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GROUND BONE-POWDER IN THE TREATMENT OF DEEP PERIODONTAL POCKETS

Review of the Literature, and Clinical Observations

by

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CONTENTS

Reattachment

The possibility of obtaining regeneration or new growth of alveolar process bone following periodontal treatment is closely related to the problem of reattachment, because an eventual production of osteoid tissue, or even bone, upon the alveolar crest margin would be of no practical value if the new formed bone is not in a functional unit with the adjacent tooth or teeth. Alveolar process bone is only present as a response to a demand for function, which means that new formed bone would resorb away sooner or later if it didn't get stimulus from function.

The treatment plan and the anticipated prognosis for patients with periodontal pockets is largely dependent on the possible type and degree of regeneration and reattachment which we hope or expect to obtain.

This problem which is so important in regard to periodontia has been discussed as far back as we find dental literature. In ancient Egyptian, Greek and Roman literature we find advocates to different types of treatment for periodontal disease: 1. The psychosomatic approach--carrying amulets around the neck as therapy 2. The general systemic approach--improved nutrition such as the use of fruit juice 3. The local approach--scraping, cauterizing and wiring the involved teeth. It is remarkable that already at that time all of the authors claimed good clinical results with their different

forms for treatment and it has been like that ever since.

The first attempt referred to in literature to prove reattachment by histological examination of the tissues concerned, is an article by Younger (1) 1893. One of his reported cases is a transplantation of a tooth, which had been extracted 2 3/4 years previously, into a socket created by him where a tooth had been missing for 25 years. Three years later he removed the tooth and let a pathologist, F. O. Jacobs, (with recommendation from the dental department in Ann Arbor) examine the specimen microscopically. The pathologist's report was: "I find the pericementum firmly attached at a part of the tooth near the cervical portion, covering quite a large portion of the cementum". I also like to quote Younger's statement about reattachment. We haven't much to add to it today. He said: "The treatment of pyorrhea alveolaris by the method recommended by myself to you several years ago, is meeting with unabated success in my hands. Teeth hanging by apical attachment only, have been rendered firm and the tissues of the diminished socket made so to contact and unite with the roots that an instrument could not be introduced between them without force and causing pain and bleeding. I am satisfied that reattachment takes place in these cases, otherwise the teeth could not become so firm and the gums and tissues of the socket cling so to the tissues of the root. It is therefore an easy matter for direct union to be established between these healthy

living tissues when the partition of calculus is thoroughly removed from the root and a granulating surface produced in the environing soft tissues of the gingivas". Different technics have been used since that time, but the basic principles for conservative treatment of a periodontal pocket are still the same and as far as proof of reattachment is concerned we are not much farther.

It is an often repeated statement that Box (2) has proven histologically that he obtained reattachment in his treatment of periodontal pockets, and we find his microphotographs used in articles and textbooks as a definite proof for reattachment. Unfortunately, it is impossible to tell from his work whether or not the reattachment he obtained was on surgically or pathologically denuded cementum surface. He is underlining the importance of surgical removal of the epithelial covering in the bottom of the pocket, and he is not measuring the depth of the pocket from any fixed point on the tooth. It has indisputably been proven by Beube (3), Fish (4) and others that reattachment can be obtained on a surgically denuded root-surface, and it can hardly be excluded as a possibility that what Box got was reattachment on root-surface denuded surgically under attempt to remove the epithelium lining in the bottom of the pocket. However, the convincing histological proof for reattachment on pathologically denuded cementum is still missing.

Many authors claim that reattachment is impossible in the cases where chronic inflammation and pus accumulation have

"soaked" the cementum. The main objection to their experiments is that the cases are not treated in the way and for the length of time a believer in reattachment would treat them.

A number of outstanding periodontists and teachers of periodontia, Bunting (5), McCall (6), Leonard (7) and Beube (3), have clinically proven that they obtained reattachment and bone regeneration in a high percentage of their patients following their advised treatment, and they all support their clinical findings with x-ray findings.

