

Osseous Autografts

I. Clinical Responses to Bone Blend or Hip Marrow Grafts

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A PRIMARY GOAL of periodontal therapy is the restoration of lost periodontium destroyed by periodontal disease. Various graft materials¹⁻¹⁷ have been used in the treatment of infrabony deformities. Currently, two such graft materials, autogenous iliac marrow-cancellous bone¹⁸⁻²² and osseous coagulum-bone blend,²³⁻²⁵ have been reported to give highly favorable results. Histological evidence in animal and human studies,²⁶⁻²⁹ using autogenous iliac marrow and cancellous bone suggested possible potentiation of regeneration and reattachment with the use of these materials. Animal³⁰⁻³² and human studies^{25, 33, 34} using autogenous intraoral graft material have supported clinical reports of regeneration of the periodontium.

The purpose of the present investigation was to clinically evaluate and compare regeneration following implantation of either osseous coagulum-bone blend obtained from intraoral sources or autogenous marrow-cancellous bone obtained from the posterior iliac crest.

MATERIALS AND METHODS

A total of 32 transplants were performed in 15 males, 23 to 64 years of age, each of whom consented to take part in this study. Twenty-five sites were treated with osseous coagulum-bone blend from intraoral sources, while seven sites were treated with frozen marrow-cancellous bone from the posterior iliac crest. Four patients received both marrow and bone blend implants in different sites.

All patients selected for this study were being treated for periodontitis at the New York Veterans Administration Hospital. These patients also suffered from a variety of other diseases (Chart I). Each patient had a complete medical work-up and where necessary, medical clearance was obtained. Pre-operative treatment, in all cases, consisted of oral hygiene instruction, adjustment for occlusal interferences, root planing, and curettage. Temporary splinting was employed where tooth mobility exceeded class II (Miller classification).³⁵

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After initial therapy, clinical and radiographic evaluations were used to determine whether surgery was necessary to eliminate the defect. An oral hygiene index (OHI-S)³⁶ was utilized during initial treatment. Only when the index approached zero was surgery considered.

Prior to surgery, periodontal conditions at the surgical site and other pertinent presurgical information were recorded on a specially prepared data sheet (Chart II).

Surgical Procedures

In all cases, an inverse bevel full thickness, mucoperiosteal flap was reflected. An effort was made to retain the marginal gingiva to ensure maximum soft tissue coverage of the graft material. Site preparation consisted of removal of chronically inflamed tissue from the osseous defects and root planing to remove root accretions. Following debridement, the donor material was prepared for insertion.

Intraoral donor sites used were tuberosities, edentulous ridges, and extraction sites. Graft material was removed with a rongeur. The spicules of cancellous and cortical bone, with a few drops of blood, were then placed in a sterile capsule, and triturated to obtain a bone blend as described originally by Diem et al.³⁷

Autogenous marrow and cancellous bone was obtained by a punch biopsy from the posterior iliac crest by the Chief of Hematology at the New York Veterans Administration Hospital. The material was stored in Eagle's minimal essential medium in a nitrogen freezer at -79°C for two weeks, then cut into small pieces, and inserted into the defect.

Regardless of the graft material used, all defects were overfilled. Following the graft placement, all patients were put on antibiotic coverage for one week beginning with the day of surgery.

Reentries were performed seven to ten weeks after the initial surgery in 23 out of 25 cases of bone blend implantation. The two remaining cases were reentered at 16 and 22 weeks. Reentries were performed four to seven months after initial surgery in all seven cases of iliac crest implants.

Documentation of Responses

During initial therapy two sets of study models were constructed. An Omnivac stent was then fabricated from 0.10 mm thickness surgical tray material to serve as a fixed reference point.

At the site of the defect, the stents were grooved in an occlusal-apical direction with a no. 556 fissure bur. All measurements were recorded using a no. 50 endodontic silver point inserted into the notch and held by locking pliers with the beaks parallel to the occlusal surface (Fig. 1). A Boley gauge was used to measure the distance to the nearest 0.1 mm. All measurements were performed by the same operator to eliminate interexaminer discrepancies. This technique of measurement using fixed distances was tested previously for variance of measurements over a period of time and no statistically significant differences were noted.

