8,9] Signs of gingival injury may be noted early and thus prevention of serious damage is predicated on early diagnosis. Often the patient involved with this type of injury is obsessive in nature, and frequent observation is necessary in order to control the patient's technique, even though, as is often the case, these patients exhibit little plaque accumulation.[21]

The histological sections revealed typical reaction of epithelial and connective tissues to injury. In the "long

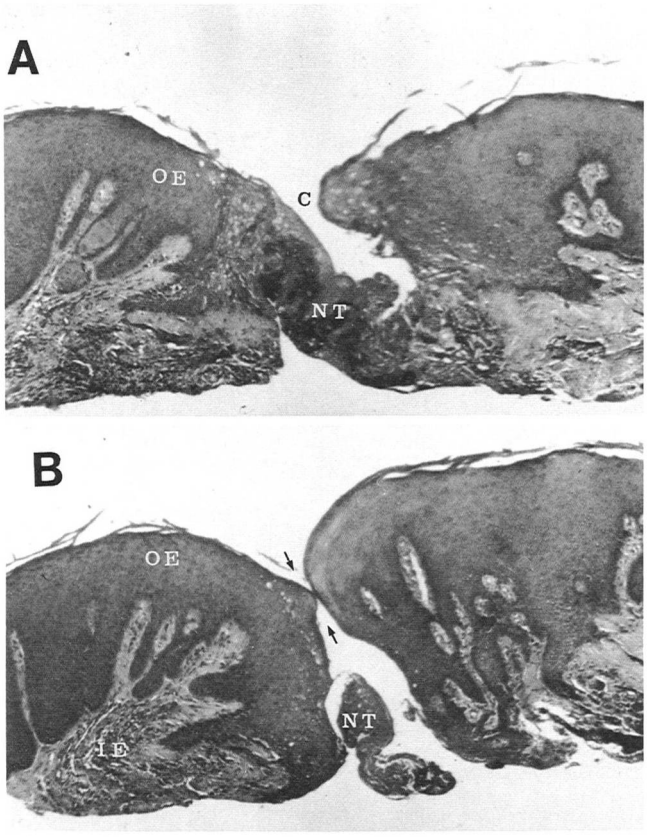

Figure 9. *Photomicrographs illustrating acute toothbrush injuries.* **A,** *proliferating acanthotic oral epithelium* (OE); *note edematous changes in the epithelium, necrotic tissue* (NT), *cleft* (C). **B,** *oral epithelium* (OE) *proliferating over exposed connective tissue, heavily inflamed lamina propria* (IE), *necrotic tissue* (NT), *cleft (arrows). (H & E. magnification × 150).*

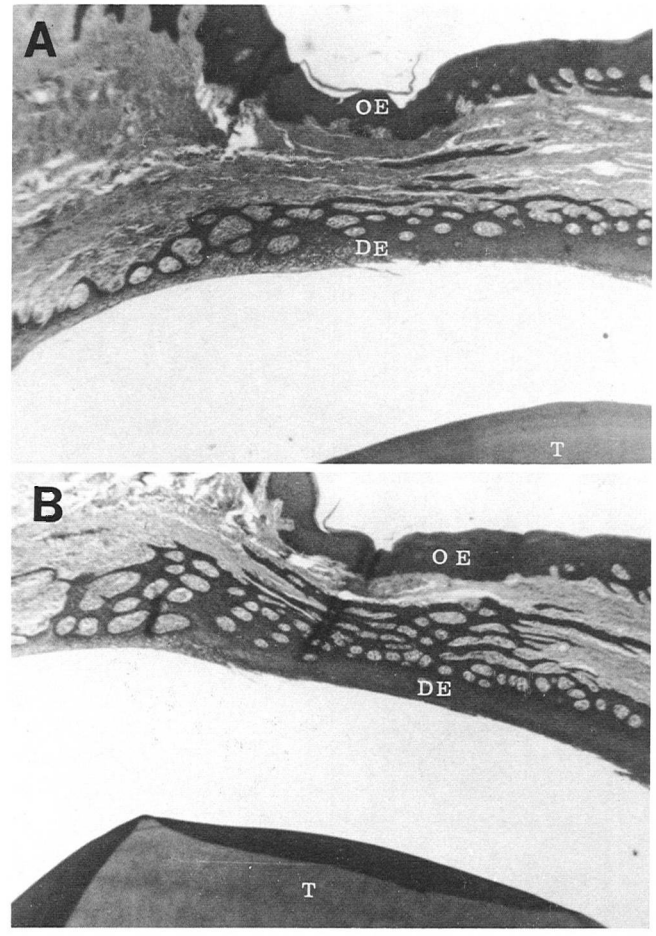

Figure 10. **A,** *penetrating dentogingival epithelium* (DE), *oral epithelium* (OE), *artifactual space (tissue retraction during preparation), tooth* (T). **B,** *more advanced epithelial penetration of lamina propria. (H & E. magnification × 150).*