Evaluation of X-ray Findings

X-ray findings can only be evaluated in correlation to the histological findings. The errors in x-ray interpretation from differences in angulation, exposure time and type of film are obvious but often overlooked. Another possibility for erroneous claim of increased height of alveolar bone crest, and spectacular bone regeneration evident on x-rays, can be understood by study of the presented microphotographs.

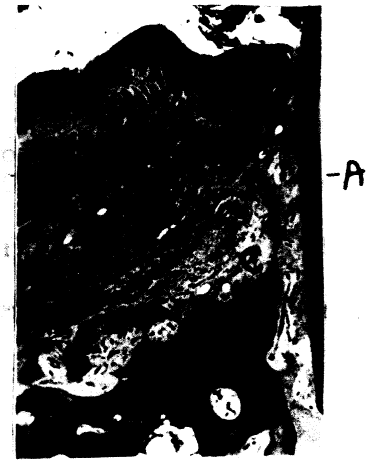


Figure 1

Periodontal fibers up to A.
End of alveolar bone B.
Bone resorption C.
(Courtesy of D. A. Kerr)

In figure 1 we see the remaining thin crest of alveolar bone up to B., marked resorption at C., and inflammation in the adjacent soft tissue. It is very possible that the extremely thin bone plate from C to B would be invisible on most x-rays. Functioning periodontal fibers are fastened up to A - B, and if the local inflammation is brought to subside, it is likely that we get a healing in of the bone at C, and as a response to the present demand for function, a thickening of the alveolar bone up to B will take place. There a new x-ray will show a marked increase in height of alveolar crest because of the thickening of this previously invisible bone lamina.

Figure 2

Severe interproximal inflammation penetrating the transeptal fibers and loss of alveolar crest margin (Courtesy of D. A. Kerr)

Figure 2 shows a marked local inflammation with deep interproximal bone resorption. The alveolar bone remains considerably higher than the supporting bone and we still have a more or less degenerated periodontal membrane fastened to these remains of the alveolar bone. These thin bone plates

plus some rests of the buccal and lingual cortical bone plate would hardly be visible on x-rays, or, at least, the involved area would have a marked increase in translucency.

In this case it would also be possible to get filling in of bone and new-formed alveolar crest to the level of the remaining alveolar bone.

Figure 3

A. alveolar crest fibers which have lost their attachment because of bone resorption at B (Courtesy D. A. Kerr)

Figure 3 shows how the transeptal fibers move down as the periodental disease progresses and previous alveolar crest fibers (A) which have lost their bone attachment seem to gain fusion with fibers in the same situation from the adjacent tooth and form transeptal fibers. It has never been proven that the level of the alveolar bone can be raised by bone apposition above the highest remaining bone level. It doesn't seem likely that the bone should grow up and partly incorporate the transeptal fibers as seen in figure 3, and neither is it according

to general x-ray findings. What we can hope for in these cases is an increase in transeptal fibers and filling in and consolidation of bone up to the highest present level of alveolar bone. Intra-bony pockets, where we have the bottom of the pocket below the alveolar process bone margin, and periodontal abcesses, give the best opportunity both anatomically and functionally for obtaining of reattachment and new formation or regeneration of bone. But it is important never to diagnose an intra-bony pocket from x-rays only (Skillen and Lundquist (8)). Generally, x-rays can not satisfactorily prove reattachment, even the extent of bone present cannot be determined conclusively from x-rays.

The theory of halisteresis (decalcification of vital bone) was previously used to explain the phenomena discussed here, but that theory seems to be losing ground in modern pathology. Weinmann and Sicher (9) , Kronfeld (10) and other authors state that we have bone resorption only by osteoclasts, entailing simultaneous disappearance of the organic and inorganic components of the ground substance. The sections presented here also show that the zone of decreased bone density which we see on x-rays during pocket formation or even early in periodontal disease, is caused by decrease in thickness of the individual bone trabeculi and also by disappearance of some trabeculi by resorption. It is a reduction of the total amount of bone present in the area. The claimed observation of decalcified bone is probably a misinterpretation

of newly formed bone not yet calcified. The process of healing is characterized by new-formation of bone from these remaining, often thin, trabeculi and laminae when the irritating factors are removed and functional stimuli are inserted.