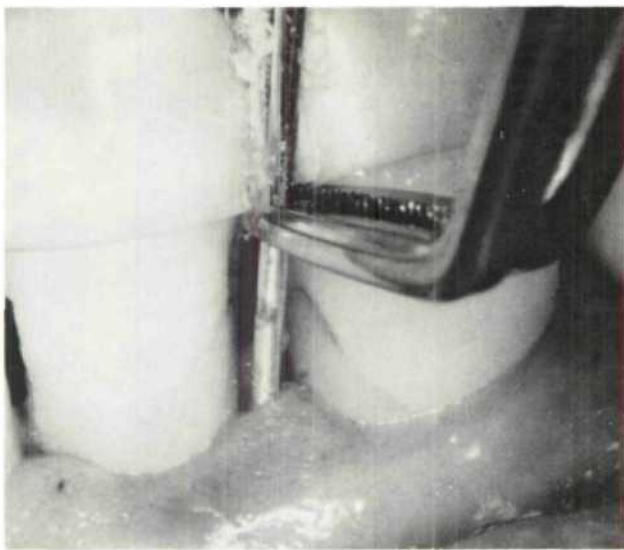


FIGURE 1. For standardization of measurements, a no. 50 endodontic silver point is inserted into a groove on the Omnivac stent at the site of the defect. The beaks of the locking pliers are placed parallel to the apical border of the stent.

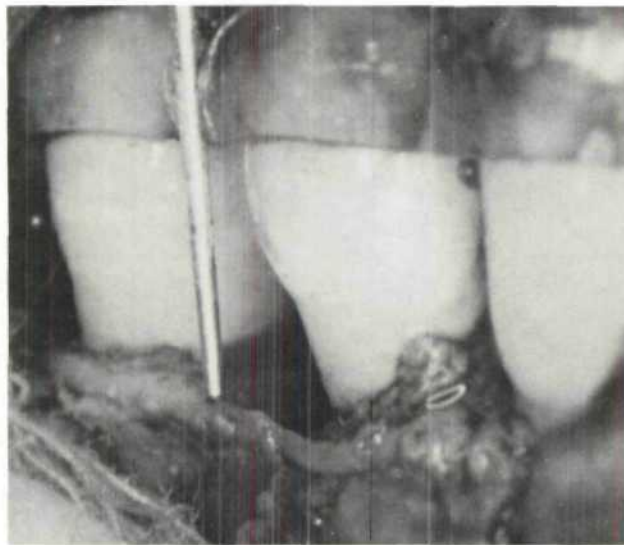


FIGURE 2. Silver point measuring the distance between the base of the stent and the most coronal wall of the defect.

not statistically significant ($t = 1.62, P < 0.05$). However, our results suggest that average fill with marrow grafts was less than that obtained with osseous coagulum-bone blend. Furthermore, it is also obvious that marrow grafts were used in deeper defects. Because of these trends we subjected our results to further statistical analysis.

Comparison of Repair Responses in Intraosseous Defects Less or More Than 4 mm in Depth

Table 1 summarizes the repair trends considering average intraosseous fill in relation to the preoperative osseous depth.

In 15 cases using bone blend (defects less than 4.0 mm) we had an average fill of 2.3 mm, while average fill using

marrow (defects less than 4.0 mm) was an identical 2.3 mm. In defects greater than 4.0 mm, the average fill using bone blend was 3.8 mm; using marrow it was 5.9 mm. The difference in osseous fill between marrow and bone blend was not statistically significant at the 0.05 level of confidence.

Table 2 lists the intraosseous depth remaining at the time of reentry. In cases where marrow was used the residual osseous depth ranged from 0 to 3.9 mm. In cases where bone blend was used, residual osseous depth ranged from 0 to 6.6 mm.

Table 3 summarizes the average reentry intraosseous depth in relation to the preoperative osseous depth.

