Human suprabony healing responses following root demineralization and coronal flap anchorage

Histologic responses in 7 sites

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Abstract. 6 suprabony pockets in 2 adult patients were treated with debridement and citric acid root demineralization. Following these procedures, coronal positioning of the marginal flaps was performed at 2 sites. At 4 sites, the marginal flaps were sutured coronally using orthodontic brackets as anchors. At 1 additional site, root debridement *only* was performed and the margin was placed at about crestal level. Prior to root planing, all roots were notched both at the level of the gingival margin and the most apically positioned calculus. Blocks were harvested 7 and 18 weeks postsurgery and prepared for histologic analysis. Clinical results showed a gain in probing attachment in both coronally positioned sites (average = 1.8 mm) and cororally anchored sites (average = 4.5 mm). The additional debrided-only site showed a gain in probing attachment of 0.1 mm. Histologically, new cementum with functionally inserted fibers was seen within the calculus notch in all coronally anchored sites. This new attachment was associated with crestal osteogenesis. In the 2 coronally positioned and root demineralized sites, new attachment was seen within the calculus notch in 1 out of the 2 specimens evaluated. Within the limits of the evidence presented, coronal anchorage of flaps enhanced probing attachment and new attachment when used in conjunction with root demineralization.

Key words: root demineralization and flap anchorage.

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In a recent publication (Stahl & Froum 1991), we reported on histologically observed new attachment in suprabony lesions treated by a combination of debridement, GTR and coronally anchored flap procedures. Such new attachment was not observed in parallel sites in which only coronally anchored flaps and debridement were employed. To further evaluate the efficacy of coronal anchorage of the gingival margin, we are now reporting on histologic healing responses in human suprabony lesions in which debridement, coronal flap anchorage and root demineralization were utilized. These evaluations were stimulated by the recognition that one of the variants determining success or failure of new attachment is the "degree of gingival recession that occurs during healing" (Gottlow, et al. 1986) and the clinical successes reported in bone fill of furcation involvements when coronal anchorage was employed as part of therapy (Martin et al. 1988, Gantes et al. 1988, Garret et al. 1990). In fact, the combination of crown anchorage and root demineralization in the treatment of furcation lesions appeared as effective in obtaining bone fill as when additional enhancing procedures such as bone grafts or collagenous membranes were used (Garret et al. 1988, 1990).

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Material and Methods

Clinical and histologic responses at 7 suprabony lesions in anterior teeth of 2 volunteer patients (1 male (patient no. 1), and 1 female (patient no. 2)) are included in this report. These patients were 55 and 56 years-old, respectively.

Both patients were in good health and each signed an informed consent following explanation of the study, and providing freedom to withdraw at the patient's will. Surgery was performed as part of the overall periodontal treatment plan in the Department of Periodontics, New York University, College of Dentistry. The 7 teeth selected had been scheduled for extraction for periodontal reasons by 2 periodontists, not a part of this study.

Prior to surgery, cause-related therapy was performed as necessary. However, root planing at the sites to be evaluated was performed only after the root was notched at time of surgery. Root debridement was performed by