Regeneration of Bone

Much advice and many suggestions have been given for stimulation of bone-regeneration and on how to promote new growth of bone. The outcome of performed experiments and the conclusions of research workers in the field are very controversial. Only a short review of the more recent literature will be given here.

Robinson (11) succeeded in 1923 in isolating an enzyme, called phosphatase, which, by hydrolysis, caused deposition of calcium from organic salts such as the calcium phosphoric esters of hexose which are present in the bloodstream.

Leriche and Policard (12), 1928, believe that with the rarefaction of fracture fragments, calcium salts are liberated in the vicinity and that local calcific surcharge is the determinant of osteogenesis in a suitable fibrous medium.

Murray (13), 1930, thinks that calcium phosphate and carbonate in the proportions in which they occur in the bone can be used as a local calcium depot in the process of bone formation, and that they form a stimulant to osteogenesis. He further states that blood sources of calcium and phosphorus are not the essential factors in calcification of the callus.

Key (14), 1934, got opposite results from his rather extensive experiments. Neither calcium phosphate and carbonate in the proportion in which they occur in bone, nor bone powder, made by removing organic matter from bone, appear to stimulate osteogenesis where impacted in a bone defect.

Stewart (15), 1934,: "Limesalts and boiled bone when placed into a bone defect with either traumatized muscle or fascia do not serve as a source of available calcium resulting in supersaturation of connective tissue and regeneration of missing bone".

The first published work about the use of powdered bone in oral bone lesions is by Beube and Silvers (16), 1934. They used devitalized sheep bone (long bone) ground to fine powder, sterilized, and implanted into surgically created cavities in the jawbone of dogs. They report increased rate of healing in 6 of 8 cases. In a later report (17) the same authors used powder of long bone of cow implanted in human jaws. They used it for 5 different types of jaw bone lesions. Of primary interest for this paper is the group, 5 cases, with periodontoclasia treated and included in the experiment. They were treated with a modified flap operation, sterilized bone powder inserted, and the flap or gingival margin retained with interrupted sutures. One case of 5 treated was claimed successful, and, strangely enough, this very case is referred to as a "typical case". What would happen if only conservative treatment

plus surgical curettage had been used is not discussed. Their advice, if bone regeneration is attempted is: "The surgical interference, with both the hard and the soft tissues, should be of such a nature as to cause a relatively large amount of tissue death". Their theory is that the use of implanted bone powder readily permits interlacing of fibrin present in the blood and effusion between the fine particles. The newly formed capillaries can permeate this mass readily, thus establishing a desirable circulatory status between the particles and the surrounding tissues. They also feel that the finer the bone particles are, the better they will be utilized as a source of calcium for the newly formed bone. The most recent and rather extensive series of experiments on experimental new bone formation is by Hellstadius (18). His animal experiments demonstrated that repeated subperiosteal injections of blood plasma, marrow extract, marrow autolysate, and extract of muscular tissue, as well as normal saline solution, provoked formation of osteoid tissue on the surface of the bone. The saline solution proved that the deposition of osteoid was merely a result of mechanical stimulus. No roentgeno-apparent calcerous deposits were formed. Such deposits were, however, observed when the injections were made on cortical bone previously having been damaged with a sharp rasp. Thus showing that a lesion of cortex is essential for the origination of true new bone formation. The same result was obtained with saline as

with plasma or marrow extract. No calcification followed from injection of suspensions of ground bone or calcium-phosphorus solutions into the osteoid tissue. Attempts to stimulate callus formation in cases of fractures by such injections were unsuccessful. The biological and chemical processes responsible for the precipitation of calcium within osteoid tissue are highly complicated and still largely obscure in character.