In cases where the initial intraosseous defect was less than 4.0 mm, the average residual osseous defect was 0.6 mm using marrow, compared to 0.3 mm using bone blend.

The average residual defect where the initial intraosseous depth exceeded 4.0 mm was 1.7 using marrow compared to 1.4 mm using bone blend.

Based on these trends, it appears that similar levels of osseous regeneration apparently took place regardless of graft material used.

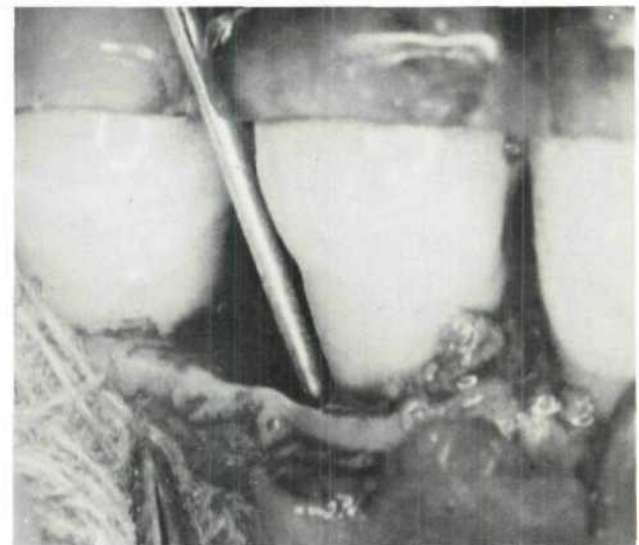


FIGURE 3. The silver point is placed into the regrooved stent to measure the distance between the base of the stent and the deepest part of the defect.

CHART III. Topography of Defect and Graft Material Used

Type of defect	Graft material used	
	Bone blend	Marrow
One-wall	9	5
Two-wall	6	1
Combination	0	1
Three-wall	8	0
Furcation	2	0
	$\overline{25}$	$\overline{7}$

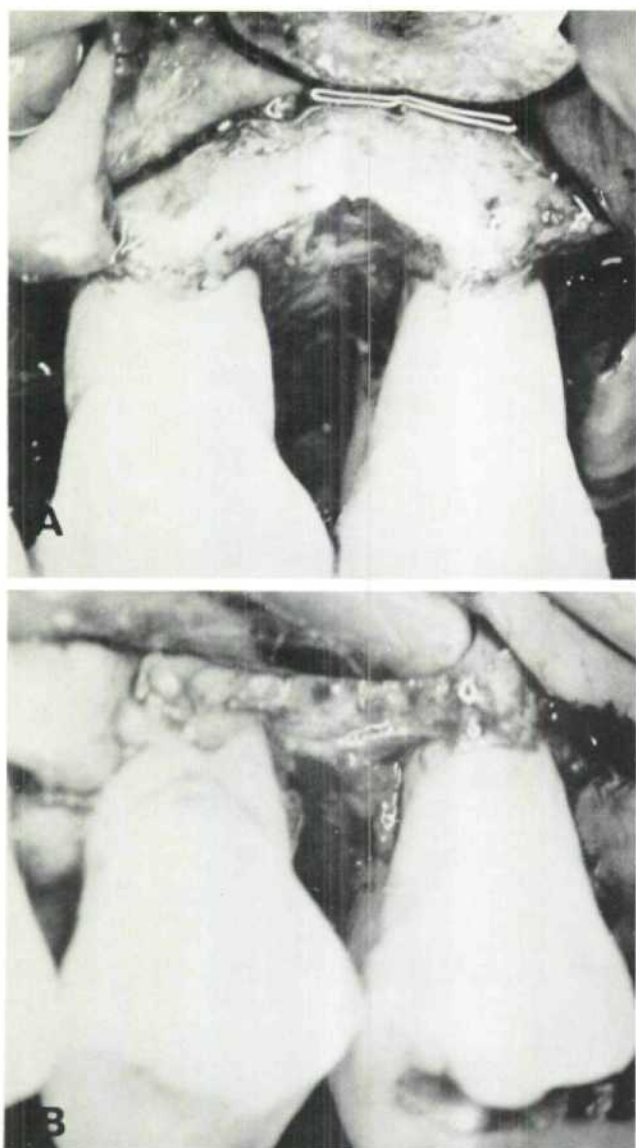


FIGURE 4 A. Preoperative appearance of the osseous defect showing horizontal bone loss, prior to placement of a bone blend graft. B. Appearance of the defect shown in A at reentry, nine weeks after initial surgery. Note osseous crestal apposition of lesion.

