Dental implants in periodontal care

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Dental implants are becoming more commonly used in periodontal offices. The literature related to implants this past year was filled with important material that will change the way we diagnose and formulate treatment plans. This review covers the key points that must be understood to maximize success with dental implants.

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In an attempt to cover the topic of dental implants in periodontal care, I have divided the literature into six categories. They comprise guided tissue regeneration around implants, splinting of natural teeth to implants, etiology and treatment of ailing implants, maintenance of implants, different coatings and types of implants, and future considerations.

Guided tissue regeneration around implants

Immediate extraction socket placement

A few articles dealt with histologic response of placing an implant into immediate extraction sockets. Becker *et al.* [1••], Caudhill and Meffert [2], and Warrer *et al.* [3••] all documented that using a barrier material can help osseointegration around the space between the implant and the wall of the socket (Fig. 1). In fact, guided tissue regeneration must be used whenever there is a space; otherwise, fibrous tissue forms next to the implant (Fig. 2). In addition, Warrer *et al.* [3••] showed that filling the socket with Interpore 200 (Interpore Intl., Irvine, CA) did not allow for osseointegration unless Gore-Tex (W.L. Gore, Flagstaff, AZ) was placed over the defect.

The only situation that showed histologic evidence of osseointegration without a barrier material involved growth factors used inside the extraction socket. Rutherford *et al* [4••] used bovine osteogenic protein in the sockets and induced new bone formation in close apposition to titanium implants within 3 weeks.

A concern that must be mentioned is that the bone in most of the histologic sections was not yet very dense. This of course can be a problem in terms of the amount of load that the implant can withstand. In addition, some patients had a dehiscence of the membrane, which had to be removed before stage 2 surgery. Dehiscences might affect the amount of bone that forms next to the implant. They would also be a problem if a resorbable membrane were used because it would dissolve quickly once exposed and might not allow for bone growth against the implant.

Dehiscence defects

Often the ridge is thinner than the implants being placed. The result is a dehiscence on the buccal or lingual surface of the implants. Two clinical studies verified the usefulness of guided tissue regeneration over dehisced defect sites [5••,6••]. Both studies were of great clinical significance because the authors observed the implants after occlusal loading and sustained the ability of the newly formed bone to bear the stress well. Jovanovic *et al.* [6••] also documented the potential problem of dehiscence of the soft-tissue flap over the barrier membrane during healing. When the material had to be removed prematurely, there was incomplete fill of the defect.

Splinting of natural teeth to osseointegrated implants

One of the highly debated subjects in treatment planning is the controversy of whether to rigidly

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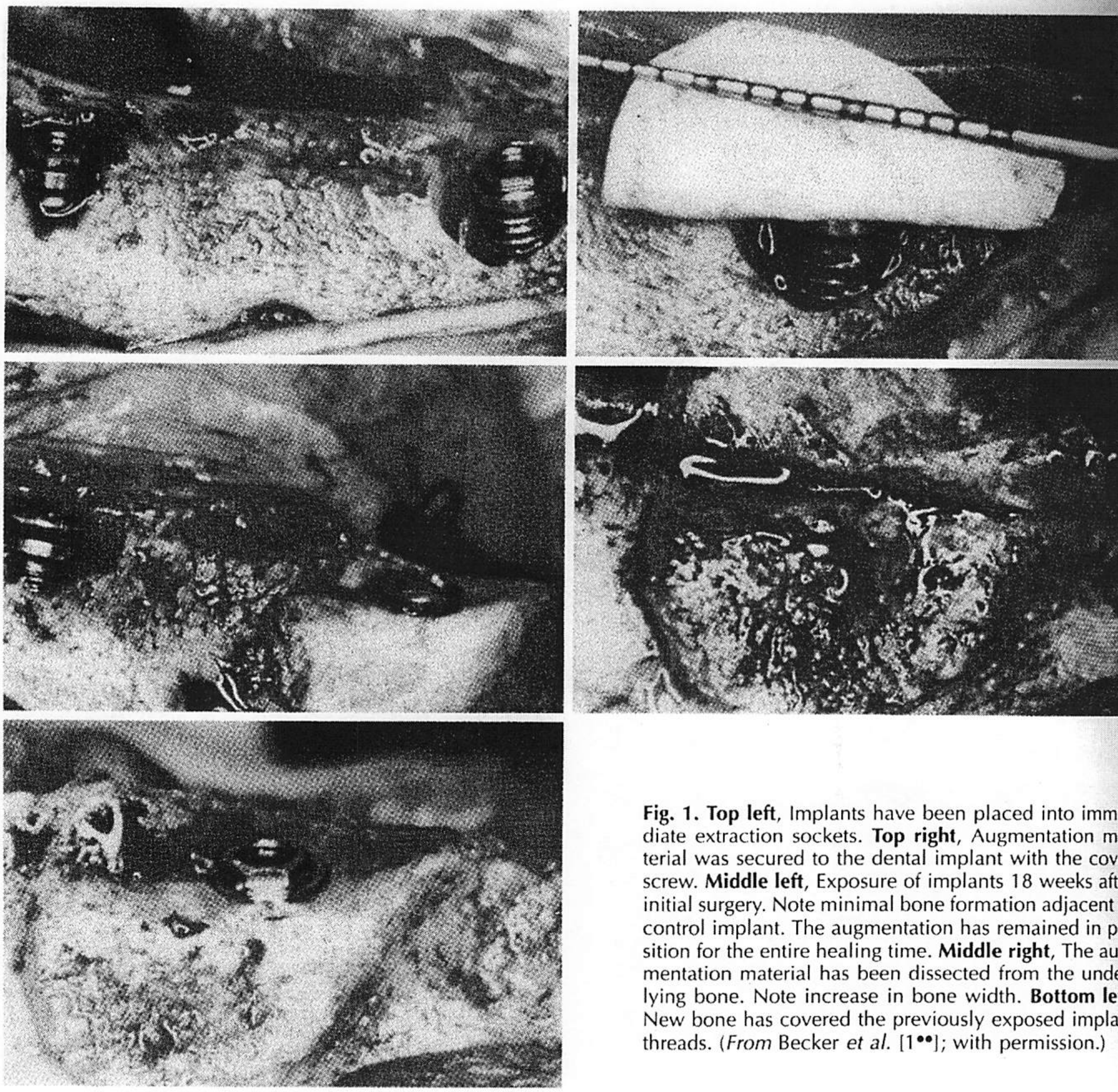