Weinmann and Sicher presume that the calcification depends largely on the local alkalinization brought about by the cellular activity of the osteoblasts in the presence of phosphatase.

The introduction of isotopes in experimental biology (Falkenheim et al (19)) has shown that phosphate of bone is rapidly exchanged in the living animal with the phosphate of the serum. This exchange relationship between the bone and the serum supports the thesis that diet can influence the healing of fractures and the health of the bones. In endeavoring to penetrate the finer mechanisms concerned in bone regeneration one has lately tried to adopt steadily improved technical methods. The successive growth of the callus formation has been followed on radiographs. The spectrographic structures of the young new bone examined and chemical analysis has been carried out. Investigations have been made into the way by which the healing of bone is influenced by the various products of the entire endocrine apparatus. But we still lack deeper knowledge about

which are the causal factors in the production of bone.

The last report in the dental literature about use of ground bone.

Beube's last article (3), 1947, is very favorable for the use of ground heterogeneous bone in periodontal pockets. Five cases, which had not responded to conservative treatment, were treated with boiled cow-bone powder and the same technique as was previously given was used. All the cases were successes with apparent reattachment and bone regeneration. Five other cases treated successfully by conservative treatment are also reported. Since this is the work which has the most bearing to my work, I would like to discuss some important details. Phase II of the article: "Clinical and Radiographic Findings of Tissue Healing in Ten Treated Cases of Periodonitosis", is of primary interest for this review. No details are given about how the pockets were measured so it is hard to tell how much of the pocket elimination is due to lowering of the gingival margin. The radiographic results may seem impressive at first glance, but they are not too convincing upon further examination. The x-rays which are compared are by no means period-identical x-rays, and the divergence in angulation seems always to help the appearance of filling in of bone. First we will consider figures 19, 20, and 21, page 65. An accurate measuring of the height of the alveolar bone with consideration taken to the change in angulation shows very little, if any, new formation of alveolar bone as far as height of the alveolar lamina

towards cingulum of the teeth is concerned. Filling in of bone in the partly radiolucent areas, as explained previously in this paper, is apparent. The same can be applied to the other pictures with the exception of figures 13, 14, 15 and 16. They possibly show new-formed alveolar bone, but we cannot exclude the possibility of some remains of bone being present on the first picture as shown on figure 1 in this paper. If the x-rays had been taken with silver point or another contrast medium in the pockets, we would have had some better chances to evaluate the results. The filling in of bone took the same length of time regardless of whether powdered bone was used or not, and the average was 10 months. The difference in result is that, by the use of bone powder, healing was obtained in cases where the pockets previously had resisted conservative treatment. How much of this success resulted from the surgical procedure performed in association with the bone meal implantation, and from lowering of the gingival margin, is not considered in the article. The concluding statement, that bone regeneration equivalent to 1/4 to 2/3 of the length of the root was observed, is not apparent from the presented x-rays.

Own Investigation

The best results with bone grafts are obtained by use of homoplastic grafts. Therefore, I used human costal bone for my experiment. The bone was first placed in metaphen (1:2500) for two days and thereafter rinsed thoroughly in tap water,

dried with low grade heat, ground meshed and autoclaved for sterilization. Teeth with deep periodontal pockets were chosen for the experiment. The pockets were first treated conservatively two or three times until the acute signs of inflammation subsided. The occlusion was adjusted and the distance from the bottom of the pocket up to the incisal edge margin was recorded by use of fine silver points. All of the measurements referred to later in this paper are measured in this way and will for convenience only be called "the distance". The roots were sealed, filed and packs, cotton strings soaked in 75% phenol and 25% camphor, were applied in the pockets for five minutes in order to cauterize the epithelial lining of the pockets. After the pack was removed, the roots were checked for possible still present roughness, rinsed with water and dried with hot air. Thereafter the pockets were filled with bone powder as much as possible, and hemorrhage was created, sufficient to fill the pocket space with blood. The presence of bone powder seemed to speed up the clot formation. The area was kept dry for about 20 minutes, in order to give the clot some time for hardening, and in most of the cases I covered the field with Wards Wonderpack for seven days. The patients were seen later one to two times a week for control. The distance was measured, massage was instituted after two weeks, and the root-surfaces were always checked for deposits.

