

Healing of human suprabony lesions treated with guided tissue regeneration and coronally anchored flaps

Case reports*

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Abstract. Teflon membranes were interposed between soft tissue flaps and roots in 4 human suprabony lesions affecting the mandibular incisor teeth in 1 volunteer patient. 4 suprabony lesions affecting the mandibular incisor teeth were used as comparisons in a 2nd patient. All roots were debrided using ultrasonic and manual instruments and the most apical positioned calculus/site on the facial surface was notched. Flaps were sutured as coronally as possible using orthodontic brackets as anchors. Tissue blocks were removed 2 to 3 months after procedures and the facial aspects of all teeth were examined histologically. New attachment in the form of new "cementum with functionally oriented fibers" was seen within the calculus notch in 3 out of 4 membrane-treated sites and immediately apical to the notch at 1 site. The 4 comparison sites showed no evidence of new attachment within or adjacent to the notch. Rather, the gingival margins were located apical to the notch. Our observations suggest that guided tissue regeneration techniques improved coronal attachment responses in human suprabony lesions within the sample described.

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Histological evaluation of human responses to the use of guided tissue regeneration (GTR) techniques have focused essentially on intrabony and furcation sites (Nyman et al. 1982, Gottlow et al. 1986, Becker et al. 1987, Stahl et al. 1990). At these sites, new attachment in the form of new cementum with functionally oriented fibers was histologically observed on root surfaces previously exposed to the oral environment. While the above-cited reports have shown positive responses using guided tissue regeneration in human furcation and intrabony sites, limited evaluations are currently available which describe histologic responses with the use of GTR techniques at suprabony sites. The present paper will ad-

dress such responses using human histologic case reports. In addition, recent reports have depicted chemical root treatment and coronal flap replacement to be associated with gains in clinical closure and osseous fill in molar furcation lesions (Gantes et al. 1988). Since an interposed membrane may maintain necessary space for coronal migration of progenitor cells in suprabony lesions (Gottlow et al. 1986), the coronal anchoring of gingival tissues could maximize new attachment at such sites. Thus, the present case reports attempted also to histologically evaluate healing responses at suprabony sites when flap margins were anchored coronally.

Material and Methods

8 suprabony lesions at 8 mandibular incisor teeth were treated in 2 male volunteer adult patients. These patients were 27 and 51 years-old respectively. Treatment consisted of open debridement

flap procedures followed by coronal anchoring of the gingival margins. At 4 sites, a membrane barrier* was inserted prior to flap closure.

Both patients were in good health and each signed an informed consent following explanation of the study and providing freedom to withdraw at the patients will. Surgery was performed as part of the overall periodontal treatment plan in the Department of Periodontics, New York University, College of Dentistry. All 8 teeth selected had been scheduled for extraction for periodontal reasons by two periodontists not part of the 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.

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* Goretex membrane manufactured by W. L. Gore Assoc. Inc. Flagstaff, AZ, USA.



Fig. 1. Preoperative clinical appearance of patient no. 1.

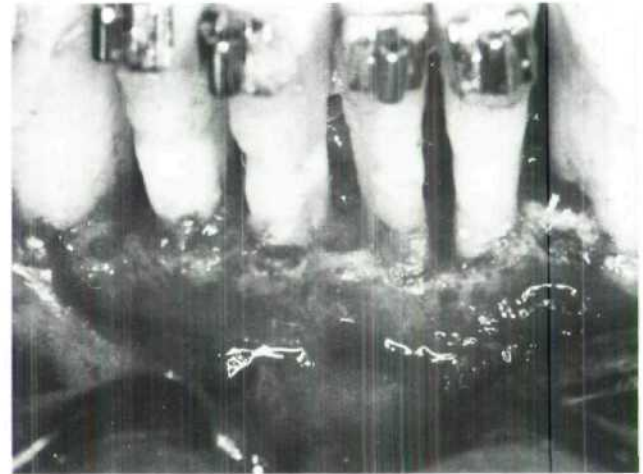


Fig. 2. Flaps retracted, patient no. 1.



Fig. 3. Membranes being placed, patient no. 1.