DISCUSSION

Several comments should be made on the significance of our findings. Case report evidence has been used in reporting our results. Recognizing that different human periodontal defects are seldom identical, we wish to stress that our results represent trends rather than possible universal repair results. However, the results of the present study generally agree with the previous literature^{20,25} which demonstrates comparable results using either intraoral cancellous bone and marrow or iliac marrow and cancellous bone as an implant material.

Theories attempting to explain the role of autogenous implants in regeneration of periodontal osseous defects suggest three possibilities:

1. Both intraoral and iliac autografts have inductive capabilities which induce osseous regeneration.^{30, 32}

2. Neither material has "inductive" abilities.
3. The degree of induction may vary with the site and the graft material used.

Although many investigators tend to support the third of the above possibilities,³⁸ our clinical data suggest no significant difference in repair responses.

Of further interest is pocket topography in our cases. We classified our defects as one-, two-, three-wall wide defects and a combination of these, following the classic terminology of describing osseous defects.³⁹ Seldom, however, did we find a defect which was purely a "one" or "two" wall defect from its base to the most coronal aspect of the remaining osseous wall. Most defects presented as a "confluence" of bony architecture. Other researchers have mentioned this phenomenon.²³ For example, a one-wall defect usually had three walls at its

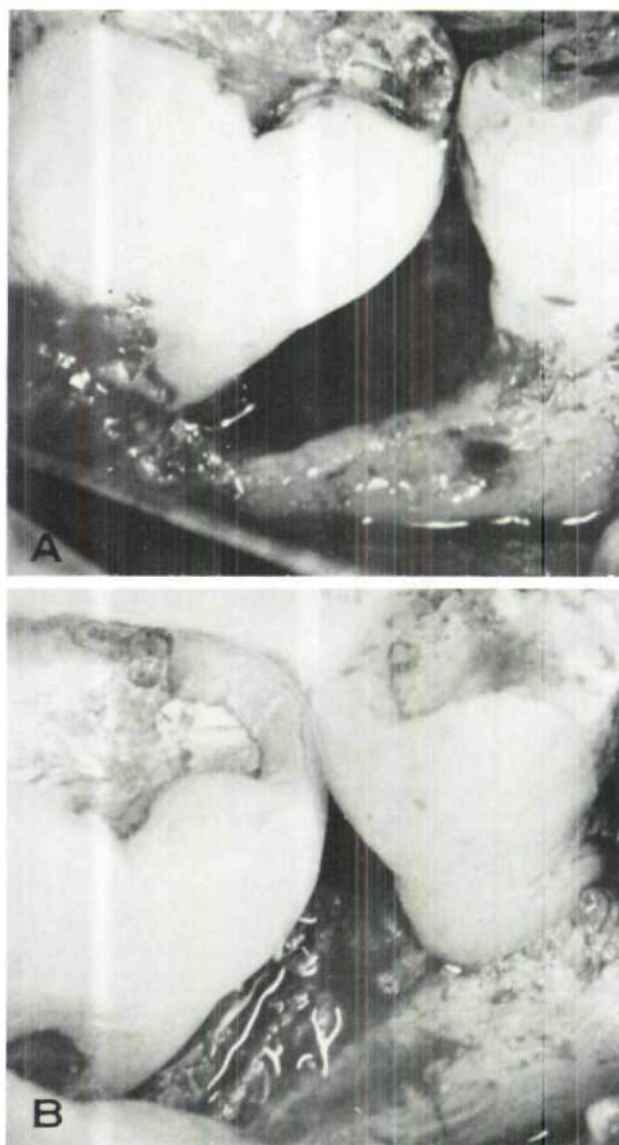


FIGURE 5 A. Preoperative appearance of the combination one, two-wall intraosseous defect prior to placement of a bone blend graft. B. Appearance of the one, two-wall intraosseous defect shown in A at reentry, eight weeks after initial surgery. Note the apparent fill and remodeling of the lesion.