If more than one deep pocket was present, other pockets were treated with sub-gingival curettage without the use of bone meal for control comparison. For the same reason a couple of typical cases treated without bone meal will be included in this report. Unfortunately, the experiments with powdered bone lasted only over a period of three months so we cannot expect much filling in of bone in such a relatively short period of time; but, as I have previously mentioned, the important feature here is whether or not powdered bone will promote healing of the pocket and clinically apparent reattachment in a better way than our routinely used sub-gingival curettage. The filling in of bone comes gradually and only as a reward for a successful treatment of the periodontal pocket. If we get healing of the pocket, the filling in of bone as shown in Beube's experiments (3), takes the same length of time, an average of ten months, whether or not powdered bone was used. If we don't get healing of the pocket, we cannot expect any bone regeneration.

Case Reports

Case I. Male, white, age 26. Good health. He came to the clinic 2-25-48 with pain and swelling in the area around tooth #6, which was a bridge abutment and in heavy traumatic occlusion. The tooth was mobile and sore to percussion, and an abcess was obviously developing. No pyorrhea elsewhere in the mouth. The bridge was removed and the acute inflammation brought to subside,

and the occlusion was adjusted.

3-10-48 Distance disto-lingual 23.5 mm
Bone powder. Wonderpack

3-15-48 Removed pack. Accumulation of debris from sloughed off epithelium. Visible opening between the tooth and the organizing blood clot.
New pack.

3-10-48

3-18-48 Pack removed

3-24-48 Massage instituted.
Distance 20.8

4-13-48 Distance 18.5

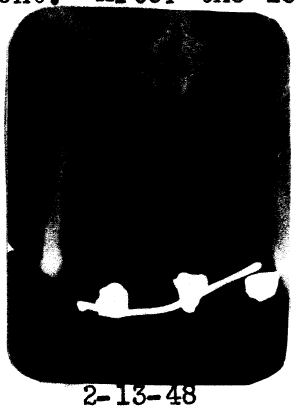
5-4-48 Distance 17.5. Again used bone meal. Chart control.

5-25-48 Distance 17.5. The tooth is firm. Depth of crevice distal 3 - 4 mm. Healthy appearance of the gingiva. No changes radiographically.

5-25-48

Case II. Female. White. Age 25. General health good. Periodontal abcess over tooth #8. Severe pyorrhea with loose maxillary front teeth and marked flow of pus from the pockets. History of previous orthodontic treatment. After the local signs of inflammation had disappeared

3-25-48. Bone meal used #6 mesial
#7 mesial and distal
#8 mesial and distal
Sub-gingival curettage without bone meal on
#9 mesial, distal
#10 mesial and distal
#11 mesial
Controlled 1-2 times weekly. Better color



2-13-48

and reaction on the side where no bone powder was used, but practically no decrease in pocket depth.

5-8-48 Same teeth treated in same way as 3-25-48. Chart control.

5-25-48 The openings of the pockets are very narrow but they could be explored by use of a thin silver point.