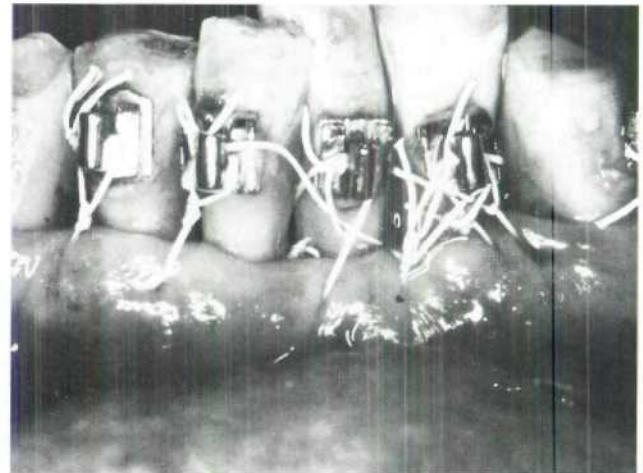


Fig. 4. Flaps coronally anchored, patient no. 1.

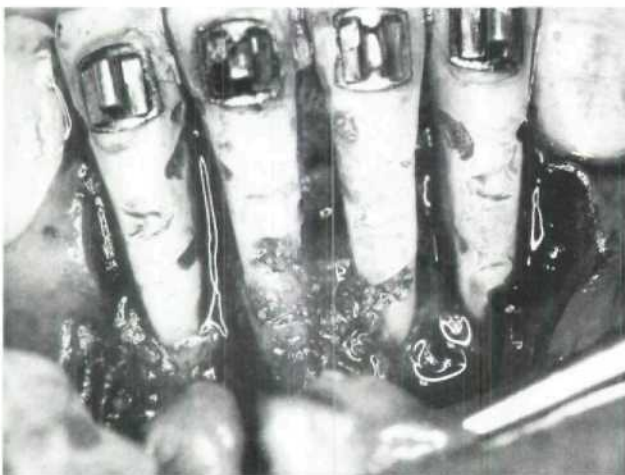


Fig. 5. Flaps retracted, patient no. 2.

Root debridement was performed by open debridement using ultrasonic scalers 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.

Measurements

All teeth included in the study had orthodontic brackets bonded to the facial surfaces of the teeth 1 to 2 weeks

Table 1. Clinical responses to the use of debridement, coronal anchoring and barrier membranes

Pt. no.	Age (years)	Tooth site (BU)	Preop. P.D. (mm)	Experiment. time (weeks)	Postop. P.D. (mm)	Recession (mm)	Gain in clin. clos. (mm)
1	51	32	6.0	8	4.0	0.0	2.0
		31	5.7	8	3.7	2.0	0.0
		41	4.2	8	1.5	0.5	2.7
		42	5.2	8	2.3	1.1	2.7
average:			5.3		2.9	0.9	1.7

Table 2. Clinical responses to the use of debridement and coronal anchoring

Pt. no.	Age (years)	Tooth site (BU)	Preop. P.D. (mm)	Experiment. time (weeks)	Postop. P.D. (mm)	Recession (mm)	Gain in clin. clos. (mm)
2	27	32	7.0	12	4.5	2.0	0.5
		31	5.5	12	3.2	2.2	0.1
		41	5.0	12	2.1	2.1	0.8
		42	6.2	12	3.1	2.2	0.9
average:			5.9		3.2	2.1	0.6

before initiation of surgical treatment. Prior to surgery, a horizontal notch was made on the facial root surface at the level of the gingival margin using a $\frac{1}{2}$ 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 base of clinical pocket was recorded prior to surgery and 1 week prior to block section. At the time of surgery, and prior to root planing, a 2nd notch was made through the most apical level of visible calculus and 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.

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 lesion and root were thoroughly debrided and above described measurements recorded. At four facial sites (patient no. 1) Goretex periodontal material was placed about 5 mm apical to the alveolar crest and 3 to 4 mm coronally. It was positioned to remain subgingival following suturing of the flaps. Membranes were secured with non-resorbable Goretex sutures placed circumferentially around the tooth using a sling technique. At all sites treated, flaps were then readapted without sutures and subsequently sutured coronally by anchoring the sutures to the facial orthodontic brackets (Figs. 1-5) Interrupted sutures of 4.0 silk or Dexon were utilized at all sites. No dressing was placed.