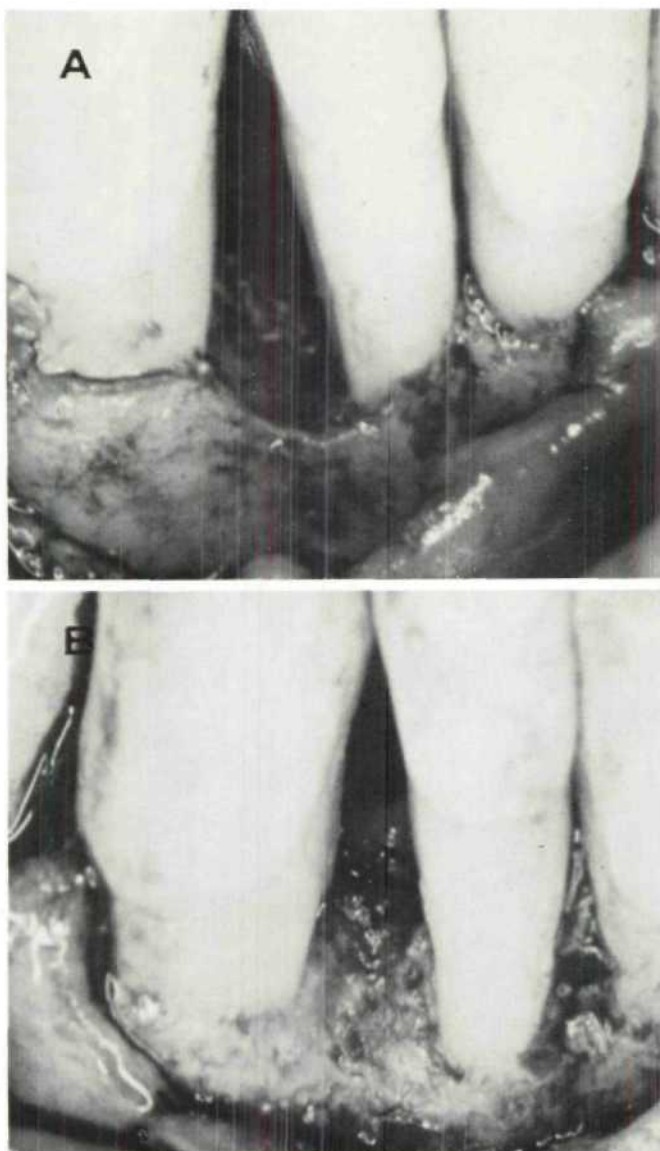


FIGURE 6 A. Preoperative appearance of the two-wall intraosseous defect prior to placement of an iliac marrow and cancellous bone implant. B. Appearance of two-wall intraosseous defect shown in A at reentry, 16 weeks after initial surgery. Again note the apparent fill and remodeling of the lesion.

TABLE 1. Average Fill in Relation to Preoperative Osseous Depth in Two Procedures

Graft material used	Initial intraosseous depth (mm)	No. of cases	Average fill (mm)
Bone blend	Less than 4.0	15	2.3
	Greater than 4.0	10	3.8
Iliac marrow	Less than 4.0	3	2.3
	Greater than 4.0	4	5.9

most apical part, two walls in the middle, and one wall at its most coronal portion. The implication of such classification in clinical research becomes apparent upon analysis of biometric data in studies dealing with osseous fill. If we take one of our cases, for example, we see how a reported complete fill could be deceiving. In this case (an

osseous coagulum-bone blend graft) no residual defect apparently remained upon reentry. However, of the original 8.5 mm osseous defect, 4.9 mm filled with new bone while 3.6 mm were eliminated by resorption of the walls of the defect. Thus, in evaluating a successful "fill," one must separate the extent of the actual osseous fill from the remodeling with and/or without resorption of the original crestal architecture.

