

Human intrabony lesion responses to debridement, porous hydroxyapatite implants and teflon barrier membranes

7 histologic case reports[†]

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Abstract. 7 vertical lesions at 7 teeth in 3 adults with severe periodontitis were treated using open surgical debridement, porous hydroxyapatite grafts and placement of a barrier membrane. Roots were notched at both gingival margins and deepest visible calculus. Flaps were sutured coronally and patients were placed on 0.12% chlorohexidine gluconate twice daily for 2 weeks, post-surgery. Patients returned frequently for plaque control until block removal at 16 to 28 weeks post-surgery. 1 additional block was harvested after 28 weeks. The latter site received root planing only and closed by epithelial adhesion. In the 7 experimental sites, clinical responses were uneventful, and gain in clinical closure varied from 1.7 to 5.0 mm (average = 3.6 mm). Histologically, 2 sites exhibited closure by a long junctional epithelium. The remaining 5 sites showed gingival recession to be apical to the calculus notch or the calculus notch to be epithelized. However, apical to the notch and within the osseous crater, cellular cementum deposition was marked as was increased bone mass. The increase in bone mass was the result of osteogenesis within the surrounding graft particles which often fused with osseous seams of the crater. A functionally-oriented PDL was seen usually at these sites.

Key words: intrabony lesions; hydroxyapatite implant; barrier membrane.

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In a recent position paper, Hancock (1989) stated that "combined procedures aimed at stimulating bone formation and encouraging coronal development of the connective tissue attachment are promising approaches to regeneration". This concept is supported by Bowers et al. (1989) who concluded that "the combination of highly osteogenic materials and epithelial exclusion techniques offer promise for enhancing the amount, frequency and predictability of periodontal regeneration." Schallhorn & McClain (1988) reported on a clinical

study combining osseous composite grafting, root conditioning and guided tissue regeneration. They noted improved gains of vertical open probing attachments (mean gain of 5.3 mm) where the combination treatment was utilized compared to sites where membrane alone was used (mean gain 4.5 mm). On the other hand, Garret et al. (1988) using a collagen membrane, root conditioning and bone grafts at 25 intraosseous sites in 21 patients, noted unpredictable clinical results after a 1-year observation period. These observations suggested the need for human histologic evaluations of vertical defects treated with both attachment-enhancing procedures (GTR) and bone-mass-increasing materials (porous particulate hydroxyapatite). For this report, responses in 7 sites of 3 patients will be presented.

Material and Methods

7 vertical periodontal lesions on 7 teeth in 3 adult (ages 44 to 66 years) volunteer patients (1 female, 2 male) were treated by open debridement flap procedure followed by fill of the defects using a porous particulate hydroxyapatite (Interpore* 200). The filled defect was covered by a teflon barrier membrane (Goretex periodontal material**).

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'

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*Interpore 200 is a product of Interpore International, Irvine, California, USA.

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

request. Surgery was performed as part of the overall periodontal treatment plan in the Department of Periodontics at New York University College of Dentistry. All 8 teeth selected were scheduled for extraction. They had been diagnosed as hopeless, for periodontal or prosthetic reasons, by 2 periodontist who are 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.

In addition to the above-cited 7 sites, 1 additional block was harvested. This site (patient no. 3, tooth #46) was treated by debridement only and harvested at 7 months post-surgery.

Measurements

Prior to surgery, a horizontal notch was made 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 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 wherever possible. 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

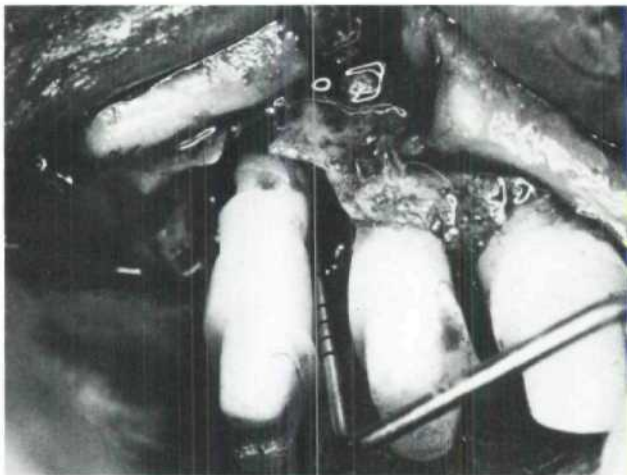


Fig. 1. Clinical appearance of debrided lesion, tooth #15, in patient no. 4.



