CARBON MATERIALS FOR ORAL IMPLANTATION: A PRELIMINARY REPORT

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The purpose of this study is to evaluate in laboratory animals and in man, vacuum vapor deposited carbon as a coating for cast metallic implants fabricated for subperiosteal dental implantation and mandibular condyle replacements. Subperiosteal implants are used in edentulous mandibles or maxillae to provide stability for specially constructed dentures for patients who cannot otherwise satisfactorily wear a dental prosthesis. Conventional dentures may be unsatisfactory because of atrophy of the alveolar ridge or because of high muscular attachments on the alveolar ridge. Subperiosteal implants have been used successfully, particularly in the mandible, for over 25 years [1-3]. The success rate, however, has been compromised because the implant must function in a chronic load bearing, through-the-mucosa setting. Thus, they are exposed into the mouth and interface with both bone and soft tissues. The material generally used is cast Vitallium. While design plays a critical role, equally important is the material used to fabricate the subperiosteal implant. Design considerations have been well evaluated, but an entirely satisfactory material has yet to be clinically accepted. Carbons of various sorts appear to have great potential for usefulness in these applications. They have excellent chemical biocompatibility. An advantage of the vacuum vapor deposited carbon is that it can be used to form a thin impermeable barrier that will confer this biocompatibility of carbon on otherwise less compatible materials such as metals [4].

The subperiosteal implants were fabricated according to the classical principles for subperiosteal design and fabrication and then coated with ORALPLATE TM carbon (General Atomic Company, San Diego, California.

The subperiosteal implants have four posts that traverse the mucosa in order to support the dental prosthesis (figure 1). These posts have a tendency to irritate the mucosa resulting in inflammation which, if unchecked, progresses to exposure of the implant and possibly frank infection. It was hypothesized that by coating the implant with carbon, the mucosa around the posts would be less irritated.

Clinical Experience

Two patients with severely atrophic mandibles, for whom subperiosteal implants were entirely appropriate, were chosen as candidate patients. Benefits versus risks were discussed with the patients.

Surgical Technique

A subperiosteal flap was turned, exposing the bare mandibular bone. Custom impression trays were used to prepare appropriate models of the mandibular bone. Using these models, subperiosteal dental implants were cast by a commercial dental laboratory. The cast Vitallium subperiosteal implant was plated with carbon. Two weeks later the patients returned for implantation. The flap was turned again, exposing the alveolar bone subperiosteally and the implant inserted. The mucosa was closed with multiple interrupted 3-0 non-absorbable monofilament sutures (Nylon or Tedvek). Sutures were removed at 10 days to 2 weeks. Dentures were fabricated subsequently. The patients have been seen at 6 weekly intervals in order to evaluate the oral hygiene and the health of the mucosa. Radiographs have been taken at 3 monthly intervals. The mucosal response has been excellent. There has been no evidence of inflammation or of erosion or ulceration. Radiographically there have been no discernible changes in the alveolar bone adjacent to the implant. The implant has remained stable and provides a solid functioning support for the dental prosthesis.

Mandibular Condyle Replacement

Compared to the subperiosteal dental implant, there is no general agreement on what optimum design considerations may include for mandibular condyle replacement. The design usually is based on empirical observations. An x-ray of the patient's mandible is used as the guide [5]. Indications for condylar replacement include severe ankylosis, traumatic avulsion or agenesis.

Studies in Dogs

Vapor deposited carbon coated Vitallium implants for mandibular condylar head replacement were evaluated in 5 dogs. The condylar heads were designed in 3 configurations to evaluate their performance in a laboratory animal. The head of the mandibular condyle was removed unilaterally in each dog, using an air driven bur. The various condylar replacements were placed subperiosteally and affixed with 5 mm carbon coated Vitallium screws and the wound closed in layers. The condylar replacements were cast in Vitallium as overlays for the lateral aspect of the mandible: 1) with 4 holes for screw placement, 2) with 4 holes for screw placement and a pin to countersink into the posterior border of the ramus of the mandible, 3) with 4 holes for screw placement and with 3 pins to be countersunk into the lateral aspect of the ramus of the mandible. Based on visual inspection of the animals, it appears that the condyles with pins countersunk into the lateral aspect are quite stable while the other 2 models were somewhat mobile. Sacrifice of the animal with the condyle replacement with a posterior border pin confirmed that there was some loosening of the screws and that the implant was slightly mobile. The success of the lateral pin models and the need for condylar excision and replacement in a patient encouraged us to evaluate a similar style replacement in man.

