Histologic and Clinical Responses to Porous Hydroxylapatite Implants in Human Periodontal Defects*

Three to Twelve Months Postimplantation

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TWELVE INTRABONY PERIODONTAL LESIONS in three volunteers received surgical debridement followed by site implantation of porous hydroxylapatite implants. These patients were followed over a total of a 1-year observation period. Blocks of treated sites were surgically removed at 3 months, 6 months and 12 months after implantation.

Clinical observation indicated a reduction in pocket depth consisting of both recession and clinical gain of attachment. No ill effects were observed. Histologic examination of the treated sites showed ossification of the implant pores and the implant periphery as early as 3 months after implantation, which became pronounced 12 months after placement. At times, peripheral ossification linked with crestal osseous seams. This ossification occurred in the presence of an adjacent root covering, long junctional epithelium, and thus there was no new attachment. On the other hand, this graft material offers the potential of increasing new bone mass within a human intrabony lesion.

Currently, periodontists are evaluating the effects of various graft materials in the healing of periodontal defects. Most recently, reports have dealt with the use of porous hydroxylapatite implants and indicated that, clinically, the use of this material reduced pocket depth and osseous depth, and led to gains in attachment level.[1] In a subsequent report, three human biopsy samples were obtained from 3- to 6-month postimplantation sites, which indicated bone formation within the implant pores. However, the authors indicated that "the exact nature of the tissue response to the porous hydroxylapatite material cannot be visualized in this study as no block sections were obtained."[2] The present report will describe clinical and histologic responses to porous hydroxylapatite implants in human periodontal defects over a 1-year observation period using human block sections for the histologic analysis of responses.

MATERIALS AND METHODS

Twelve periodontal lesions in three volunteer patients (aged 33, 47, and 52 years) were subjected to histologic and clinical evaluations of the effects of porous hydroxylapatite implants† on the repair of intraosseous lesions. All participants were in good health and every patient received an explanation of the study and signed an informed consent as part of the protocol requirements. Sites used in this study had been diagnosed by an independent dental treatment team as having a hopeless prognosis.

In order to eliminate interexaminer differences, all measurements and surgical procedures were performed by the same examiner (SJF). Prior to surgery, cause-related therapy was performed. This consisted of oral hygiene instruction, scaling and root planing, occlusal adjustment and temporary splinting where indicated (tooth mobility measuring Class III). Surgery was performed only when the plaque control index was less than 10%.

Measurements. Prior to surgery (at least 6 weeks after initial therapy), a horizontal notch was made in the root at the level of the gingival margin using a ½ round bur. A vertical notch (steering groove) was placed in the crown of the tooth at each study site to guide the positioning of the silver point used for measurements. All measurements were made to the nearest 0.1 mm using an endodontic silver point, a locking plier and a Boley gauge.[3] The distance from the gingival notch to

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† These implants are marketed as "Interpore 200 porous hydroxylapatite" by Interpore International, Irvine, CA.

the base of the clinical pocket was then recorded as was the degree of tooth mobility. Following flap reflection, a second notch was placed through the most apical extent of calculus at the involved root site and the following measurements obtained: 1. Distance from calculus notch to deepest point of the osseous defect. 2. Distance from calculus notch to crest of defect. The defect was also classified accordingly to the number of osseous walls remaining.

Surgical Procedure. After obtaining local anesthesia, a full-thickness mucoperiosteal flap was elevated. After root/calculus notching, the lesion was then thoroughly debrided and appropriate measurements taken. Following intramarrow penetration, the site was overfilled with the porous graft material using both wedge material contoured to approximate the defect and graft granules. The flap wall was then positioned as incisally as possible, and complete closure was attempted. Interrupted sutures (4.0) were used and a periodontal dressing applied over the sutured site. All pre- and immediate postsurgical measurements, photographs and radiographs were taken during this time. Patients were then placed on penicillin 250 mg four times daily for 10 days. Ten to 14 days after graft placement, dressings and sutures were removed and the site lightly debrided and irrigated. All patients received weekly professional plaque removal of the surgical site for the first 6 weeks and then once every 2 to 4 weeks until the block was removed. At the time of block removal, appropriate clinical records, photographs and radiograms were taken and pocket depth, recession and clinical closure gain recorded, again using the gingival marginal notch as the fixed point of reference. Blocks were removed 3 to 12 months after graft placement. No adverse reactions were noted during our observation time.