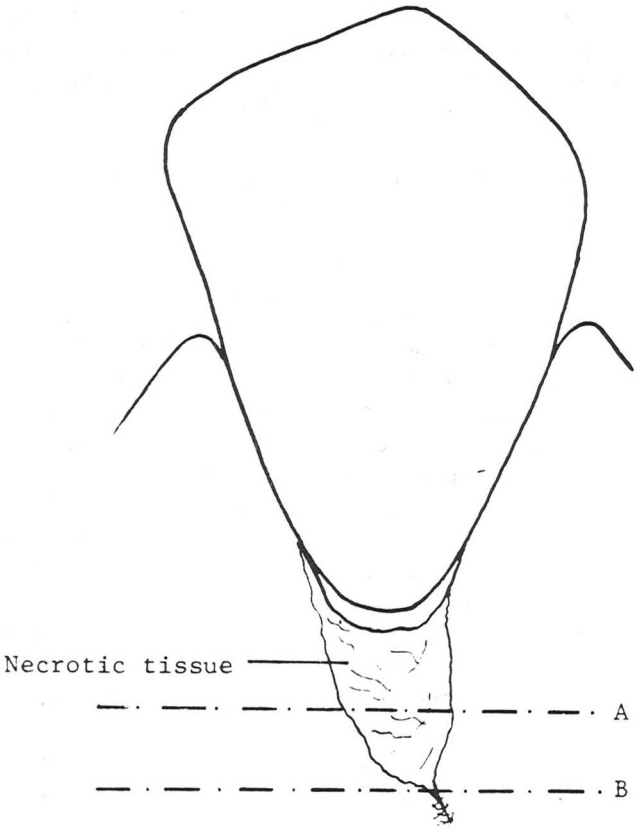

Diagram II: *Diagrammatic illustration indicating areas from which histological sections were taken for Figure 9.* A *and* B *correspond respectively to photomicrographs* A *and* B *in Figure 9.*

standing" sections, the reactive hyperkeratotic epithelium is acanthotic. The superficial layers lose their adhesiveness and either spontaneously desquamate or are easily dislodged by sustained toothbrush abuse. The inflammatory change in the subepithelial connective tissue is either due to the injury, plaque induced, or more likely, is a combined process. Inflammatory destruction of the connective tissue core accompanies the recession/clefting process. In the more acute lesions, the connective tissue destruction is virtually complete and the epithelial proliferation is dictated by the exposed connective tissue, thereby producing clefts/recessions. Plaque accumulations in the narrow clefts can perpetuate inflammatory change in the connective tissue core between the dentogingival and oral epithelium, thus promoting further deleterious change.[1-3] The histologic evidence from sections taken from broad recession areas tends to confirm the hypothesis that destruction of the intevening connective tissue cores more easily permits penetration of a proliferating dentogin-

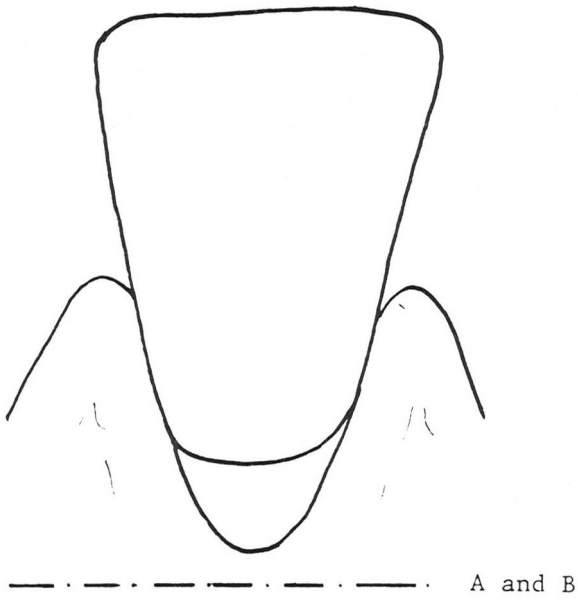

Diagram III: *Diagrammatic illustration indicating areas from which histological sections were taken for Figure 10.* A *and* B *correspond respectively to photomicrographs* A *and* B *in Figure 10.*

gival epithelium until such time as the dentogingival and oral epithelia coalesce. Loss of proper nutrition to the enlarged epithelial layer enhances loss of adhesiveness and encourages desquamation and/or physical removal.[3]

The potential for destruction from toothbrush trauma cannot be overestimated, thus early prevention is paramount. The clinical cases, histologic observations and hypotheses presented tend to support this statement.

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