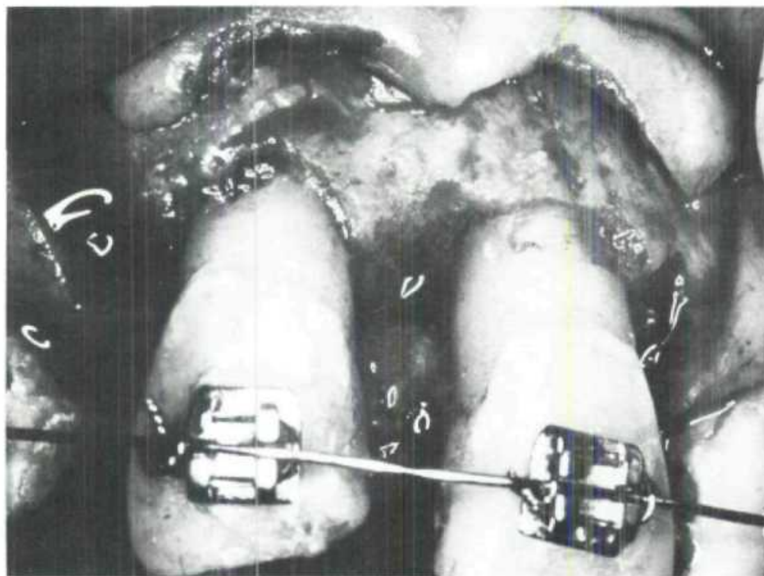

Fig. 1. Clinical appearance of debrided sites with facial brackets, patient no. 2, teeth #11 and 21.

open debridement using an ultrasonic scaler and hand instruments until all visible calculus was removed. Both magnifying lenses and fiber optic light were employed to detect calculus. Pre-treatment photographs and radiograms were taken at this time and photographs were obtained during surgery for clinical documentation. In addition, 4 teeth (patient no. 2) included in this study had orthodontic brackets bonded to the facial surfaces of these teeth 2 weeks prior to surgical therapy.

Measurements

Immediately prior to surgery, a horizontal notch was made on the facial root surface at the level of the gingival margin using a 1/2 round bur. To insure reproducibility at subsequent measurements, a vertical notch was placed in the crown of each tooth to guide the silver point used for measurements. All measurements were made to the nearest 0.1 mm using a number 50 silver point, a locking plier and a Boley gauge. The distance from the gingival notch to the base of the clinical pocket was recorded prior to surgery and 1 week prior to block section. At the time of surgery, and prior to root planning, a 2nd notch was made through the most apical level of visible calculus and the distance from the calculus notch to the osseous crest was measured. The notching accuracy of the visible calculus was optimized in these sites, since they were at facial surfaces of anterior teeth and therefore clearly visible to the operator (SF).

Surgical procedure

An intrasulcular incision was made to elevate a full/split thickness mucoperiosteal flap in order to retain as much marginal gingiva as possible. The apical split thickness procedure allowed for coronal stretching. After root/calculus notching, the root was thoroughly debrided and the measurements described above recorded. At 6 facial sites, a rubber dam was placed. After placement of the dam, citric acid, pH 1, was applied to the root surfaces for 3 min using a cotton pellet to rub the acid into the root surface. At 2 sites (patient no. 1, teeth #22, 23), the flaps were sutured coronally. At 4 sites (patient no. 2, teeth #11, 21, 31, 41) the flaps were anchored coronally by suturing to the facial orthodontic brackets (Figs. 1, 2). Interrupted sutures of 4.0 silk or Dexon were utilized at all sites. No dressing was placed. At 1 site, (patient no. 1, tooth #11, root debridement only was performed and the flap was sutured at about the crestal level.

Patients were instructed to rinse with 0.12% chlorhexidine gluconate 2× a day for 2 weeks. Flap sutures were removed 2 weeks following surgery. Patients returned for professional plaque removal every 2 to 3 weeks until the blocks were harvested.

Block sections were removed at 7 and 18 weeks after surgery. At the time of block removal, clinical records, photographs and radiographs similar to those described at initial surgery were taken.

After block removal, teeth were fixed in 10% buffered formalin, decalcified in EDTA and embedded in paraffin. Step serial sections 8 μ thick were cut and stained for histologic evaluation using routine histologic stains.