Upon removal, all specimens were decalcified and prepared for histologic study. Step-serial, mesiodistally cut sections were prepared and selectively stained with hematoxylin-eosin, Mallory-trichrome and Van Kossa stains.

CLINICAL OBSERVATIONS

Preoperative pocket depth at the 12 sites ranged from 6.3 to 9.9 mm and intraosseous depth ranged from 2.8 to 10.7 mm. The osseous configurations were essentially one- to two-wall lesions. Mobility varied from slight to severe (I to III, Miller classification). At the time of block removal, the sites showed pocket depth ranging from 3.0 to 5.0 mm. Gingival recession was present at all sites and ranged from 0.8 to 2.3 mm. Clinical gain in closure ranged from 2.0 to 4.2 mm. Mobility pattern did not change at the 3-month postoperative period but was somewhat less at the 6- and 12-month intervals (Figs. 1–6; Table 1).

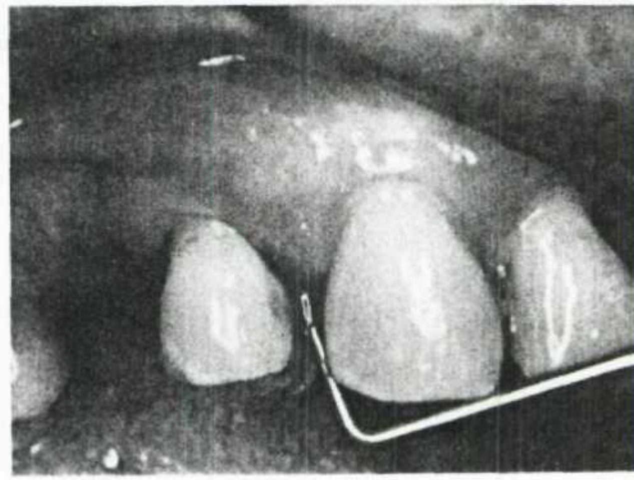

Figure 1. *Preoperative photograph using a periodontal probe to indicate pocket depth in Patient IS (for photographic purposes).*