Fig. 1. Top left, Implants have been placed into immediate extraction sockets. **Top right**, Augmentation material was secured to the dental implant with the cover screw. **Middle left**, Exposure of implants 18 weeks after initial surgery. Note minimal bone formation adjacent to control implant. The augmentation has remained in position for the entire healing time. **Middle right**, The augmentation material has been dissected from the underlying bone. Note increase in bone width. **Bottom left**, New bone has covered the previously exposed implant threads. (*From* Becker *et al.* [1••]; with permission.)

connect osseointegrated implants to natural teeth to support fixed partial dentures. The concern was that the rigidly connected bridgework would put extra stress on the implants through the potential movement of the abutment tooth. Gunne *et al.* [7••] reported on 46 bridges placed bilaterally in 23 patients. On one side the bridge was supported by implants and on the other by a rigid connection between an implant and a tooth. The authors' findings were interesting in that after 3 years of occlusal loading, four of the implant-supported and only two of the combination-supported bridges failed. In addition, there was slightly less marginal bone loss around the implants on the side splinted to teeth. This study certainly questions the opinion that osseointegrated implants should never be splinted to teeth. In fact, splinting may be beneficial.

Another reported side effect of interlocking nonrigidly to teeth is the potential for changes in the position of interlock. The teeth may intrude, causing the male part of the precision interlock to be more occlusal in position after a few months of loading (Fig. 3). However, the explanation of this intrusion is still unknown. Cho and Chee [8••] reported on two noncemented telescoped teeth that migrated apically out of an implant-supported

Fig. 2. Control specimen with soft-tissue interface between implant and bone (*asterisks*). (*From* Becker *et al.* [1••]; with permission.)

bridge. Further research must be done to verify whether the teeth are in fact intruding or whether the bone supporting the implants is being stimulated after loading and thus is allowing for supereruption of the bridgework.

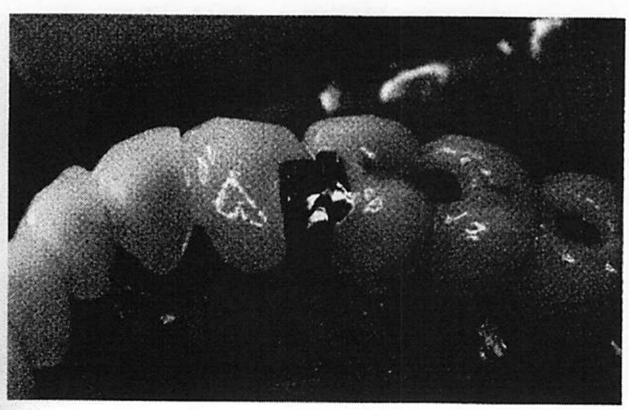

Fig. 3. Note that the male part of the interlock is now more occlusal in position after 6 months of loading.