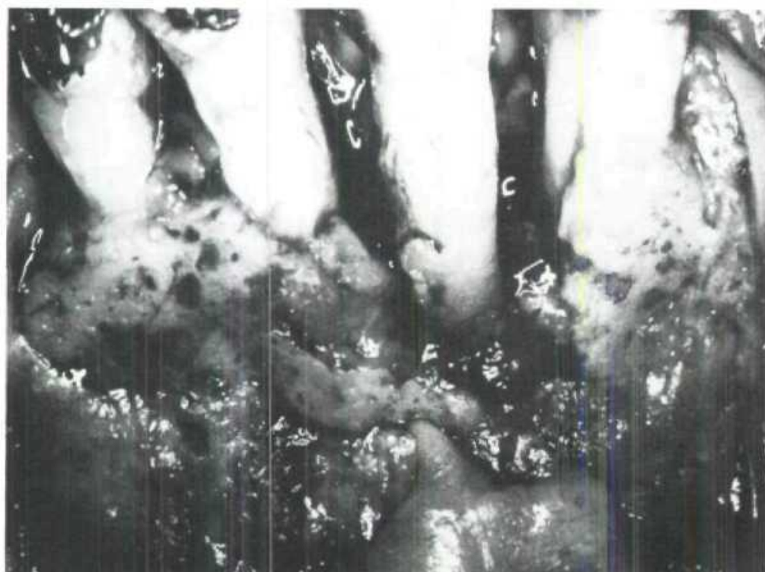

Fig. 2. Clinical appearance of debrided sites with facial brackets, patient no. 2, teeth #31 and 41.

Results

Clinical Observations (Table 1)

Pertinent clinical findings are reported in Table 1. Summarizing these obser-

Table 1. Root demineralization and coronal flap placement

Patient no.	Tooth #	Proced.	Preop. P.D. (mm)	Observation time (weeks)	Postop. P.D. (mm)	Recession (mm)	Gain in probing attach. (mm)
1	22	cor.	7.0	7	3.6	1.5	1.8
	23	posit.	5.0	7	1.2	2.1	1.7 N.A.
2	11	cor.	6.6	18	1.2	1.2	4.2 N.A.
	21	anchor.	6.0	18	1.8	1.0	3.2 N.A.
	31		12.2	18	2.0	3.5	6.7 N.A.
	41		7.0	18	2.1	1.2	3.7 N.A.
3	11	debr. only	6.0	7	3.0	2.9	0.1

N.A.: New attachment.

vations, we noted that the average preoperative pocket depth at the 6 sites receiving root demineralization was 7.3 mm (5.0 mm–12.2 mm). Following surgical procedures, the average postoperative pocket depth was 2.0 mm (1.2 mm–3.6 mm). Recession averaged 1.8 mm (1.0 mm–3.5 mm) and gain in probing attachment averaged 3.6 mm (1.7 mm–6.7 mm).

The debrided-only site (patient no. 3, tooth #11) showed a preoperative pocket depth of 6.0 mm and a postoperative pocket depth of 3.0 mm. Recession was 2.9 mm and the gain in probing attachment was 0.1 mm. Observation time was 7 weeks.

In comparing specific gain in probing attachment between coronally-placed and coronally-anchored sites, we noted that the average gain in probing attachment following coronal positioning was 1.8 mm (1.7 mm–1.8 mm), while gain in probing attachment following coronal anchorage averaged 4.5 mm (3.2 mm–6.7 mm).

No untoward clinical responses were recorded at any treated site during the entire observation period.

Histologic observations (Table 1)

The site treated by debridement and marginal placement at crest level (patient no. 3) showed closure by epithelial adhesion at a root site apical to the calculus notch.

The sites treated by debridement, root demineralization and *coronal flap positioning* showed varying healing responses. At 1 site, the gingival margin had receded apical to the calculus notch and closure was by epithelial adhesion. At the other site (patient no. 1, tooth #23), the calculus notch showed epithelial adhesion in its' coronal portion. At the apical portion of the notch, the dentin surface demonstrated both deposition of repair cementum with inserted collagen fibers and surface dentin resorption in the presence of odontoclasts. Thus, within this calculus notch, both dentin resorption and new attachment were present 7 weeks after procedure. Such responses apparently limited the apical migration of the junctional epithelium to the coronal portion of the calculus notch at the time of block section.