Figure 2. *Preoperative radiogram of surgical site in Patient IS.*

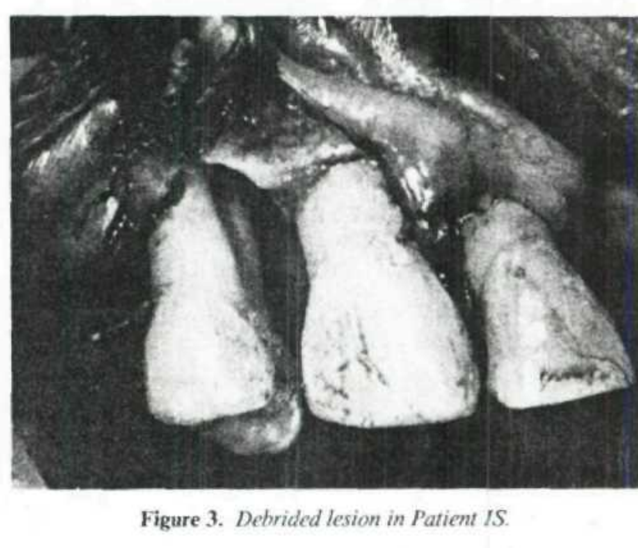

Figure 3. *Debrided lesion in Patient IS.*

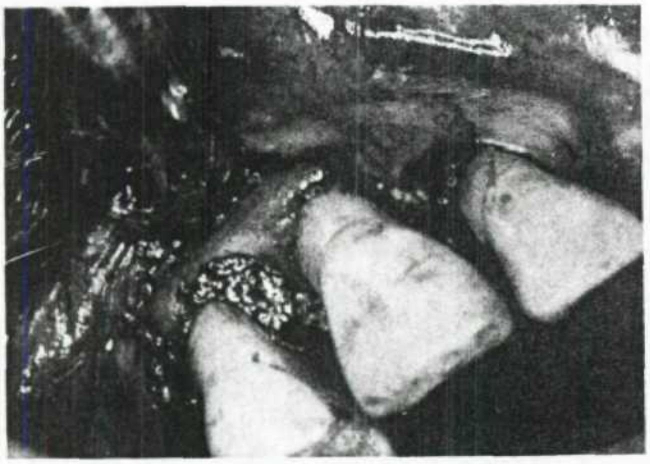

Figure 4. *Graft placed in debrided lesion in Patient IS.*

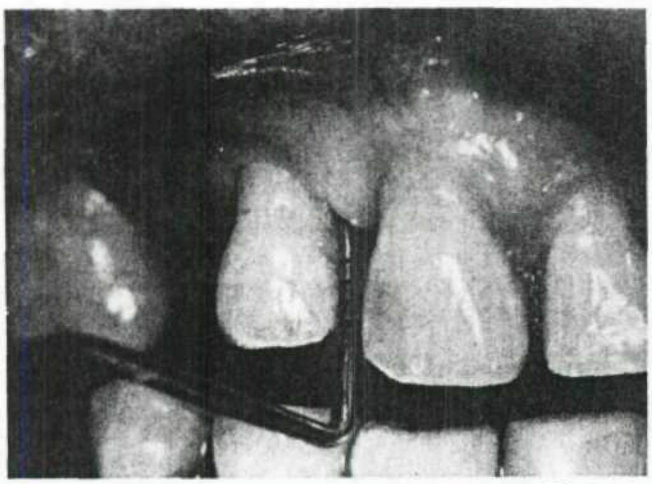

Figure 5. *One year postoperative clinical appearance of lesion in Patient IS.*

HISTOLOGIC OBSERVATIONS

The 3-month blocks showed closure by long junctional epithelial adhesion. Inflammation was essentially seen within the marginal gingival region. At the implant sites, the implant particles were surrounded by cellular connective tissue. No significant inflammatory infiltrate was present in these areas (Fig. 7). Within the implant and at its periphery, bone formation had taken place at some sites (Figs. 8 and 9). In addition, direct fusion of bone from the implant periphery with crestal bone was observed in some sections (Fig. 10). However, osteogenesis within, and at the periphery of, the particles was limited at this time. Crestal remodeling was present in all sections at this time interval and repair-

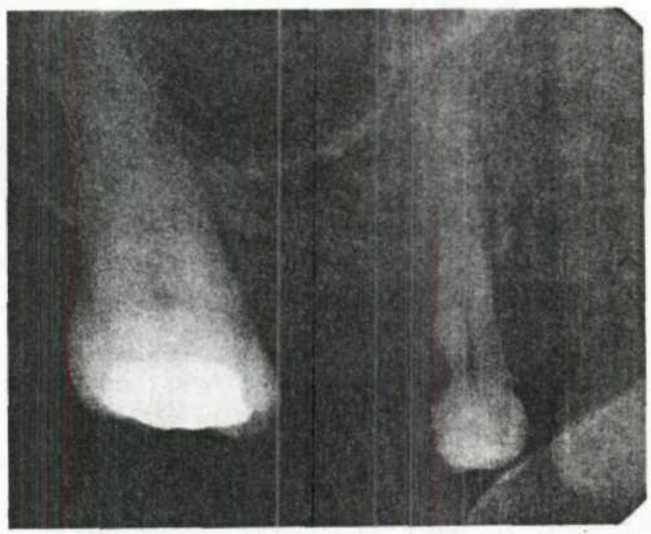

Figure 6. *Radiogram of lesion site 1 year after graft placement in Patient IS.*

TABLE I

PRE AND POST SURGICAL CLINICAL FINDING AT IMPLANT SITES

PATIENT	AGE (YRS)	TOOTH SITE	OBSERVATION PERIOD (WKS)	INITIAL POCKET DEPTH (mm)	INITIAL OSSEOUS DEPTH (mm)	FINAL POCKET DEPTH (mm)	FINAL GINGIVAL RECESSION (mm)	GAIN IN CLINICAL CLOSURE (mm)
P.M.	47	m 4	12	9.2	3.9	4.2	0.8	4.2
		m 14	26	9.5	10.7	4.5	1.2	3.8
M.N.	33	d 7	12	7.3	3.0	3.0	2.3	2.0
		m 7	12	7.3	4.0	3.3	2.0	2.0
		d 8	12	6.3	3.0	3.0	1.0	2.3
		m 8	12	7.2	3.1	3.0	1.1	3.1
		m 9	12	9.1	5.0	4.2	1.5	3.4
		d 9	12	8.7	2.8	4.0	2.1	2.6
		m 10	12	9.1	3.0	5.0	2.2	2.0
		d 10	12	9.1	3.5	5.0	2.1	2.0
		m 11	12	9.9	4.6	4.9	2.0	3.0
I.S.	52	m 5	48	9.2	6.2	4.3	1.6	3.3

cellular cementum was seen at the crestal level of the root with small incisal gain.