5-22-48

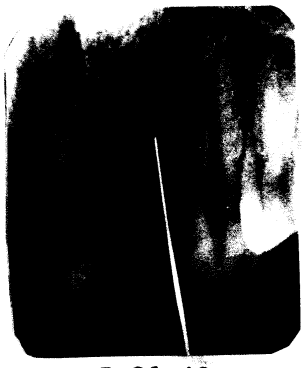
Distances 3-25-48	Distances 5-22-48
#6 mes - 11 mm	11 mm
7 dist - 12 mm	11 mm
7 mes - 14 mm	13 mm
8 dist - 15 mm	15 mm
8 mes - 14 mm	12 mm
9 mes - 14 mm	12 mm
9 dist - 13 mm	12 mm
10 mes - 12.5 mm	11 mm
10 dist - 12.5 mm	11 mm
11 mes - 12 mm	11 mm

A slight decrease in pocket depth but marked improvement in color and decreased mobility. Recession of the gingival margin 2 - 3 mm. The side where bone meal was used was always behind in healing. On x-rays no changes.

Case III. Male, Arabian. Age 32. General health good. Chronic Vincent's infection and severe pyorrhea. Fistula over #7 present for 4 years. Traumatic occlusion especially #7 and #8. After the symptoms of Vincent's infection had subsided 3-20-48, bone powder was implanted #6 mesial and #7 distal and mesial. A flap operation was performed and interproximal area between #6 and #7 was curetted, sutured

and Wonderpack. #8 distal and mesial and #9 mesial treated conservatively. Control once a week. No apparent difference in places where bone meal was used compared with the rest of the mouth. Chart control 5-25-48. The teeth are firmer and good color but deep recession of the gingival margin.

3-20-48

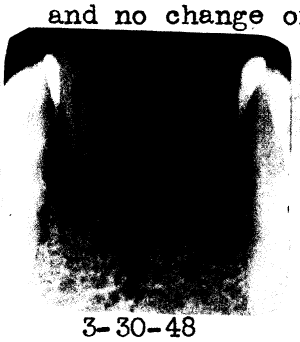


5-26-48

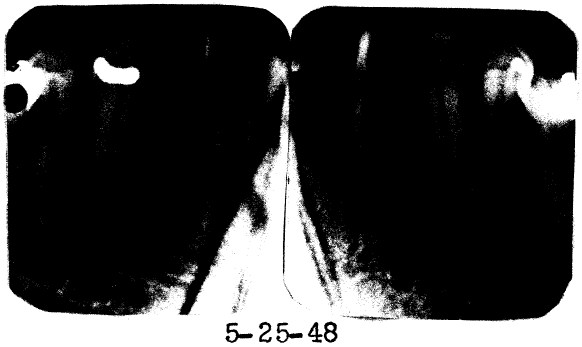
Distances:

3-20-48		5-26-48
#6	mes 18 mm	16 mm
7	dist 19 mm	16.5 mm
7	mes 12 mm	12 mm
8	dist 12 mm	12 mm
8	mes 14 mm	13 mm

Case IV. Female. White. Age 50. General health good. Pyorrhea. Bone meal used 4-1-48 on pocket #23 distal--distance 16.5 mm. Pocket distal #26--distance 12 mm. Conservative treatment. Once a week control. Distances 1 mm less in both pockets 5-25-48. No difference in reaction and no change on x-rays.