We observed that the amount of new bone (fill) may depend on *available* osseous surfaces rather than *number* of osseous walls. In fact, as noted in our results, the difference in fill using osseous coagulum-bone blend in defects greater than 4.0 mm and defects less than 4.0 mm showed a statistically significant difference ($t = 2.42, P < 0.05$). Thus, the deeper the defect, the greater the fill. In this manner, one, two, or three walls may be considered as a clinical expression of variations in available osseous surfaces. Therefore, a 10 mm defect of one- or two-wall configuration may give significant responses because it may present greater surface area than a wide, shallow three-wall defect.

The possibility that treatment of any single surface

TABLE 2. Reentry Intraosseous Depth

Iliac marrow		Bone blend	
Less than 4 mm preoperative depth	Greater than 4 mm preoperative depth	Less than 4 mm preoperative depth	Greater than 4 mm preoperative depth
0.0	0.0	0.0	0.0
0.0	0.8	0.0	0.0
1.8	2.0	0.0	0.0
	3.9	0.0	0.4
		0.0	0.5
		0.0	0.6
		0.0	1.5
		0.0	2.1
		0.0	2.3
		0.0	6.6
		0.0	0.1
		0.1	0.1
		1.7	1.7
		3.0	3.0
66.0%*	50.0%	86.7%	60.0%

* Percentage of cases with <1 mm defect remaining.

TABLE 3. Average Reentry Intraosseous Depth in Relation to Preoperative Osseous Depth in Two Procedures

Graft material used	Initial intraosseous depth (mm)	No. of cases	Average intraosseous reentry depth (mm)
Bone blend	Less than 4.0	15	0.3
	Greater than 4.0	10	1.4
Iliac marrow	Less than 4.0	3	0.6
	Greater than 4.0	4	1.7

may lead to considerable osseous remodeling also exists. Certainly our data show remodeling of the crest including resorption as a common phenomenon in the repair of infrabony lesions occurring within the first few weeks after surgery. It may, however, continue for many months^{29, 33} or years after surgery as part of the functional demands placed on the periodontium during the lifetime of the tooth.

Finally a comment should be made concerning the timing of reentry procedures which in all but two cases of osseous coagulum-bone blend grafts, were performed seven to ten weeks postoperatively. Experimental histologic data in monkeys have demonstrated that bone responses following the use of osseous coagulum implants were completed by 90 days after graft surgery.³² Another study dealing with grafts of cancellous bone obtained from intraoral sources implanted into bifurcation defects showed evidence of new bone "connecting adjacent graft particles" as early as three weeks postoperatively.³⁰ Using rabbits, Urist⁴⁰ created defects in the rami of mandibles and filled these with demineralized bone. These grafts were "resorbed and refilled partially with new bone within four weeks."⁴⁰ Other studies dealing with graft resorption, demonstrated a mean resorptive time of six weeks when autogenous cancellous bone was implanted intramuscularly in dogs.⁴¹

Since our study was aimed essentially at comparisons of repair potential rather than complete remodeling, and furthermore since human studies indicated that remodeling may not be complete until about five years after graft placement,³⁴ we felt that the seven- to ten-week time interval chosen would give us adequate documentation for an analysis of repair potential following the use of different graft modalities.

SUMMARY

A clinical evaluation was undertaken to compare regeneration of osseous defects following implantation of either osseous coagulum-bone blend from intraoral sources or autogenous iliac marrow-cancellous bone. Thirty-two transplants were performed in 15 male patients. The intraosseous defects in which marrow was placed (initial average depth = 7.18 mm) filled 60.7% (average fill = 4.36 mm). Defects in which osseous coagulum-bone blend was placed (initial average depth 4.0 mm) filled 73% (average fill = 2.93 mm). The difference in results between the two materials was not statistically significant. Therefore, similar levels of osseous regeneration apparently took place regardless of graft material used.

