VARIOUS APPLICATIONS OF PYROLYTIC CARBON IN ALVEOLAR BONE TO RETARD RESORPTION AND STIMULATE OSTEOGENIC ACTIVITY.

A Preliminary Report

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In the oral cavity, when a tooth is extracted or a bone defect has occurred as a result of a pathologic process, the bone repairs itself through the osteogenetic activity of the osteobast cells that infiltrate the ensuing blood clot in the socket of the defect site. The filling in of the defect is an ongoing regenerative sequence, but the resulting healed bone volume is reduced and a contraction or resorption of the lateral and crestal alveolar bone results. This causes a weakening of the adjacent teeth and/or reduces the gross area of ridge which may be called upon to support a dental prosthesis. Our need has been to have a biomaterial in a bulk configuration that could be placed into the defect thereby increasing the rate of regeneration as less bone volume would be required, therefore the collapse of the ridge would be reduced and the original volume could be more normally maintained. Further, in pathologic disease of alveolar bone such as is found in periodontal disease around natural teeth roots, we sought a configuration of a biomaterial that could be packed into these defects to aid in stabilization and support of weakened dentition while healing was taking place after surgical intervention.

DISCUSSION

Investigation in animals and humans of implants inserted into fresh extraction sites is showing that such carbon implants are capable of inhibiting alveolar bone loss.[1] The results suggest that the carbon surface may be osteogenic in nature which could have substantial impact in other modalities. These early observations have led to the use of small carbon particles in boney defects to aid in the regeneration of bone around periodontal diseased teeth.[2] In previous work with vitreous carbon endosseous dental implants, we found it had two distinct disadvantages. One, it is radiolucent, and two, it is brittle, which required bulk or metal reinforcing for strength. The radiolucency factor has hindered radiographic studies in that we "lose the implant" in the films thereby making it impossible to track accurately or follow its position in relation to its supporting bone. Further, we could never adequately delineate the apposition of the new bone growth in relation to the surface of the implant. Studies have shown the bio-compatibility of pyrolytic carbon (LTI carbon) in the environment of the bone found in the oral cavity.[3] The LTI carbon overcomes these two disadvantages, hence our interest centered on this material as the one of choice for our current studies in animals and humans. A third application of carbon we found was it is capable of being coated to metals such as vitallium or titanium with a strong surface bond where this modality was desired.

TECHNIQUE:

Four configurations of these endosseous implants have been utilized to date. Cones or cylinders, segmented sections, granular particles and blades are available. We will discuss here the first three configurations wherein the carbon is to be (fig. 1) completely buried and encapsulated with new bone growth. The cones or cylinders are placed as immediate root replacements at the time of extraction of the natural tooth. These are utilized where the defects are large. The segment configuration is used in smaller defects and the granular particles are packed into infraboney pockets found adjacent to natural roots for support of same. Any combination of the above sizes can be utilized in the same defect to afford the best "fill" but keeping in mind not to overfill the defect as the unincorporated pieces beyond the direct influence of the blood clot will enfoliate. (fig. 2) In fact, we found it is best to keep the level of the fill 2mm. below the level of the lowest point of crestal bone support so that an adequate cover of new bone growth will bridge over the implants to submerge completely all carbon. An advantage of the segment and particle sizes is that if extrusion or exfoliation develops, the total "fill" is not lost, only the topmost portion.

RESEARCH:

Our current studies also include buried cones and cylinders that are re-exposed surgically subsequent to healing and a super structure, with a female extension, is cemented into the root to simulate a tooth replacement. The advantage of this technique is that the new bone growth encapsulates the carbon root in a completely physiologic environment to afford the maximum stabilization of the implant prior to loading with occlusal forces.

Histologic studies of buried biomaterials all in the same host, are also currently underway to compare their respective interfaces. (fig. 3) By placing one of each of the following materials in the same animals (dogs), we hope to determine if they are equally biocompatible or if, in fact, carbon is superior as preliminary reports seem to indicate. Vitallium, LTI carbon, titanium, titanium coated acrylic, and surgical stainless are the five being utilized in this study; the conclusions will be reported elsewhere.

SUMMARY:

Animal and clinical results to date have been significantly encouraging to indicate that this modality appears to stimulate osteogenic activity which hastens the repair of boney defects and, in turn, retards the rate and quantity of alveolar bone resorption in animals and humans.

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Fig. 1, carbon cones, cylinders, segmented spheres and particles

Fig. 2, radiographs of segments encapsulated with new bone

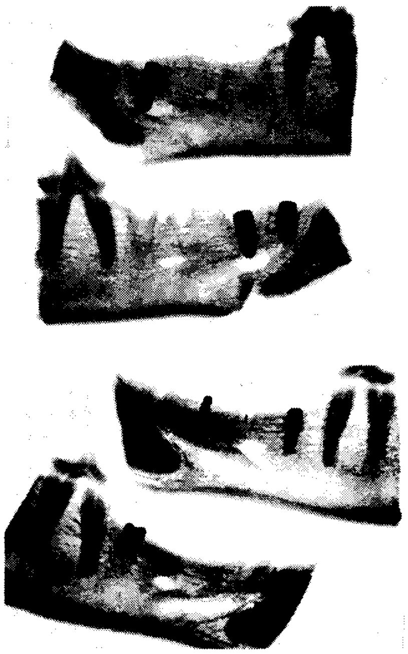

Fig. 3, sections of dog mandibles showing implants prior to sectioning