Patients were instructed to rinse with

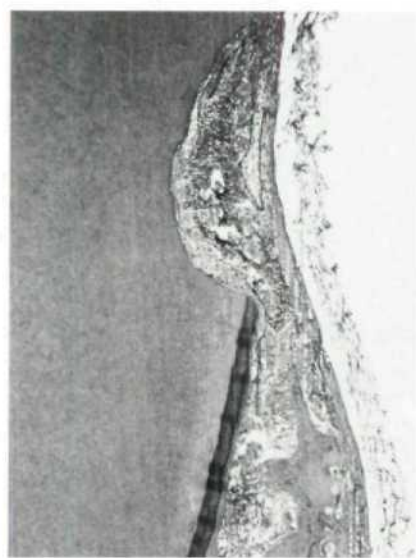


Fig. 6. Overview of tooth #32 in patient no. 1. Hematoxylin-eosin stain ($\times 10$). Note soft tissue closure within notch, and shape and position of alveolar crest.

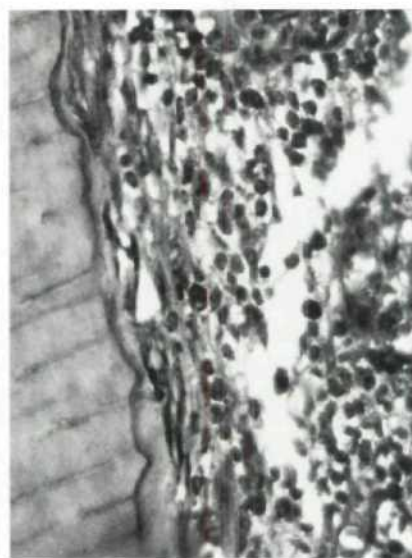


Fig. 7. Higher magnification of calculus notch shown in Fig. 6 ($\times 160$). Note cementum lining the resorbed dentinal surface and fiber attachment into cementum.

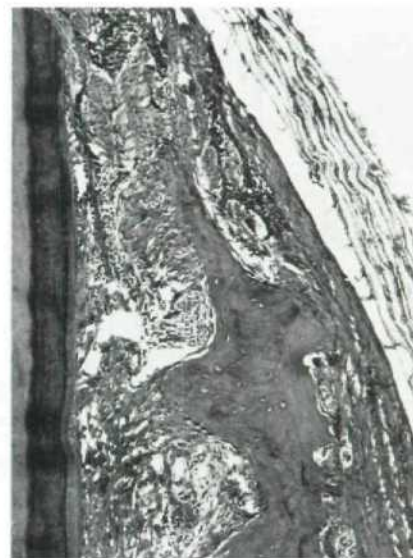


Fig. 8. Higher magnification of crestal area from site shown in Fig. 6 ($\times 25$). Note resorption at the facial aspect of the labial plate, osteogenesis at the periodontal aspect of the plate and cementogenesis at the root surface. Also note the tip of the crest tilting toward the root.

1.2% chlorhexidine gluconate twice a day for 2 weeks. Flap sutures were removed 4 weeks following surgery. Patients returned for professional plaque removal every 2 to 3 weeks until block sectioning was performed.

Block sections were removed 8 weeks after membrane placement in patient no. 1. The non-membrane containing sites were removed in block 12 weeks after surgery to accommodate patient no. 2. At the time of block removal, clinical records, photographs and radiographs similar to those described at initial surgery were taken.

At 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 routine histologic evaluations using hematoxylin-eosin and trichrome stains.

Clinical Observations

Pertinent clinical findings are summarized in Tables 1, 2. Summarizing these observations, we note that average initial pocket depth was similar in both patients, 5.3 and 5.9 mm, respectively. Average post-operative pocket depth also appeared to be similar, 2.9 and 3.2 mm, respectively. A clinical difference was seen in the average amount of gingival shrinkage/recession that took place in the non-membrane containing sites (2.1 mm), while at the membrane

treated sites, average recession was 0.9 mm. Gain in clinical closure reflected this difference, namely an average gain of 1.7 mm in the membrane treated group and 0.6 mm in the non-membrane containing sites.

