

# Histologic healing responses in human vertical lesions following the use of osseous allografts and barrier membranes\*

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**Abstract.** 4 vertical lesions at 3 teeth in 2 volunteer adults with severe periodontitis were treated by open surgical debridement, osseous allografts and barrier membranes. Roots were notched at both gingival margins and the deepest visible calculus and flaps were sutured coronally. Patients were placed on 0.12% chlorhexidine gluconate 2× daily post-surgery, and blocks were harvested 5 to 6 weeks after surgery. No abnormal clinical responses were noted during the observation period. In the 4 sites, the average preoperative pocket depth was 9.4 mm; the post-operative pocket depth averaged 4.9 mm, recession averaged 0.9 mm and gain in clinical closure averaged 3.6 mm. Histologically, new cementum measured coronally-apically at the treated sites varied from 0.0 mm to 1.7 mm, with an average of 1.1 mm. Osseous remodelling and crestal osteogenesis were seen in association with cementogenesis. The newly deposited cementum showed insertion of functional oriented fibers. New attachment was present within 2 out of 4 calculus notches in this sample.

**Key words:** human vertical lesions; osseous allografts; barrier membranes

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Bowers et al. (1989) recently postulated that the combination of highly osteogenic materials and epithelial exclusion techniques offered promise for enhanced and predictable periodontal regeneration. A clinical study (Schallhorn & McClain 1988) noted that sites treated with bone grafts did as well or better than sites treated with membrane alone. However, combination of treatment improved gain in probing depth when compared with use of membrane alone (mean gain in vertical probing attachment level, membrane alone: 4.5 mm; mean gain using combination of bone graft, root conditioning and GTR: 5.3 mm). Yet the histologic form of closure was not identified by this clinical evaluation. We recently reported histologic evaluations of human healing responses to the use of porous hydroxyapatites and barrier membranes in verti-

cal lesions. In that series, bone mass appeared enhanced, but new attachment was not observed in any of the 7 sites evaluated (Stahl & Froum 1991). We now wish to report on histologic observations when a combination of osseous allografts and barrier membranes were used in the treatment of human vertical lesions.

## Material and Methods

4 vertical (1-2 wall) periodontal lesions on 3 teeth in 2 adult volunteer patients were treated by open debridement flap procedure followed by fill of the defects using demineralized freeze-dried bone allografts. The filled defect was covered by a teflon barrier membrane (Goretex periodontal material<sup>‡</sup>).

All patients were in good health and each signed an informed consent following explanation of the study and providing freedom to withdraw at the patients'

request. Surgery was performed as part of the overall periodontal treatment plan in the Department of Periodontics at New York University College of Dentistry. The 3 teeth selected were scheduled for extraction for periodontal or prosthetic reasons by 2 periodontist who were not part of the present study. Prior to surgery, cause-related therapy was performed. However, root planing at the selected sites was performed only after notching of the root at time of surgery. Root debridement was carried out using ultrasonic scalers and hand instruments until all visible calculus was removed. Both magnifying lenses and fiberoptic light were employed to detect calculus. All necessary pre-treatment photographs and radiograms of the sites were taken at this time and photographs were obtained during surgery for clinical documentation.

## Measurements

Prior to surgery, a horizontal notch was made at the level of the gingival margin using a  $\frac{1}{2}$  round bur. To insure reproduc-

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‡ Goretex periodontal material is a product of W. L. Gore Associates, Inc. Flagstaff, Arizona, USA.