Etiology and treatment of ailing and failing implants

Despite the long-term success of osseointegrated implants, failures occur with time and use. When bone loss occurs around an implant to the point where it is mobile, it is a failed implant. If the implant has a significant rate of bone loss but is still nonmobile, it is a failing implant. If the implant has lost bone but the bone loss is now arrested, then it is an ailing implant. Surgical repair of the ailing implant may be attempted, but the outcome of the treatment is still unknown and unpredictable. Three different types of healing may occur around an ailing implant. The ideal healing response is reosseointegration, in which bone forms directly against the previously exposed ailing implant. The second-best response is repair, with long junctional epithelium, or fibrous tissue, or both against the implant. The third-best response is the arrest of any further bone loss, but without repair of bone or soft tissue against the exposed implant.

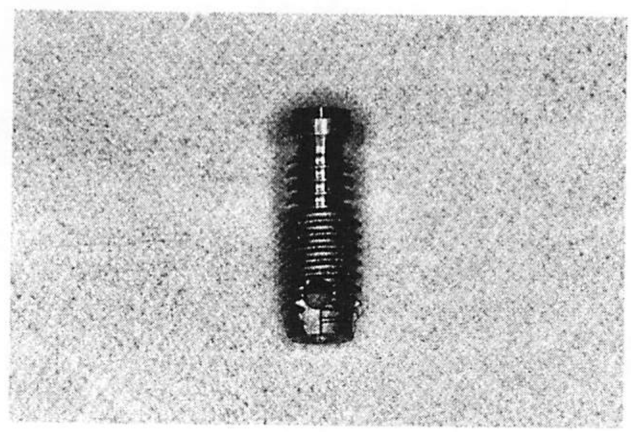

Fig. 4. New prototype of hybrid design with a machined titanium surface in the coronal half and a plasma-sprayed titanium surface at the apical half. This will theoretically allow for minimal plaque accumulation at the crest if the implant becomes exposed to the oral environment while still maximizing the percent of bone integration.

To attempt reosseointegration the defect must first be debrided, and the implant must be detoxified and then treated with guided tissue regeneration. A series of studies [9,10••,11••] showed that detoxification of an implant surface may occur by both chemical and physical means. However, all tests were *in vitro*, and detoxification and debridement of the ailing implant may not be as predictable in an intrabony defect. Detoxification is a problem if the implant is a screw type instead of a cylinder because the screw may block the effectiveness of the debridement. In another study, by Burchard *et al.* [12], stannous fluoride was shown to retard fibroblastic attachment to various implant surfaces *in vitro*. Stannous fluoride may therefore not be the chemical of choice to detoxify an implant if repair reosseointegration is being attempted.

There is no histologic evidence that reosseointegration is possible *in vivo*. Therefore we must approach case reports showing "fill" of a defect around an ailing implant with caution because this "fill" may represent reosseointegration.

From a bacteriologic standpoint, Rosenberg *et al.* [13••] differentiated between an implant that failed because of occlusal trauma and one that failed because of infection. Implants that failed because of trauma had morphotypes similar to those of healthy implants, whereas those that failed because of infection had bacteria similar to those found in teeth with periodontitis.

Soft-tissue reaction around implants was also evaluated by many investigations [14,15,16••,17,18]. Of particular interest was the research by Lindhe *et al.* [16••] in which experimental inflammation was created around teeth and implants in dogs. Both clinical and radiographic signs of tissue destruction were more pronounced around implants and most important, the lesion around implants extended into the bone marrow. The fact that the inflammatory infiltration was not limited to the soft tissue may mean that failed implants could result in an osteomyelitis in some cases. However, this evidence must be documented further in both other animal models and humans before bone infiltration can be accepted as the pathway of inflammation around an implant.

Maintenance of dental implants

Many review articles were written about implant maintenance [17,19,20•]. The article by Jensen and Jensen [20•] is highly recommended for its thoroughness and excellent literature review. As far as new research is concerned, the article by Gantes and Nilveus [21••] demonstrated the effectiveness of a new plastic tip on an ultrasonic scaler. It also reemphasized the safety of using a rubber cup and plastic hand scaler on titanium. However, the new plastic ultrasonic tip must be tested on titanium and other implant surfaces before being used.

Probster *et al.* [22••] also demonstrated that acidulated fluoride prophylactic agents should be avoided around titanium implants because they can corrode the surface. However, neutral fluoride solutions did not cause that problem and were safe to use.