The 6-month specimen showed responses similar to the 3-month specimens.

At 1 year after graft particle placement, the specimen again showed closure by epithelial adhesion. In this specimen, the junctional epithelium lined the apical notch (deepest penetration of calculus on the root) (Fig. 11). Adjacent to the notch, ossification of graft particles was evident. The connective tissue between the epithelial-lined notch and the ossifying graft particles was not functionally oriented, but appeared as loose connective tissue with minimal inflammatory infiltrate (Fig. 12). Higher magnification of the root and crest apical to the notch showed the presence of cellular (repair) cementum at the level of crest and slightly incisal at a site of previous root resorption. The crest of bone demonstrated sites of union with ossifying graft particles (Figs. 13 and 14). Figure 15 depicts peripheral and central ossification pattern at a graft particle in this area.

The evidence of root resorption/repair in this specimen coupled with active root resorption seen at the crestal level in a 3-month postimplant specimen (Fig. 16) again focuses on this resorptive process as a possible component of the repair/regeneration phenomenon observed in these sites.

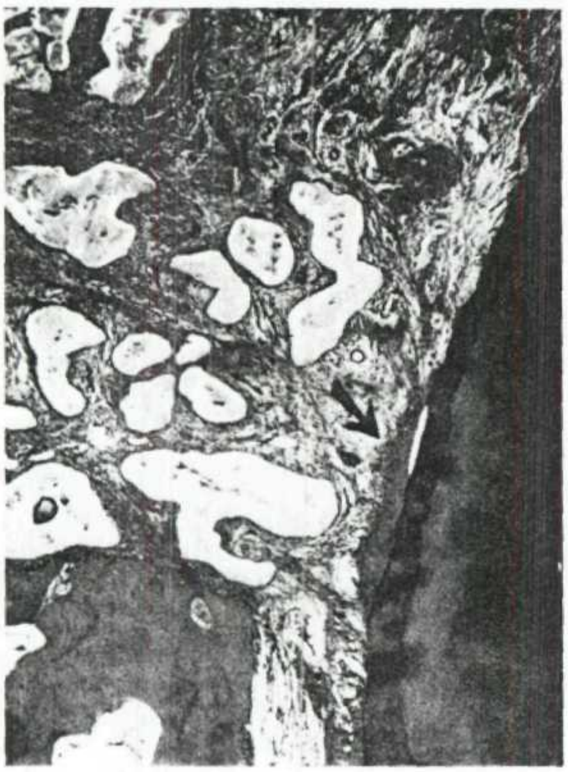

Figure 7. *Histologic overview of grafted site in Patient MN, Tooth No. 9, distal surface, 3 months after graft placement. Note presence of graft particles (arrow) and limited cellular (repair) cementum at crest level (arrow) (H & E stain).*

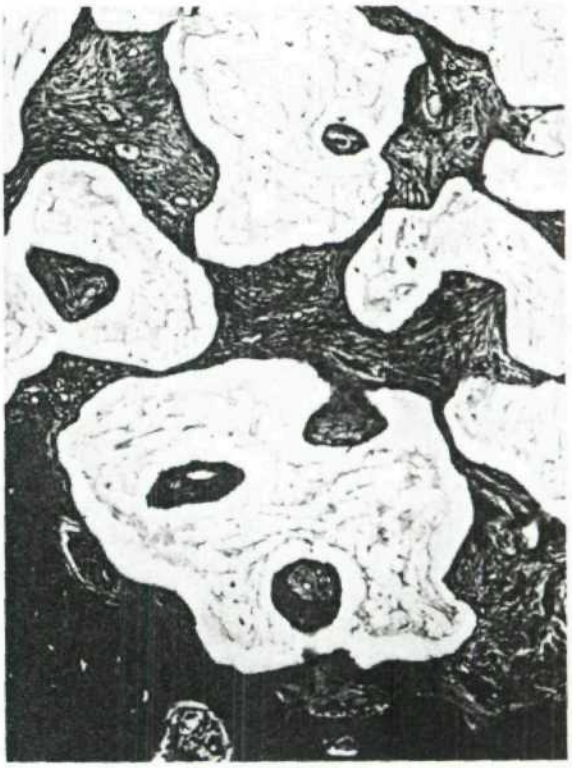

Figure 8. *Higher magnification of sites of ossification at central and peripheral graft particle sites shown in Figure 7 (H & E stain, magnification × 25).*