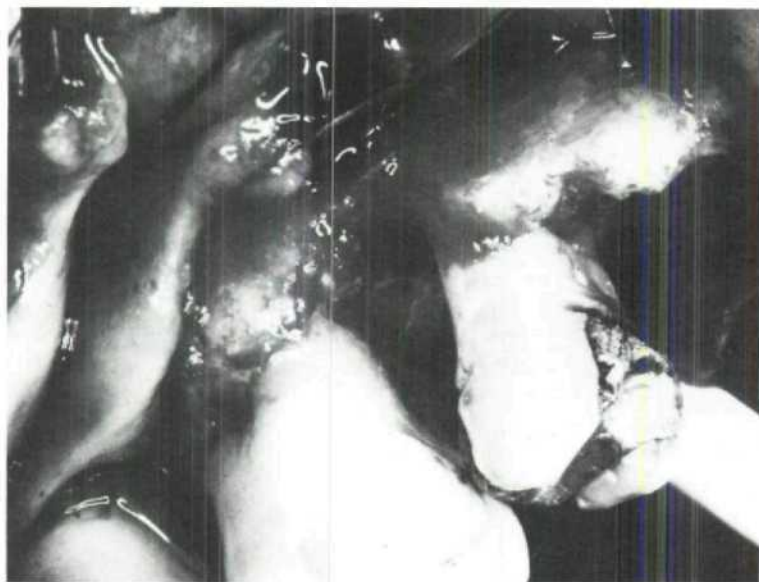


Fig. 1. Debrided site in patient no. 2.

ibility 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 utilizing 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, prior to root planing, a second notch was made through the most apical level of visible calculus and the following measurements were made: (1) distance from calculus notch to the deepest point of the osseous defect; (2) distance from calculus notch to the alveolar crest.

Following defect and root debridement, the defect was classified according to the number of osseous walls remaining.

#### Surgical procedure

An intrasulcular incision was made to elevate a full thickness mucoperiosteal flap in order to retain as much marginal

gingiva as possible. After root/calculus notching, the lesion and root were thoroughly debrided and the above-mentioned measurements recorded. In all sites, the vertical defect was packed to slightly above crest with the osseous allograft. Following this, the teflon membrane was placed at least 4–5 mm apical to the crest of the bony defect. It was also positioned coronally to remain subgingival following flap suture.

Membranes were secured with sutures placed circumferentially around the tooth using a sling technique. The flaps were readopted without sutures to allow adjustment of the position of the membranes and then sutured coronally in these positions with interrupted sutures of 4-0 silk or Dexon. No dressing was placed. Patients were instructed to rinse with 0.12% chlorhexidine gluconate 2 × a day for 2 weeks. Flap sutures were removed 10–14 days following surgery. Patients returned for plaque removal once a week until block sections were harvested.

Block sections were removed 5 to 6 weeks after surgical therapy. At the time

of block removal, clinical records, measurements, photographs and radiographs similar to those described at initial surgery were taken (Fig. 1).

#### Histologic processing and measurements

At the time of block removal, teeth were fixed in 10% buffered formalin, decalcified in EDTA and embedded in paraffin.

Step serial sections 8  $\mu$  thick were cut and stained for routine histologic evaluations. The length of new cementum was measured microscopically in 3 centrally located step serial sections (60  $\mu$  apart). They were measured in a linear direction along the root surface. The new cementum was measured from its most coronal to its most apical root position, but never beyond the base of the osseous crater. The distances reported per site are the mean of 3 measurements taken per block (Table 1).

#### Observations

##### Clinical (Table 1)

Pertinent clinical findings at each site are presented in Table 1. In summary, the clinical findings for sites removed 5 to 6 weeks after surgery showed an average preoperative pocket depth of 9.4 mm (range 7.3 mm–11.3 mm) and a post-operative average pocket depth of 4.9 mm (range 3.5 mm–5.5 mm). Recession averaged 0.9 mm (range 0.7 mm–1.5 mm) and gain in probing depth averaged 3.6 mm (range 2.3 mm–5.6 mm).

##### Histologic (Table 1)

##### Membrane and osseous allograft treated; 5 to 6 weeks post-surgery

Of the 4 sites harvested, 1 site exhibited closure by epithelial adhesion (long junctional epithelium). Apical to the J.E., parallel oriented fibers covered the supracrestal root surface. No evidence of osteogenesis or new attachment was observed (Fig. 2).