Fig. 2. Site at tooth #15, patient no. 1 filled with Interport graft.

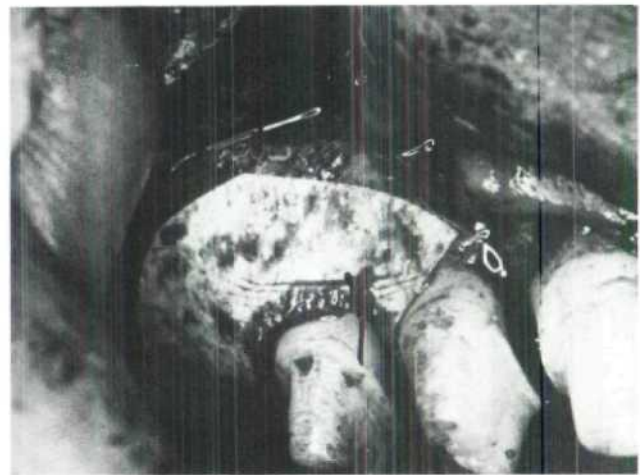


Fig. 3. Site at tooth #15, patient no. 1 with barrier membrane in place.



Fig. 4. Debrided site at tooth #46, patient no. 3. This site received debridement only.

gingiva as possible. After root/calculus notching, the lesion and root were thoroughly debrided and above-described measurements recorded. In all sites (except in the debridement-only site), the vertical defect was packed to slightly above crest with the porous hydroxyapatite. 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 non-resorbable 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% chlorohexidine gluconate 2 × a day for 2 weeks. Flap sutures were removed 10–14 days following surgery. Patients returned for plaque removal once a week for 1 month, then every 2 to 3 weeks until block section was performed.

Teflon membranes barrier were removed 6 to 8 weeks after placement during a 2nd surgical procedure. Block sections were removed 16 to 28 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 (Figs. 1–3).

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 μ 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 μ

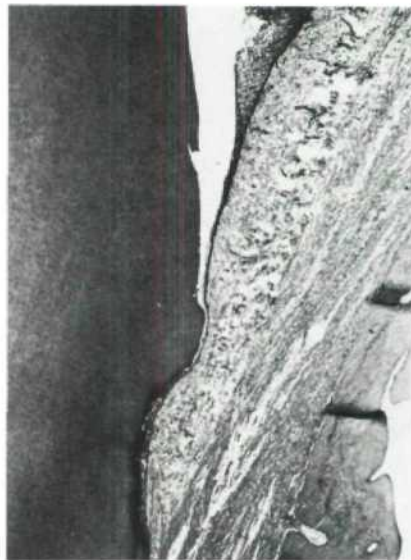


Fig. 5. Histologic overview of site shown in Fig. 4. H&E stain. Note calculus notch is epithelized and closure is by long junctional epithelium.

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

Pertinent clinical findings at each site are presented in Table 1. In summary, the clinical findings for sites removed 16 to 28 weeks after surgery showed an average preoperative pocket depth of 9.5 mm (range 7.5–13.0 mm) and a postoperative average pocket depth of 4.5 mm (range 2.8–8.2 mm). Recession averaged 1.4 mm (range 1.0–1.7 mm) and gain in clinical closure averaged 3.6 mm (range 1.7–5.0 mm).