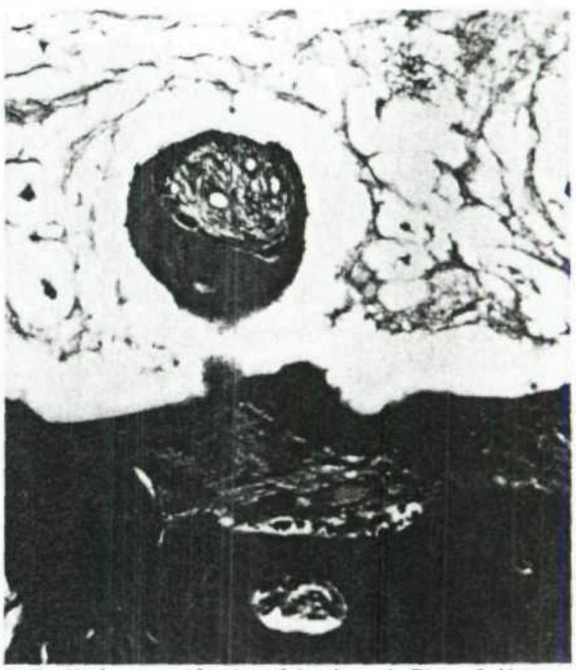

Figure 9. *Higher magnification of site shown in Figure 8. Note central ossification. Peripheral ossification at this site is separated from crest by cellular connective tissue (H & E stain, magnification × 64).*

COMMENTS

The overall healing pattern following surgical debridement and porous graft implantation in our specimens appears similar to those reported previously.[4-12]

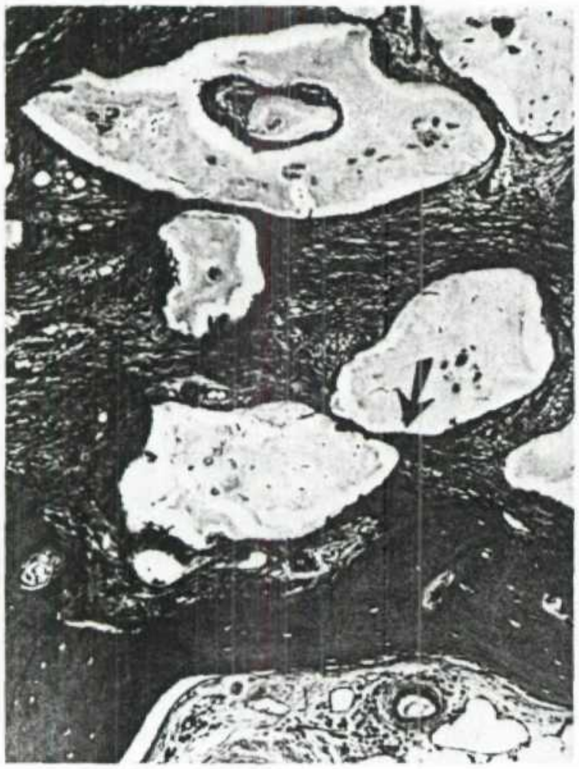

Figure 10. *Site of peripheral graft ossification linking with crest from block shown in Figure 7 (arrow) (H & E stain, magnification × 25).*