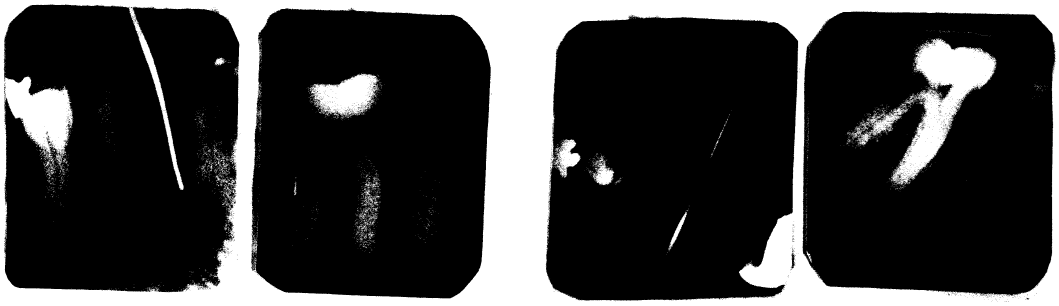


3-30-48



5-25-48

Case V. Female. White. Age 55. Pulmonary T.B. Severely ill 1939-42. Now fairly good health. Severe pyorrhea. Periodontal abcess #10. Treated conservatively from 11-10-47. Distance #10 distal 17 mm. Distance #19 distal 14 mm. Controlled first once a week, later once a month. Phenol camphor packs used three times. Distances 5-17-48, #10 distal--14 mm. #19 distal 9 mm. The pocket distal on #19 is completely closed. Distal on #10 rather deep atrophy of interdental papilla in association with 3 mm reattachment has eliminated the pocket down to 4 mm depth.



11-10-47 5-17-48

On the x-rays some slight filling in of bone can be seen. The case is referred to here as typical of cases treated with conservative treatment, subgingival curettage and phenol-camphor packs.

Ten cases were treated with bone meal implantation in the period from 3-1-48 to 5-25-48. The cases reported here are typical for all of the cases, and the reported result of routine conservatively treated cases is average of what we see in daily practice.

Results

No marked difference in healing could be observed clinically in the cases where bone powder was used compared with cases in which it was not used. Bone powder promotes a faster clotting, but is seemed to give more retraction of the clot from the root surface than a naturally formed clot. Where bone meal was used in some pockets, and in others not, in the same mouth, it seemed that the healing was slightly slower where bone powder was used and more often pus discharge formed from these pockets. In most of the cases some decrease in clinically measurable pocket depth was obtained. The x-ray findings are of no significance for the short period of time spent on these experiments.

Discussion

Ten cases treated over a two to three month period are by no means sufficient material for drawing a conclusion about the value of bone powder in treatment of periodontal pockets, but the uniformity of the results gives these few cases an increased value, and they will be discussed here in connection with the literature about this subject.

Weinmann and Sicher (9) summarise their opinion as follows: "The local utilization of implanted calcium salts has been proven unlikely. It is also improbable in the grafting of bone. The implanted bone is resorbed by osteoclasts which destroy the organic matrix, and the liberated mineral salts are carried

away by the blood and lymph and macrophages. That resorption could increase the local concentration of calcium salts for any length of time seems impossible". They mention as a possibility that calcium salts and remnants of bone may act as a stimulus for the differentiation of osteoblasts in the proliferating connective tissue.

Their conclusion seems to express the opinion of the last research workers in the field. In Beube's experiments (3) the average length of time for filling in of bone was 10 months, regardless of whether he used powdered bone or not.

The reattachment and creation of functional stimulus is of primary importance for the bone regeneration. At the time of new bone formation, the implanted powdered bone probably is carried away long ago.

My cases show some unification taking place between the tooth and the surrounding tissues, evident by clinically decreased depth of the periodontal pockets measured from a fixed point on the tooth. A spectacular organisation of the blood clot filling the pocket, with reattachment to the cementum after a single treatment, has never happened to me. But a gradual decrease in pocket depth during continuous treatment as reported in Case I is a common finding. What kind of attachment we obtain has never been proven, and can only be proven by coordination of accurate clinical observations, followed by histological examination with the use of special

stain for collagen and reticulum. The use of Wonderpack for protection of the clot did not seem to be of any value. Some separation between the granulation tissue and the cementum can always be observed by close inspection, so we only get unification in the deeper part of the pocket. Many different sealing media have been advised to protect the clot from saliva and mouth organisms, but no convincing proof of their value can be found. A slight delay in healing was observed in the cases where bone meal was used as compared with other pockets treated in the same mouth, and as compared with cases treated without bone meal.

The possible effect of bone powder would be a better and more resistant clot formation and stimulating effect on the ingrowing granulation tissue to form functioning connective tissue and later stimulate bone formation. No such effect could be found from my clinical observation.

Conclusion

The use of powdered homoplastic bone in the treatment of periodontal pockets, with the technic described in this paper, was of no value.

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