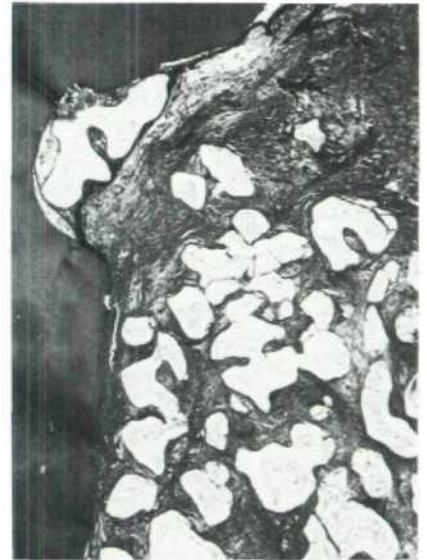


Fig. 6. Histologic overview of site shown in Fig. 1. This site received the Interpore graft and barrier membrane and the block was harvested 16 weeks after surgery. H & E stain. Note epithelized calculus notch. Apical to the notch, cellular cementum is present which contains inserted fibers extending into the connective tissue surrounding the graft particles.

For the debrided-only site, (patient no. 3, tooth #46) the clinical measurements were as follows: preoperative pocket depth = 12.2 mm, postoperative pocket depth = 7.0 mm, recession = 3.6 mm and gain in clinical closure = 0.8 mm. The observation period was 28 weeks.

No unusual sequelae were noted for any patient during the entire period of observation and healing progressed satisfactorily at all sites treated.

Histologic

Debrided-only site

The histologic findings at this site demonstrated closure by epithelial adhesion (long junctional epithelium). The calcu-

Table 1. Responses following use of debridement, hydroxyapatite graft and barrier membrane

Patient no.	Tooth	Initial P.D. (mm)	Observation time (weeks)	Post-surg. P.D. (mm)	Recession (mm)	Gain in clinical closure (mm)	New cementum (mm)
1	25	8.0	16	2.8	1.6	3.6	2.4
2	32	13.0	16	8.2	1.0	3.8	1.4
3	16	9.8	28	6.8	1.3	1.7	1.0
3	17	7.5	28	4.0	1.7	1.8	0.0
3	18	8.7	28	3.0	1.0	4.7	0.9
3	37	10.1	28	4.0	1.5	4.6	1.1
3	36	9.5	28	3.0	1.5	5.0	0.0

P.D.: pocket depth.



Fig. 7. Higher magnification (25x) of cellular cementum shown in Fig. 6.

lus notch was lined with epithelium and the vertical osseous seam showed no evidence of significant osteogenesis (Figs. 4, 5).

Membrane and hydroxyapatite treated site; 16 to 28 weeks post-surgery

Of the 7 sites harvested, 2 sites exhibited closure by epithelial adhesion (long junctional epithelium) and demonstrated no evidence of osteogenesis or new attachment. The remaining 5 sites showed epithelial lining within the calculus notch or gingival marginal recession to root sites apical to the calculus notch. However, at these apical root sites and within the osseous crater, cementogenesis was often



Fig. 9. Histologic overview of site shown in Fig. 8. H & E stain. Note cellular cementum apical to calculus notch and adjacent to ossifying graft particles.

pronounced along the root surface. It was coupled with notable osteogenic activity within and at the borders of the graft particles which frequently appeared fused to the alveolar walls and crest (Figs. 6-10). The periodontal membranes appeared well organized in most sections examined. Length of new cellular cementum measured coronally-apically along the root surface averaged 0.9 mm and ranged from 0.00 mm to 2.4 mm (Table 1).

It should be noted that osteogenesis within and surrounding graft particles was seen at some locations directly opposite the long junctional epithelium

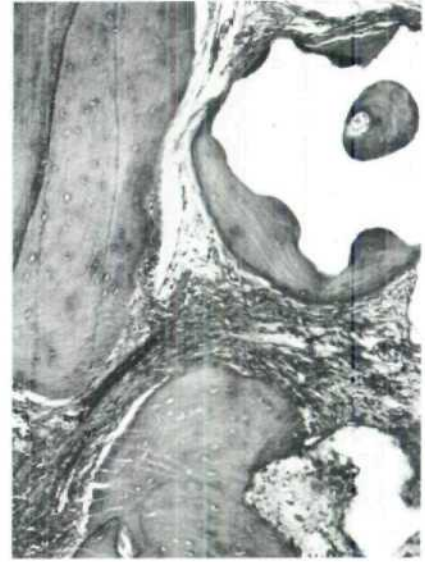


Fig. 10. Higher magnification of site shown in Fig. 9. Magnification 64x. Note character of cellular cementum and osteogenic activity within graft particles.