In the remaining 3 sites, 2 of them

Table 1. Clinical and histologic responses to the combined use of GTR and DFD bone allografts

Patient no.	Tooth no.	Initial P.D. (mm)	Observation period (weeks)	Postop. P.D. (mm)	Recession (mm)	Gain in probing attach. (mm)	New cement. (mm)
1	36d	8.5	5	5.5	0.7	2.3	0.0
2	25m	7.3	6	3.5	0.8	3.0	1.5 (N.A.)
	25d	11.3	6	5.0	0.7	5.6	1.7 (N.A.)
	26m	10.5	6	5.5	1.5	3.5	1.3
average		9.4		4.9	0.9	3.6	1.1

showed new attachment within the calculus notch but not coronal to it. 1 site demonstrated cementogenesis with functionally inserted fibers apical to the calculus notch (Figs. 3, 4). Osseous remodelling and crestal osteogenesis was

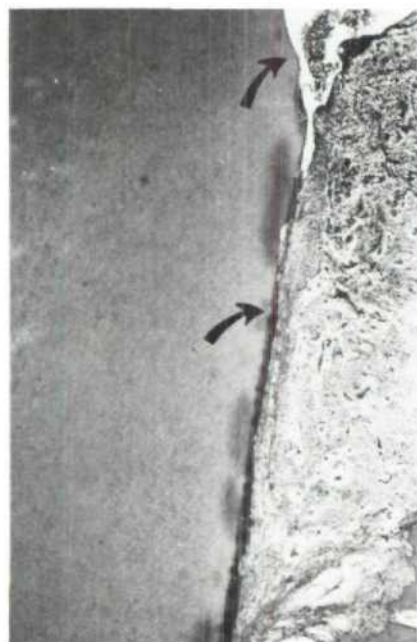


Fig. 2. Overview of treated site, tooth no. 36d, patient no. 1, 5 weeks after surgery. Hematoxylin-eosin stain. Note closure is by epithelial and connective tissue adhesion apical to the calculus notch. Arrows point to apical border of notch and apical termination of the J.E.

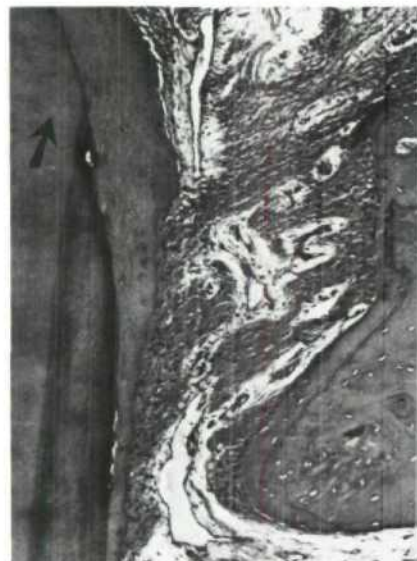


Fig. 3. Cementogenesis within calculus notch (arrow), and osteogenesis with functionally oriented PDL in tooth no. 25m, patient no. 2, 6 weeks after surgery. Magnification 25x, hematoxylin-eosin stain.

seen in association with cementogenesis at all of the 3 sites examined. Length of new cellular cementum measured coronally-apically along the root surface averaged 1.1 mm and ranged from 0.00 mm to 1.7 mm (Table 1).

#### Comment

A limited gain in clinical probing attachment was reported by Schallhorn & McClain (1988), when responses to combinations of regenerative procedures were compared with responses following use of a single regenerative technique. Our present clinical observations support these findings. However, our main interest focused on the histologic healing responses when both GTR and bone grafts were used in the same human vertical lesion. The responses observed were identical to those reported when either GTR (Nyman et al. 1982, Gottlow et al. 1986, Stahl et al. 1989) or bone grafts (Bowers et al. 1989) were used, i.e., both techniques create an environment in which new attachment can take place. Unfortunately, our data do not support the speculation that combinations of highly osteogenic materials and epithelial exclusion may lead to predictable and enhanced periodontal regeneration (Bowers et al. 1989). Among possible reasons

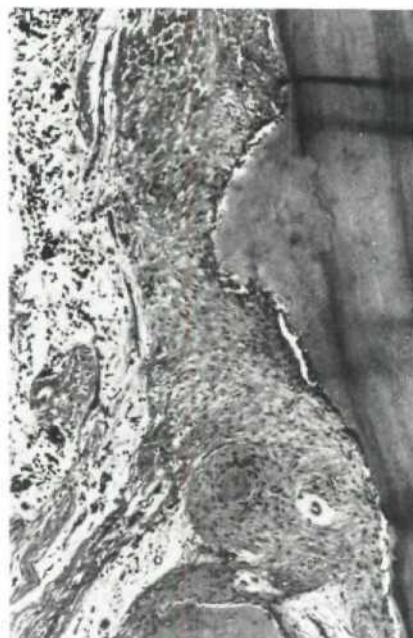


Fig. 4. Cementogenesis and functionally oriented fiber attachment within calculus notch, tooth no. 25d, patient no. 2, 6 weeks after surgery. Magnification 25x, hematoxylin-eosin stain.