Obviously, the number of sites presented are too small to provide clinical data of statistical or clinical *significance*. Rather the aim of this report was the histologic evaluation of the healing modes which occurred at the treated sites. Yet, the clinical trends noted were in synchrony with the histologic observations.

Histologic Observations

Membrane treated sites (patient no. 1)

At 3 of the 4 sites tested, we observed "repair cementum" formation within the apical portion of the calculus notch associated with evidence of dentin resorption. Functionally oriented fibers were found at the "cementum" fiber interface within the notch. Incisal to the new attachment, epithelium adhered to the notched dentin as part of the junctional epithelial closure mechanism. At 1 of the 4 sites, the notch was epithelized, but "repair cementum" into which fibers seemed functionally inserted was seen immediately apical to the most apical border of the notch (Figs. 6, 7).

Apical to the notch, we observed reformation of a supracrestal unit. In some sections, crestal osteogenic activity

was marked and the newly forming crest appeared to "bend" toward the root (Fig. 8). However, this osteogenic activity was not present in every serial section within a specific block (Figs. 9-11).

Bone resorption at the facial aspect of the labial plate was seen in all specimens in close proximity to the membrane. At the periodontal surface of the labial plate, compensatory osteogenesis was frequently encountered. The facial root surfaces opposite the bony plate demonstrated active cementogenesis (Figs. 8, 11). In all specimens, the membrane was seen to be located on a thin epithelial layer which separated it from the underlying connective tissue.

Inflammation was marked in the gingival margin of these specimens which reflected the significant debris accumulations seen clinically at the sites. The debris levels reflected the patient's reluctance to cleanse the operative sites.

Non-membrane containing sites (patient no. 2)

These sites showed plaque and calculus adhering to the dentinal wall within the calculus notch. All gingival margins were located apically to the notches and the facial attachment apparatus had shifted apically (Figs. 12, 13). No evidence of new attachment was seen at the 4 sites tested. Inflammation was

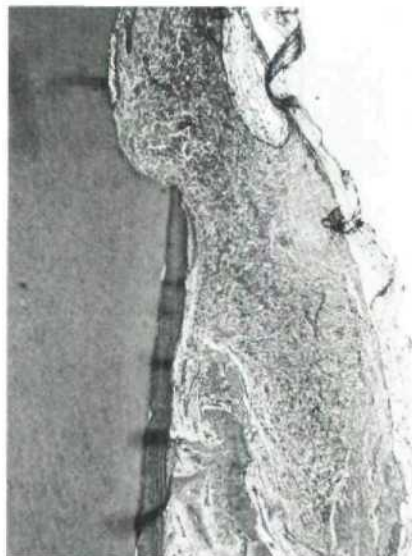


Fig. 9. Overview of Tooth #31 in patient no. 1. Hematoxylin-eosin stain ($\times 10$). Note soft tissue closure within notch and shape and position of alveolar crest.

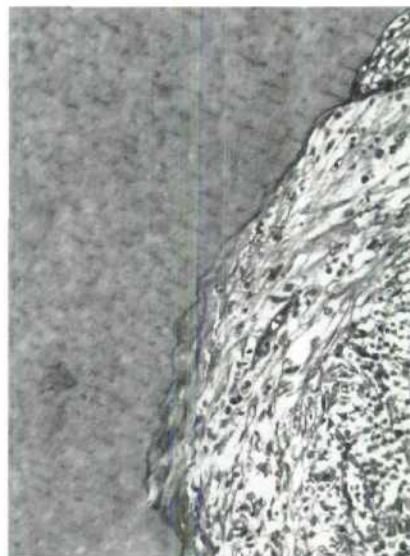


Fig. 10. Higher magnification of notch area shown in Fig. 9 ($\times 160$). Note cementum lining resorbed dentinal surface and fiber attachment into cementum.