The sites treated with debridement, root demineralization, and *coronal flap anchorage* demonstrated new attachment within the calculus notch at all 4 sites examined. At one site (patient no. 2, tooth #31, 18 weeks postsurgery), the gain in probing attachment of 6.7 mm was reflected histologically by new attachment within the calculus notch and root surface resorption coronal to the calculus notch (Figs. 3, 4). Thus, as seen at 7 weeks postsurgery, combinations of both regeneration and root surface resorption was also observed at 18 weeks after surgery within the same site. Again, these responses limited the apical migration of the junctional epithelium.

At other calculus notch sites where the coronal anchorage was employed, new attachment was seen within the apical portions of the calculus notches. New attachment was visualized by deposition of cellular (repair) cementum with attached fibers present on the dentin surface of the notch (Figs. 5, 6). Within the calculus notches and coronal to the new attachment, connective tissue often lined the dentin and extended to the level of epithelial adhesion. New attachment responses were also associated with varying degrees of crestal osteogenesis in all observed specimens. It should be noted that site serial sections demonstrated variations in extent of the histologic responses described above. However, the regenerative responses depicted were present in the great majority of serial sections within each site.

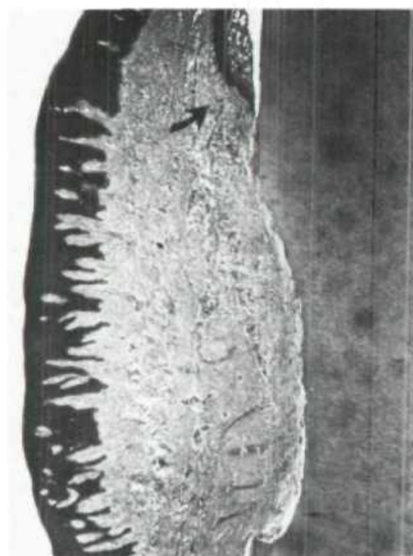

Fig. 3. Overview of root surface coronal to calculus notch at tooth #31 in patient no. 2, 18 weeks after surgical procedure. Hematoxylin-eosin stain. Note root surface resorption apical to junctional epithelium. Arrow points to apical position of J.E.

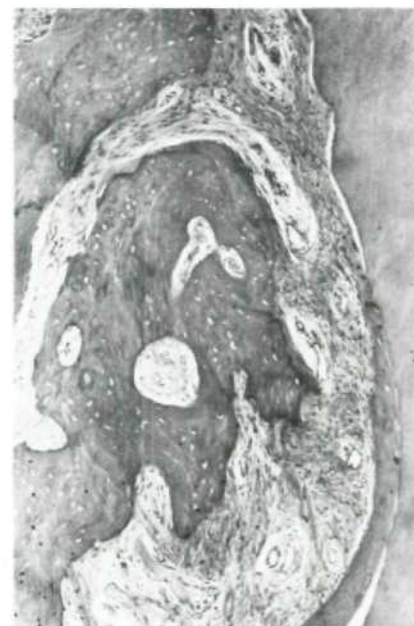

Fig. 4. Site of calculus notch in specimen shown in Fig. 3 (25 ×). This was located apically to root surface resorption. Note osteogenesis, cementogenesis and oriented PDL fibers (new attachment) within the calculus notch.

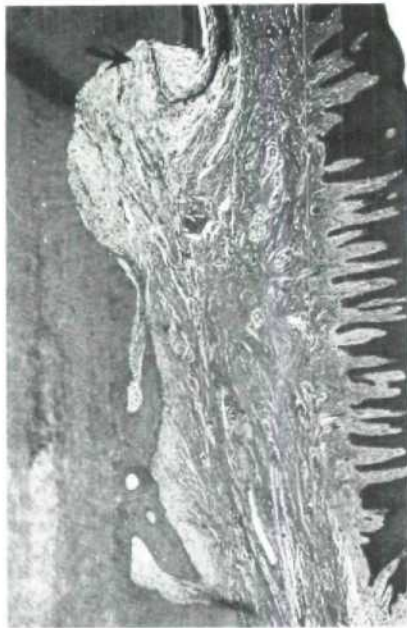

Fig. 5. Overview of calculus notch in tooth #11, patient no. 2, 18 weeks after surgical procedures. Hematoxylin-eosin stain. Note new attachment in apical portion of notch facing the supracrestal gingival unit. Arrow points to apical position of J.E.