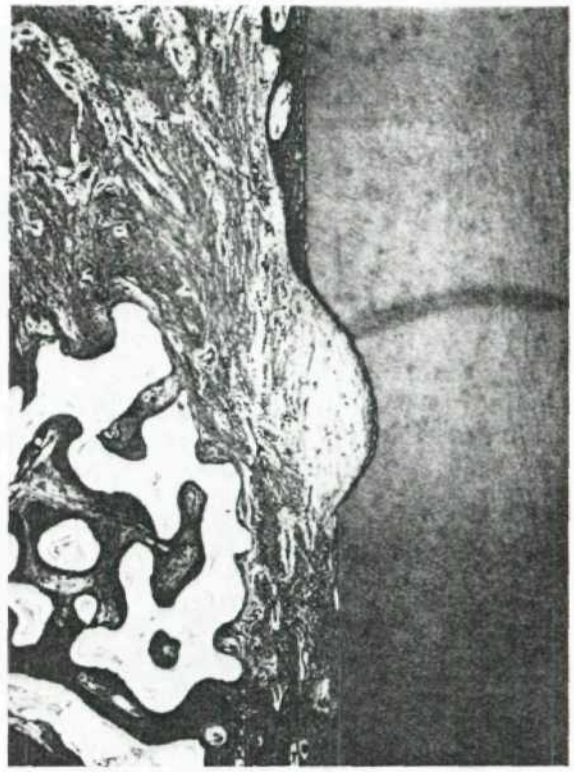

Figure 11. *Histologic overview of block from Patient IS, 1 year postsurgery. Note long junctional epithelium lining apical notch. Adjacent to the notch are decalcified graft particles showing central and peripheral ossification (H & E stain).*

Figure 12. *Higher magnification of notch area seen in Figure 11 showing epithelium-lined notch with loose connective tissue situated between notch and graft particles (H & E stain, magnification × 25).*

In general, while clinical closure following debridement and graft placement was enhanced, histologic evidence did not demonstrate significantly greater or more frequently occurring new attachment. Thus significant cementogenesis on previously exposed root surfaces and new functionally inserted fibers did not seem to take place when this form of graft was added to surgical debridement of a lesion (note that the gingival margin had receded apical to the notch marking the deepest calculus/root adherence in all specimens). However, the porous hydroxylapatite implants in our specimens showed some osteogenesis within the implant pores as early as 3 months after placement and significantly in our 1-year postgrafting specimen. In some areas, this new bone appeared to join crestal seams, especially in the older specimens. Similar time sequences for bony ingrowth following graft placement have also been observed in experimental ridge augmentation studies.[13] Thus, this form of graft material offers the potential of bony ingrowth into the pores and ultimately new bone mass within the intrabony periodontal lesion. However, it must be underscored that in our specimens, the observed osteogenic activity was not associated with significant new connective tissue attachment but rather took place adjacent to an epithelial-covered root surface.

Finally, root resorption and repair were observed in these specimens at 3 to 12 months after surgery and graft implantation. These responses are similar to those observed after other ceramic graft placements[14] as well as after subgingival crown placement in humans.[15] Since these active resorption responses appeared in specimens 3 months after graft implantation or later, they may not necessarily reflect early postsurgery sequellae when gingival connective tissue contacts de-

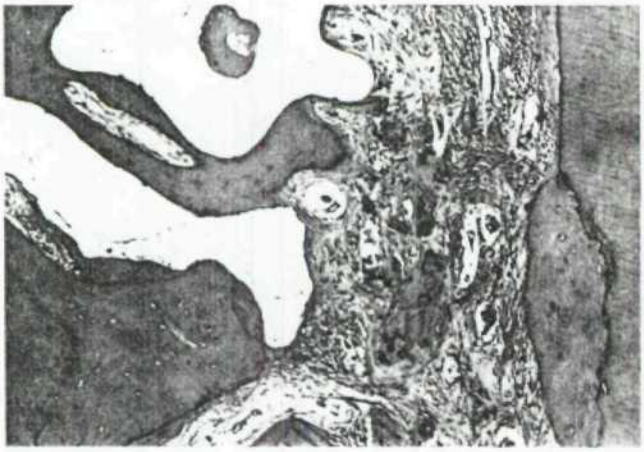

Figure 13. *Higher magnification of central and peripheral ossification graft particles shown in Figure 12. Note also cellular (repair) cementum in area of root resorption and areas of ossification within the crestal PDL (H & E stain, magnification × 64).*