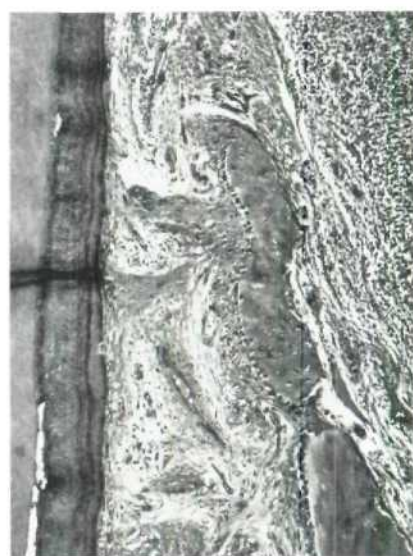


Fig. 11. Higher magnification of remodelling activity at the crest of site shown in Fig. 9 ($\times 25$). Note resorption at the facial surface and osteogenesis at the periodontal surface of the crest.

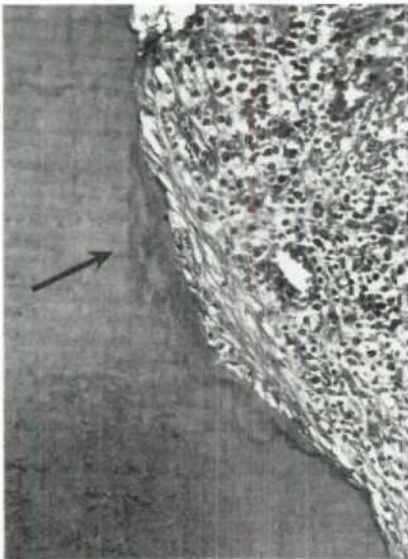


Fig. 12. New cementum on resorbed dentin at apical border of notch at serial section from block shown in Fig. 9 ($\times 160$). Note cementocyte within newly formed cementum (arrow).

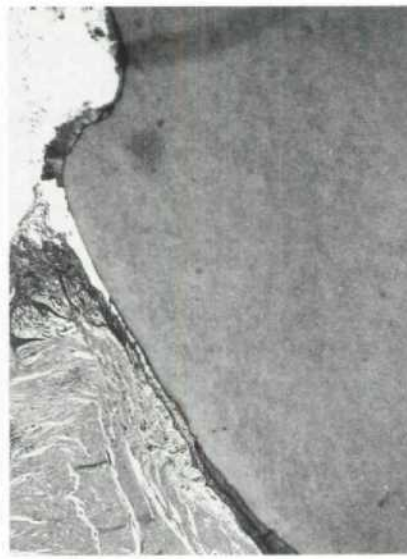


Fig. 13. Overview of tooth #31 in patient no. 2. (non-membrane containing). Hematoxylin-eosin stain ($\times 10$). Note plaque accumulation in notch. Apical to notch, closure occurred by junctional epithelial adhesion to the root.

present at all gingival margins in association with the marked plaque accumulations found in these locations, again reflecting the patient's reluctance to cleanse the operative sites.

Comments

It is generally accepted that gain in clinical closure at debrided suprabony lesions is the result of epithelial and connective adhesion to the debrided root surface (Box 1924, Levine & Stahl 1972, Yukna 1976, Stahl 1979, Steiner et al. 1981). However, the GTR approach has posited that delayed epithelization of the exposed root surface may enhance new attachment at such sites. This, despite the fact, that progenitor cell presence on the root in suprabony lesions is essentially dependent on coronal up-growth of such cells. In addition, the presence of a suprabony placed membrane could provide a physical space necessary for the initial healing to take place by modes other than adhesion (Gottlow et al. 1986). Our current observations support such concepts, albeit in a small human sample, particularly since similar new attachment was not seen in the coronally placed, debrided-only sites.

The present histologic observations depicting new attachment at suprabony

lesions without adjoining vertical defects appear rather consistent in these human samples. However, the degree of new attachment was limited, and variations in extent of new attachment were seen between sites and within a site. Yet, the histologic responses offer support for the concept that, biologically, supra-crestal new attachment is possible in the human model.

Of further interest was the accommodation responses of the labial plate to the presence of the membrane in close proximity. Compensatory facial resorption and periodontal surface apposition were routinely observed at the labial plates of the experimental specimens at 8 weeks after membrane placement. Since healing responses including cementogenesis occur within one or two weeks after injury, (Stahl et al. 1972), it appears advisable to remove a non-resorbable membrane after the initial healing phenomena have taken place or use a membrane which will resorb within this time frame. Furthermore, it should be noted that the healing responses observed particularly at the experimental sites took place despite the marked plaque accumulations and associated gingival inflammation. The presence of the facial orthodontic brackets and the history of recent surgery made our patients reluctant to use good oral hy-

giene. One can only speculate how more ideal plaque control measures would have affected the healing responses.