(Fig. 11). Thus, graft osteogenesis did not correlate directly with cementogenesis in our samples. Nor did clinical probing changes (gain in clinical closure) indicate the histologic nature of the closure. In fact, the site showing the largest gain in clinical closure (5.0 mm) demonstrated histologically a long junctional epithelium without any evidence of regeneration.

Comment

The question raised in the introduction, namely does a combination of a barrier membrane and a porous hydroxyapatite increase new attachment in human vertical lesions, cannot be answered positively on the basis of the case reports presented. Rather, the present responses, in some aspects, appear similar to our observations in human intrabony lesions where barrier membranes *only* were used (Stahl et al. 1990). For example, cemental deposition measured in a linear direction on treated roots in those sites ranged from 0.5 to 1.7 mm, a range very similar to that reported in the present cases. On the other hand, bone mass appeared more pronounced with the use of hydroxyapatite graft material. Obviously, our site numbers are too small for statistical evaluation. However, the trends seen in our clinical responses are similar to a published clinical study in which grafting, root conditioning and GTR were used (Schallhorn & McClain 1988).



Fig. 8. Clinical appearance of debrided site of tooth #37 in patient no. 3. This site was treated with Interpore graft and barrier membrane and the block was harvested 28 weeks after surgery.



Fig. 11. Histologic overview of treated site at tooth #36 in patient no. 3. The site was treated with Interpore graft and barrier membrane and the block harvested 28 weeks after surgery. H & E stain. Note closure by long junctional epithelium and ossification in adjacent graft particles.

Regarding histologic evidence of new attachment, the data presented here must be compared with published histologic observations of increased new attachment when barrier membranes and root debridement were used (Nyman et al. 1982, Gottlow et al. 1986, Stahl et al. 1990). It should be noted that cementogenesis with functional fiber attachment did not take place within the calculus notches of the present sites, but rather apical to the notches. Thus, the possibility must be considered that the apical cementogenesis may depict re-attachment rather than new attachment.

Our present observations confirm published human histologic observations of increased bone mass when porous hydroxyapatite particles were placed in vertical lesions. However, cementogenesis was *not* observed when this graft material *alone* was used. (Stahl & Froum 1987). Therefore, the combination utilized in the present cases appeared to *enhance cementogenesis* and *increase bone mass* within the limits of the osseous crater. (In this context, it is of interest that in a clinical study, Bowen et al. (1989) reported similar bone fill when porous hydroxyapatite grafts or osseous allografts were used in human vertical lesions).

Finally, in comparing our results with published data, we concur with Gottlow et al. (1986) that "the amount of new attachment varies with specific sites when the GTR technique is employed".

Among the reasons for such variations, Gottlow et al. (1986) speculated that "in the presence of an angular bony defect, a space exists between the osseous walls and the root into which bone-forming cells in the periphery of the defect can migrate". Indeed, the maintenance of such vertical space using porous hydroxyapatite grafts was associated with notable osteogenesis and cementogenesis within such spaces in 5 out of 7 sites we examined. However, it did not enhance new supracrestal attachment (Nyman & Karring, 1979). In turn, lack of marked supracrestal attachment may relate to the positioning of the flap margin, since *coronal anchoring* of the gingival margin enhanced supracrestal new attachment in human supracrestal lesions treated by the use of debridement and a barrier membrane (Stahl & Froum 1991).

A final comment: our debrided-only block was used for guidance of responses, since it was taken from a patient who also received the combination treatments at other sites. The epithelial closure observed at the debrided-only site supports published observations of this mode of closure following root debridement alone (Hancock 1989).