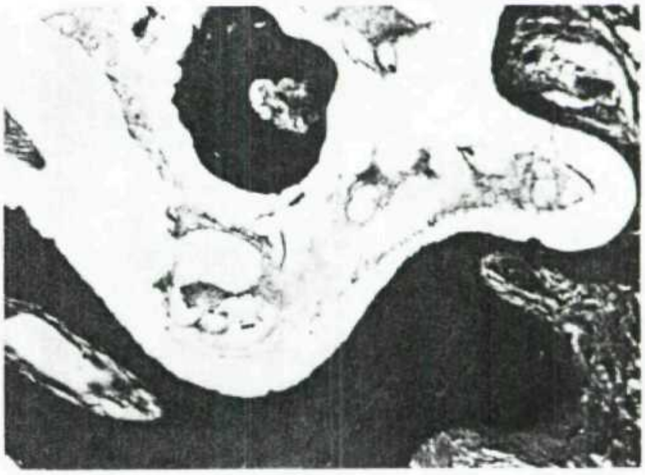

Figure 15. *Higher magnification of ossifying structure within the center and periphery of a graft particle shown in Figure 12 (H & E stain, magnification × 160).*

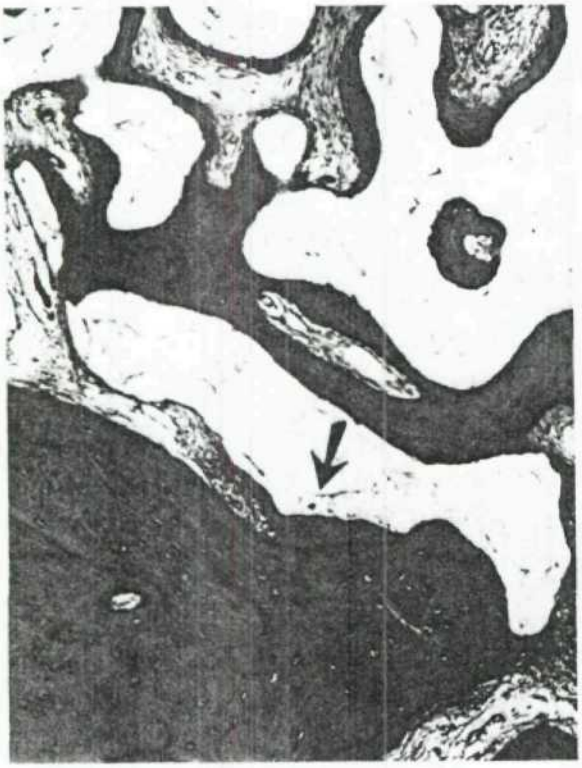

Figure 14. *Detail of peripheral and central ossification of graft particles shown in Figure 13. Note fusion between peripheral graft ossification and crestal bone (arrow) (H & E stain, magnification × 64).*

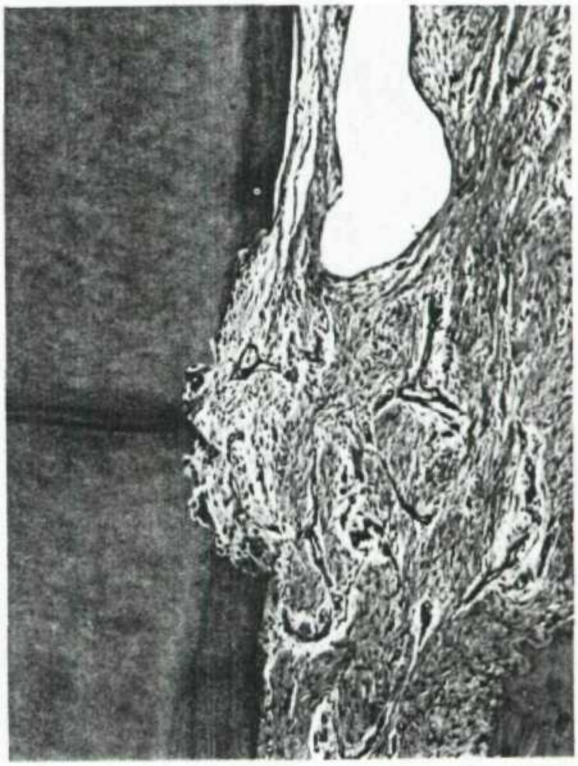

Figure 16. *Site of active root resorption from block removed 3 months after surgery (Patient PM, Tooth mesial No. 4) (H & E stain, magnification × 25).*

nuded dentin[16] but rather depict cementum-dentin responses to ongoing shifts in inflammation at these sites.

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