Finally, a comment regarding the responses at the non-membrane containing sites where an apical shift of the marginal attachment apparatus took place at all sites tested. Our results are in contrast to those reported clinically by Gantes et al. (1988). However, it must be underscored that the quoted results were observed at furcation sites and followed citric acid root treatment. Thus, the morphology of the lesions and treatments of the root were significantly different from those present in our sample. Here again, we must recognize the influence of lesion morphology and root surface condition on gingival healing sequences. In this regard, the histologic evidence of dentinal resorption at the new attachment sites within the notches of our samples suggest the need for further study regarding the role of dentinal resorption in new attachment responses (Egelberg 1987, Polson 1987).

Zusammenfassung

Die Heilung von supraalveolären Läsionen, die mit gesteuerter Geweberegeneration behandelt wurden. Regeneration und koronal fixierte Lappen - Fallbeispiele

Bei einem Versuchspatienten wurden 4 supraalveoläre Läsionen an Unterkiefer-Frontzähnen mit Teflonmembranen, die zwischen den Weichgewebelappen und der Wurzel lagen, behandelt. Beim zweiten Patienten dienten 4 supraalveoläre Läsionen an Unterkiefer-Frontzähnen als Vergleich. Alle Wurzeln wurden mit Ultraschall- und Handinstrumenten kurettiert. Die apikalste Stelle mit Zahnstein auf der Fazialfläche wurde mit einer Kerbe versehen. Der Lappen wurde so koronal wie möglich zugenäht, wobei kieferorthopädische Brackets als Verankerung benutzt wurden. Die Gewebelöcher wurden 2 bis 3 Monate nach dem Eingriff entfernt und die faciale Situation wurde bei allen Zähnen histologisch untersucht. Neues Attachment in Form von neuem "Zement mit funktionell orientierten Fasern" wurde in 3 von 4 Zähnen, die mit Membranen behandelt wurden, innerhalb der Zahnsteinkerbe und an einem Zahn leicht apikal der Kerbe beobachtet. Die vier Vergleichszähne zeigten keinerlei Anzeichen von neuem Attachment innerhalb oder neben der Kerbe. Der Ansatz der Gingiva war eher apikal der Kerbe gelegen. Unsere Beobachtungen lassen vermuten, daß in den beschriebenen Fällen die Technik der gesteuerten Geweberegeneration das koronale Attachment

bei menschlichen supraalveolären Läsionen verbesserte.

Résumé

Guérison des lésions supra-osseuses humaines traitées par régénération tissulaire guidée et lambeaux fixés sur la couronne. Comptes rendus de cas

Des membranes en Teflon ont été interposées entre les lambeaux de tissu mou et les racines dans 4 lésions supra-osseuses humaines affectant les incisives inférieures chez un patient volontaire. Pour la comparaison on a utilisé 4 lésions supra-osseuses affectant les incisives inférieures chez un autre patient. Toutes les racines ont été débridées au moyen d'instruments ultrasoniques et manuels, et on a marqué d'une encoche la localisation du tartre/site le plus apical sur la face vestibulaire. Les lambeaux ont été suturés à un niveau aussi coronaire que possible en utilisant des "brackets" orthodontiques pour la fixation. Des blocs de tissu ont été prélevés 2 à 3 mois après les interventions et on a procédé à l'examen histologique du côté vestibulaire de toutes les dents. On a constaté la présence, dans l'encoche correspondant au tartre pour 3 sur 4 des sites traités avec membrane, et au niveau situé immédiatement en apical de l'encoche pour l'un des sites, d'une nouvelle attache formée de "cément à fibres orientées fonctionnellement". Dans les 4 sites servant pour la comparaison, on n'observait aucun signe indiquant une nouvelle attache, ni dans l'encoche ni à côté d'elle. En fait, les rebords gingivaux étaient situés en apical de l'enco-

che. Nos observations semblent indiquer que les techniques de régénération tissulaire guidée favorisaient les réponses de formation d'attache coronaire dans les lésions supra-osseuses humaines au sein de la population décrite.

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