ACKNOWLEDGMENTS

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Abstracts

THE ROLE OF ANTIBIOTICS IN THE MANAGEMENT OF OPEN FRACTURES

Patzakis, M. J., Harvey, J. P., and Ivler, D.
J Bone Joint Surg **56-A**: 532, April, 1974.

Four culture specimens were obtained from the open fractures of 310 patients divided into groups receiving penicillin and streptomycin, cephalothin, or no antibiotics and studied for infection. An infection was considered to have occurred when clinical signs and symptoms of infection such as fever, erythema, tenderness, and wound drainage were present along with a positive gram stain or a positive culture. The relationship of retrieval of bacteria after injury and incidence of infection was then correlated. The incidence of infection was 13.9% in the control group and 9.7% in the penicillin and streptomycin group. This difference was not statistically significant. In the group receiving cephalothin there was a significantly lower infection rate of 2.3%. The results suggested that cephalothin is an effective antibiotic for prophylactic therapy of open fracture due to direct trauma. *Department of Surgery-Orthopedics and the Department of Microbiology, University of Southern California, School of Dental Medicine, Los Angeles, California*

EFFECT OF ANTI-THYMOCYTE ON CHRONIC GINGIVAL INFLAMMATION IN DOGS

Nobréus, N., Attstrom, R., and Egelberg, J.
J Periodont Res **9**: 236, No. 4, 1974.

To determine the role of cellular immunity in chronic gingivitis, six experimental and four control beagle dogs with well-established chronic gingivitis were used. The experimental group was injected with anti-thymocyte serum (ATS) to suppress cellular immunity and the control group was injected with rabbit IgG. The immunosuppressive effect of ATS was measured using 1-dinitro-2,4-chlorobenzene (DNCB), a chemical which will initiate a delayed hypersensitivity reaction. The level of gingival inflammation was determined before and after administration of ATS by measurements of crevicular leukocytes, gingival fluid, and acid phosphatase activity in crevicular samples. The results showed the ATS inhibited skin reactions of DNCB. The gingival parameters were only slightly reduced in both experimental and control groups. The role of cellular immunity in chronic gingivitis appeared to be a minor one. Other inflammatory mechanisms may be active in the maintenance of this condition. *School of Dentistry, Carl Gustavs väg 34, S-214 21 Malmo, Sweden*

THE PLAQUE-REMOVING ABILITY OF SOME COMMON INTERDENTAL AIDS. AN INTRA-INDIVIDUAL STUDY

Bergenholtz, A., Bjorne, A., and Vikstrom, B.
J Clin Periodont **1**: 160, No. 3, 1974.

Interdental aids including a soft toothbrush, waxed dental tape, and rectangular, round, and triangular toothpicks were tested for plaque removal on 63 teeth which were in contact with neighboring teeth and with open interdental spaces. Each of the 23 subjects was required to use each of the aids with the toothbrush for different randomized periods of two weeks and in one session, the brush was used alone as a control. Plaque accumulation was measured by a modified Plaque Index (Silness and Loe) at the beginning and end of each period and a gingival index (Loe and Silness) of inflammation at the start and completion of the ten weeks. No significant differences were found in the plaque-removing ability of the different aids on any surfaces except that all interdental aids were more effective in cleaning buccal interdentally than toothbrushing alone. The triangular toothpick was significantly more effective than the rectangular one. Lingually localized interdental areas were best cleansed by the triangular toothpick and dental tape while on linguoaxial surfaces the triangular toothpick was the only one more effective than toothbrushing alone. There was no significant difference in gingival inflammation between the start and completion of the study. *Department of Periodontology, University of Umeå, S-901 87 Umeå, Sweden*

BONE INDUCTION BY ALLOGENOUS RAT DENTINE IMPLANTED SUBCUTANEOUSLY

De Groot, K.
Arch Oral Biol **19**: 477, June, 1974.