Discussion

Previous studies from our department reported on closure by epithelial adhesion following root demineralization in human suprabony lesions without evidence of new attachment (Stahl & Froum 1977, Kashani et al. 1984). Contrary to those observations, the responses observed in the present material are similar to those reported in human periodontal lesions by Cole et al. (1980), who described new attachment following debridement and root demineralization in 10 treated surfaces. Furthermore, our present histologic results also support the clinical observations that reduction in marginal recession during the early stages of flap healing enhances gain in probing attachment (Martin et al. 1988, Gantes et al. 1988).

Of special interest in the present material is the odontoclastic activity (root surface resorption), seen at both the 7 and 18 weeks postsurgery interval. Root surface resorption may well be a response to root demineralization. On the other hand, it may be part of a regenerative phenomenon, since it has been observed following techniques other than root demineralization (Karring et al. 1984, Magnusson et al. 1985). Surface resorption may also be due to contact between gingival connective tissue and root surface, which may be enhanced by coronal flap anchorage (Karring et al. 1980). Obviously, from the material at hand, we cannot identify the specific etiology of root surface resorption in these cases, nor can we predict the ultimate extent of such resorption. However, it may well be limited, since extensive root resorption, such as that observed with the use of marrow grafts, has not been reported following the regenerative procedures discussed above. On a positive note, root surface resorption appear to limit migration of the junctional epithelium. Such limitation may be due to the linkage between dentinal collagen and wound surface collagen which has been reported to occur as early as 7 days following surgery and root demineralization (Garret et al. 1978, Selvig et al. 1981, 1988, Frank et al. 1983).

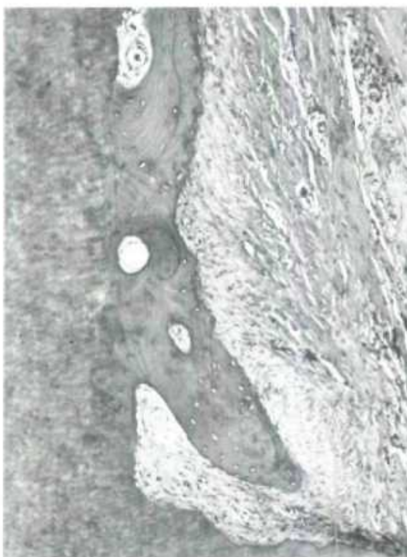

Fig. 6. Higher magnification of new attachment site shown in Fig. 5 (Magn. 25×). Cellular cementum is deposited on dentinal wall and fibers are attached to the cementum.

Finally, let us compare clinical and histologic healing responses in human suprabony lesions when either coronal anchorage and barrier membrane or coronal anchorage and root demineralization was used. Such a comparison shows similar histologic responses with both techniques, namely a pronounced tendency toward new attachment at root sites previously covered by plaque and calculus. Gain in probing attachment appeared similar when either coronal anchorage and barrier membrane (average gain: 1.7 mm) or coronal suturing and root demineralization was employed (average gain: 1.8 mm). However, gain in probing attachment appeared enhanced when *coronal anchorage* and root demineralization was used (average gain: 4.5 mm). Since, histologically, the root surfaces apical to the notch demonstrated both cemental deposition and resorption, length of newly deposited cementum could not be measured accurately in these specimens.

As we compare our results, words of caution are necessary. First, the number of sites we studied histologically are, of necessity, extremely limited. Therefore, they do not permit statistical projections of significance. Second, results were not site predictable. However, the tendencies toward regeneration, seen histologically with techniques using barrier membranes, root demineralization or bone grafts, are encouraging. In addition, the control of marginal shrinkage during the early healing stages may also play an important role in enhancing regeneration of lost attachment (Garrett et al. 1990).