for the lack of improved regenerative responses following the use of combination techniques may be: (a) our small sample; (b) the initial shrinkage of the flap margin in the early healing stages, thereby effectively limiting new attachment (Garrett et al. 1990); supracrestal overfill may indeed enhance this shrinkage by expanding the supracrestal space; (c) a physical obstruction to optimal coronal migration of progenitor cells when graft particles fill the intraosseous lesion; (d) the recognition that our present regenerative techniques only create an environment for specific growth factors to initiate new attachment. Identification and utilization of such specific factors should ultimately lead to predictable new attachment at root sites previously exposed to the oral environment.

#### Zusammenfassung

*Histologische Heilungsergebnisse von menschlichen vertikalen Knochendefekten nach der Anwendung von Knochenimplantaten und Membranen*

Bei zwei erwachsenen Versuchspersonen wurden an 3 Zähnen 4 vertikale Knochendefekte durch eine offene chirurgische Belagentfernung, Knochenimplantate und Membranen behandelt. Die Wurzeln wurden sowohl an der marginalen Gingiva, als auch an der tiefsten Stelle mit sichtbarem Zahnstein, eingekerbt. Der Lappen wurde koronal angenäht. Nach der Chirurgie spülten die Patienten zweimal täglich mit 0.12% Chlorhexidin-Digluconat. Blocksektionen wurden 5 bis 6 Wochen nach der Chirurgie entnommen. Während der Beobachtungsperiode wurden keine anormalen klinischen Reaktionen beobachtet. Bei den 4 Stellen war die durchschnittliche präoperative Taschentiefe 9.4 mm; die post-operative Taschentiefe betrug durchschnittlich 4.9 mm, Rezessionen betragen durchschnittlich 0.9 mm und der Gewinn an klinischem Attachment 3.6 mm. Histologisch variierte das neue Zement, koronal-apikal gemessen, an den behandelten Stellen von 0.0 mm bis 1.7 mm, mit einem Durchschnitt von 1.1 mm. Knöcherner Umbau und Alveolarknochenbildung wurden, zusammen mit der Zementogenese, beobachtet. Das neu gebildete Zement wies Insertionen von funktionell orientierten Fasern auf. Neues Attachment war in dieser Probengruppe in 2 von 4 Zahnsteinkerben vorhanden.

#### Résumé

*Cicatrisation des lésions verticales après l'utilisation d'allogreffes osseuses et de membranes isolantes chez l'homme: réactions histologiques*  
Chez 2 sujets volontaires atteints de parodontite sévère, 4 lésions verticales au niveau de 3

dents ont été traitées par débridement chirurgical à ciel ouvert, allogreffes osseuses et membranes isolantes. Des encoches ont été pratiquées sur les racines au niveau des rebords gingivaux et au niveau du tartre visible le plus profond; les lambeaux ont ensuite été fixés par suture coronaire. Après l'intervention, les patients étaient traités 2 fois par jour au gluconate de chlorhexidine à 0.12%; 5 à 6 semaines après l'intervention des blocs ont été prélevés. Aucune réaction clinique anormale n'a été observée pendant la période d'observation. Dans les 4 sites, la moyenne préopératoire de la profondeur des poches était de 9.4 mm; la moyenne post-opératoire de la profondeur des poches était de 4.9 mm, la moyenne de la rétraction était de 0.9 mm et la moyenne du gain clinique obtenu était de 3.6 mm. Du point de vue histologique, la formation de nouveau ciment, mesurée en direction corono-apicale au niveau des sites traités, variait de 0.0 mm à 1.7 mm, avec une moyenne de 1.1 mm. Un remodelage osseux et une ostéogénèse de la crête ont été observés en même temps que la cémentogénèse. Dans le ciment qui venait de se déposer, on consta-

taît l'insertion de fibres orientées suivant la fonction. Dans 2 des 4 encoches indiquant le niveau du tartre dans cet échantillon, on constatait la présence d'une nouvelle attache.

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