In the patient presented here, ankylosis of long standing had resulted in an opening of the mandible of less than 5 mm interincisal distance (normal = 35 - 45 mm).

Surgical Procedure

An incision was made at the posterior border and angle of the mandible exposing the area of the mandibular condyle. A bony carapace extended inferiorly from the zygomatic arch covering the condylar head. This was removed along with a dense fibrous connective tissue band holding the condylar head in the fossa and the enlarged, roughened condylar head was removed with an air driven bur. The prosthesis was fitted into place by countersinking holes in the lateral aspect of the ramus of the mandible to accept the pins prepared in the condylar replacement. Four holes were countersunk through the lattice work of the implant and 7 mm carbon coated Vitallium screws were inserted (figure 2). An opening of nearly 30 mm was achieved on the operating room table without opening the contralateral side. The patient has been able to eat solid foods and continues, after 6 months, to function in a nearly normal way with an unassisted opening of 25 mm.

Summary and Conclusions

Vacuum vapor deposited carbon as a coating for implant materials confers a high degree of inertness. The observations reported here, although preliminary in nature, tentatively confirm the usefulness of carbon coating for subperiosteal implants by imparting greater tissue tolerance to transmucosal posts. The observations on condylar replacement implants have also encouraged us to investigate further, both in the laboratory and in man, these provocative clinical problems.

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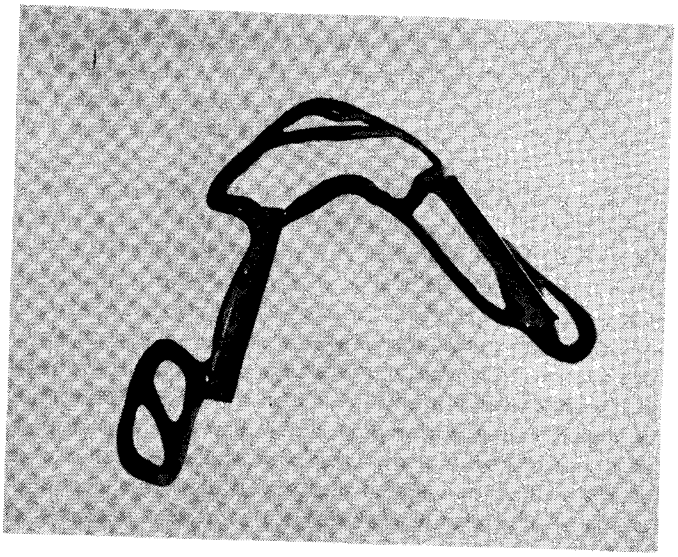

Fig. 1 : Cast Vitallium subperiosteal dental implant coated with vacuum vapor deposited carbon (ORALPLATE TM). The four small posts traverse the mucosa and are topped by a lintel to support the denture.

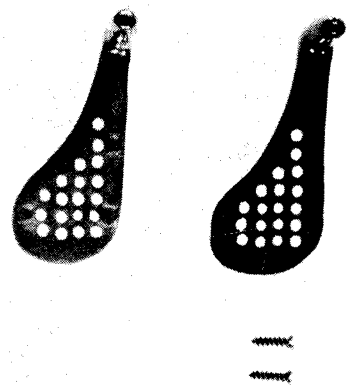

Fig. 2: Prototype human mandibular condyle replacements, Leake and Freeman design. Left, cast Vitallium; right, vapor deposited carbon (ORTHOPLATE TM) coated Vitallium condyle. 7 mm Vitallium screws are also coated with vapor deposited carbon.