Zusammenfassung

Menschliche, supraossäre Heilungseffekte nach Wurzeldemineralisation und koronaler Lappenverankerung. Histologische Antworten an 4 Stellen

Bei 2 erwachsenen Patienten wurden 6 supraossäre Taschen mit Konkremententfernung und Wurzeldemineralisation durch Zitronensäure behandelt. Nach diesen Behandlungssequenzen wurden die marginalen Lappen an 2 Stellen koronal befestigt. An 4 Stellen wurden die marginalen Lappen koronal mit Suturen versehen und durch orthodontische brackets verankert. An einer zusätzlichen Stelle wurden *ausschliesslich* Konkremente entfernt und der Zahnfleischrand etwa in der Höhe des Knochenkammniveaus befestigt. Vor der Wurzelglättung wurden in Höhe des Zahnfleischniveaus und der am weitesten apikal vorkommenden Zahnsteinkonkremente, Wurzelkerben angebracht. 7 und 18 Wochen nach dem chirurgischen Eingriff wurden Gewebeblocks entnommen und zur histologischen Analyse vorbereitet. Die klinischen Resultate zeigten einen Gewinn sondierten Attachments bei sowohl den koronal befestigten (Mittelwert = 1.8 mm) als auch den koronal verankerten Stellen (Mittelwert = 4.5 mm). Bei der zusätzlichen, ausschliesslich depurierten Stelle wurde ein Attachmentgewinn von 0.1 mm beobachtet. An allen Stellen mit koronal verankerten Lappen zeigte das histologische Bild neugebildeten Zement mit funktionell orientierten Fasern innerhalb der Zahnsteinkerben. Dieses neugebildete Attachment war mit osteogenetischen Vorgängen in der alveolären Knochenleiste vergesellschaftet. Bei den beiden koronal befestigten und wurzeldemineral-

lisierten Stellen wurde bei 1 der 2 untersuchten Präparate neugebildetes Attachment innerhalb der Zahnsteinkerbe beobachtet. Die hier angegebenen, begrenzten Aussagen zeigen, dass die koronale Lappenverankerung das sondierbare Attachment sowie die Neubildung von Attachment verbesserte, wenn gleichzeitig die Wurzeln demineralisiert wurden.

Résumé

Guérison supraosseuse humaine suite à la déminéralisation radiculaire et ancrage coronaire du lambeau. Réponses histologiques au niveau de sept sites

6 poches supraosseuses chez deux adultes ont été traitées par lissage radiculaire et déminéralisation radiculaire à l'acide citrique. Les lambeaux ont ensuite été positionnés en coronaire au niveau de deux sites. Les lambeaux marginaux ont été suturés en coronaire à l'aide de brackets d'orthodontie utilisés comme ancrage au niveau de quatre autres sites. Au niveau d'un autre site, seul un lissage radiculaire a été effectué et la gencive placée au niveau de la crête osseuse. Avant le lissage radiculaire, toutes les racines ont été entaillées au niveau de la gencive marginale ainsi qu'à celui du tartre le plus apical. Des biopsies ont été obtenues 7 et 18 semaines après l'opération et préparées pour l'analyse histologique. Les résultats cliniques ont montré un gain d'attache au sondage tant aux sites positionnés en coronaire (moyenne = 1.8 mm) qu'aux sites ancrés en coronaire (moyenne = 4.5 mm). Le dernier site n'avait qu'un gain de 0.1 mm. Du nouveau cément avec fibres insérées a été trouvé dans l'entaille sous le tartre dans tous les sites ancrés en coronaire. Cette nouvelle attache était accompagnée d'ostéogenèse crestale. Seul un des deux sites positionnés en coronaire avait une nouvelle attache conjonctive dans l'entaille sous le tartre. Malgré le nombre restreint de sites analysés, il semblerait qu'un ancrage en coronaire des lambeaux associé à la déminéralisation radiculaire, augmente l'attache conjonctive.

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