Upper and lower incisors of Sprague-Dawley strain adult rats were demineralized, mechanically scraped free of pulp tissues, lyophilized and incubated at various temperatures, times, and pH levels. Quantitative evaluation, 28 days following implantation, was determined by the calcium content in implants and by histometric calculations of calcium concentration due to new bone formation and remineralization of old dentine matrix. Bone morphogenetic properties of dentine were found to be labile when incubated at neutral pH, higher temperature, and longer time, although mineralization properties of bone and dentine matrix were different. *Department of Material Science, School of Dentistry and Medicine, Free University, Amsterdam, de Boelelaan, 1115, Netherlands*

Results Following Three Modalities of Periodontal Therapy*

by

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CONVINCING EVIDENCE of new connective tissue¹ and epithelial attachment² following periodontal therapy has revived the interest in therapeutic methods aimed at reattachment. Although new attachment has been reported following several modalities of treatment,³⁻⁵ there is a remarkable lack of data from controlled clinical trials to indicate the short and long term potential for gain or loss of periodontal attachment following treatment.

Some treatment methods such as subgingival curettage and Widman flap surgery⁶ are more specifically aimed at reattachment than pocket elimination surgery which basically is aimed at stopping the progress of destructive periodontal disease through surgical elimination of periodontal tissues coronally to the most apical extent of the pockets, and to restore surgically a "physiologic" gingival contour at that level.

In selection of periodontal therapy the main concern is to maintain as much attachment for the teeth as possible for the lifetime of the individual. Whether this goal can be served best by therapy aimed primarily at reattachment or by surgical pocket elimination still is a highly controversial issue.

The purpose of the present study was to compare over a period of five years results following two methods aimed at combined reattachment and surgical pocket reduction (i.e. subgingival curettage and modified Widman flap surgery) with results following attempted complete surgical pocket elimination and restoration of gingival contour.

METHOD

The criteria for acceptance of patients and for scorings were the same as published in our previous studies.⁷⁻⁸ Calibration tests before and during the study indicated

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that the scoring errors would have an insignificant effect on the total results reported in this paper.

After examination and scoring, all patients had initial treatment consisting of scaling, initial root planing, instruction in oral hygiene, and occlusal adjustment. They also received emergency dental care and recommendations to have dental restorations placed in carious lesions.

As in our previous studies,⁸ the teeth in one half of the mouth (divided in the midsagittal plane between the central incisors) constituted the experimental unit. The means from measurements and scores for individual teeth within this unit were used for clinical evaluation and for statistical analysis of results.

Using the analysis of variance to test for significant differences between the three modalities of treatment does not maximize the power of the analysis since the advantage of the paired treatment design was not fully utilized. This resulted in conservative significance levels for the analysis of variance which were considered to be appropriate considering the small clinical magnitudes of the differences. With three treatment modalities for either the left or the right side of the mouth there were six possible combinations for each patient. One of these six combinations was assigned to each patient using a table of random numbers as he entered the study.

The subgingival curettage and the surgical pocket elimination were performed as described in previous reports.⁷⁻⁸ The Widman flap surgery was modified as described recently.⁹

All patients were recalled for prophylaxis by a dental hygienist every three months, and rescored every year following the initial treatment by the investigator who did the original scoring.

All patients admitted to the study after July 1, 1966 were included in this routine. Results from patients treated prior to that time were not in any way included in the present report since it is essential for fair comparison of the results that each method of treatment had equal chance to be compared with the other methods of treatment in the same patients, performed at the same time, and by the same therapists. Unfortunately it is, for practical reasons, impossible to start all patients at the same time, and they cannot be completed at the same time. Thus we had to organize our data on the basis of time intervals of years following the initial treatment. Most of the patients included in this report had their initial treatment in 1967 to 1969, but a few have been admitted later. The cut off date for the data included in this report was December 31, 1973.

SAMPLE

A total of 82 patients had their periodontal treatment completed in the study. The present report is based on followup results in 79 patients. Eighteen patients have been lost, and at the time when the present data was compiled (December 31, 1973) there were 64 patients