Zusammenfassung

Die Heilung von menschlichen Knochentaschen nach: Belagentfernung, Implantation poröser Hydroxylapatits und Teflon-Membran-Einbringung. 7 histologische Fallbeispiele

Bei 3 erwachsenen Versuchspersonen mit schwerer Parodontitis wurden an 7 Zähnen 7 vertikale Knochendefekte durch eine offene chirurgische Belagentfernung, Implantation poröser Hydroxylapatits und Einbringung von 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 zwei Wochen lang zweimal täglich mit 0.12% Chlorhexidin-Digluconat. Von der 16ten bis 28ten Woche kamen die Patienten häufig zur Plaquekontrolle. Bis zur Blocksektion nach 16 bis 28 Wochen kamen die Patienten häufig zur Plaqueentfernung. Ein zusätzlicher Block wurde nach 28 Wochen entnommen. Die letztere Stelle erhielt nur eine Wurzelglättung und heilte durch epitheliale Adhäsion. Bei den 7 experimentellen Defekten war die klinische Heilung ohne besondere Vorkommnisse und der Gewinn an klinischem Attachment variierte von 1,7 bis 5,0 mm (Durchschnitt=3,6 mm). Histologisch zeigten 2 Stellen einen Verschluss durch ein langes Saumepithel. Die verbliebenen 5 Stellen wiesen Gingivarezessionen bis apikal der Kerbe auf oder hatten eine epithelialisierte Zahnsteinkerbe. Jedoch befand sich apikal der Kerbe und innerhalb des Knochenkraters eine Ablagerung zellulären Zementes und eine größere Knochenauffüllung. Die Vermehrung des Knochens war das Ergebnis einer Osteogenese innerhalb und in der Umgebung der Implantatpartikel, die oft eine Fusion mit den knöchernen Begrenzungen des Kraters zeigten. Ein funktionell orientiertes parodontales Ligament wurde gewöhnlich an diesen Stellen gesehen.

Résumé

Réactions des lésions intra-osseuses humaines au traitement par débridement, implants poreux d'hydroxyapatite et membranes barrières de téflon. Rapports histologiques sur 7 cas

Chez 3 adultes, atteints de parodontite sévère, 7 lésions verticales sur 7 dents ont été traitées en utilisant un débridement chirurgical à ciel ouvert, des greffons poreux d'hydroxyapatite et interposition d'une membrane comme barrière. Des encoches ont été pratiquées sur les racines au niveau du rebord gingival et au niveau le plus profond du tartre visible. Les lambeaux ont été suturés au niveau des couronnes et on a prescrit aux patients des rinçages au gluconate de chlorhexidine à 0,12%, 2 fois par jour pendant 2 semaines après l'intervention. Les patients recevaient des séances fréquentes de contrôle de la plaque, jusqu'à ce que soit fait un prélèvement en bloc 16 à 28 semaines après l'intervention chirurgicale. Un bloc supplémentaire a été prélevé après 28 semaines. Dans le site de ce bloc, seul un surfaçage radiculaire avait été fait, et la fermeture s'était faite par adhésion épithéliale. Dans les 7 sites expérimentaux, les réactions cliniques avaient été sans complications, le gain de la cicatrisation clinique variait de 1,7 à 5,0 mm (moyenne=3,6

mm). A l'examen histologique, 2 des sites avaient une cicatrisation avec long épithélium de jonction. Les 5 autres sites présentaient une récession gingivale en apical de l'encoche, ou une épithélialisation de l'encoche faite au niveau due tartre. Cependant, en apical de l'encoche et à l'intérieur du cratère osseux, il s'était produit un dépôt marqué de ciment cellulaire, ainsi qu'une nette agumentation de la masse osseuse. Cette augmentation de la masse osseuse était le résultat de l'ostéogénèse se produisant dans les particules des greffons et autour d'elles et entrant souvent en fusion avec les bords osseux du cratère. Un desmodonte orienté suivant la fonction était généralement constaté dans ces sites.

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