Different types and coatings of implants

The controversy over different types of implants and their surface coating and morphology continued. Of particular interest was the study by Buser *et al.* [23] showing that nonsubmerged implants had a high success rate in a 3-year longitudinal study. Lum *et al.* [24] again documented in primates that blade implants integrate histologically when not loaded and sometimes even when loaded immediately.

Whether to use durapatite coatings is still a source of great controversy. Certainly, if hydroxyapatite becomes exposed to the oral environment, it may become a plaque trap and can cause oral hygiene problems. However, it still gives faster integration and a higher percentage of bone-to-implant contact during the early stages of healing. Gottlander and Albrektsson [25••] reported this early healing phenomenon in rabbit tibias at 6 weeks, but showed more bone-to-implant contact with titanium implants at 1 year. Why this reversal takes place and whether it occurs in humans has not been substantiated.

Future considerations

Growth factors will be used extensively in the future. They will allow faster and more complete integration of implants. In addition, they will probably be used to treat ailing implants in an attempt to achieve reosseointegration rather than to repair defects.

The use of resorbable membranes will increase. These materials will take their place alongside nonresorbable filters but will not replace them. There will be a place for both types; only after more research will we know in which situation to use each one.

New surface textures and coatings will be used. Most common will probably be a hybrid type of implant with a rough titanium or durapatite coating to maximize bone integration on the apical half, and a machined surface on the coronal half (Fig. 4). This combination has the potential to increase bone deposition while minimizing peri-implantitis if the top half of the implant should become exposed to the oral environment.

Certainly there will be better instruments to test the bone density and the load-bearing capabilities of implants in that bone. These instruments will help prevent the failures often seen from occlusal overload, and will aid the practitioner in proper design and treatment plan for the patient.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • Of special interest
- •• Of outstanding interest

1. BECKER W, BECKER B, HANDELSMAN M, OCHSENBEIN C,
•• ALBREKTSON T: **Guided tissue regeneration for implants placed into extraction sockets: a study in dogs.** *J Periodontol* 1991, 62:703–709.

This study documented the fact that guided tissue regeneration allows bone deposition on an implant placed into simulated extraction socket. Control sites showed fibrous tissue between the bone and the implants.

2. CAUDHILL RF, MEFFERT RM: **Histologic analysis of the osseointegration of endosseous implants in simulated extraction sockets with and without e-PTFE barriers: Part I. Preliminary findings.** *Int J Periodontol Rest Dent* 1991, 11:207–215.

3. WARRER K, GOTFREDSEN K, HJORTING-HANSEN E, KARRING
•• T: **Guided tissue regeneration ensures osseointegration of dental implants placed into extraction sockets: an experimental study in monkeys.** *Clin Oral Implants Res* 1991, 2:166–171.

This study documented the need for guided tissue regeneration over extraction sockets. Even placing synthetic bone did not allow for osseointegration unless a membrane was placed.

4. RUTHERFORD RB, SAMPATH K, RUEGER DC, TAYLOR TP: **Use**
•• **of Bovine osteogenic protein to promote rapid osseointegration of endosseous dental implants.** *Int Oral Maxillofac Implants* 1992, 7:297–301.

This is the only article to document osseointegration without a barrier material in immediate extraction sockets. Growth factors will clearly be used in the future.

5. DAHLIN C, LEKHOLM U, LINDE M: **Mebrane-induced bone**
•• **augmentation at titanium implants: a report on ten fixtures followed from 1 to 3 years after loading.** *Int J Periodontol Rest Dent*, 1991, 11:273–280.

This article documents the fact that new bone formed by guided tissue regeneration seemed to be able to bear occlusal loading without resorbing.

6. JOVANOVIC SA, SPIEKERMANN H, RICHTER EJ: **Bone regener-**
•• **ation around titanium dental implants in dehisced defect sites: a clinical study.** *Int J Oral Maxillofac Implants* 1992, 7:233–245.

This study documented that newly formed bone seems to bear the forces of occlusion well. When the barrier material became exposed prematurely, there was incomplete bone fill of the defect.

7. GUNNE J, ASTRAND P, AHLEN K, BORG K, OLSSON M: **Im-**
•• **plants in partially edentulous patients: a longitudinal study of bridges supported by both implants and natural teeth.** *Clin Oral Imprant Res* 1992, 3:49–56.

This study documents the fact that implants can be splinted to natural teeth and that they may even do better than those that are entirely implant supported in partially edentulous patients.

8. CHO GC, CHEE WWL: **Apparent intrusion of natural teeth**
•• **under an implant-supported prosthesis: a clinical report.** *J Prosthet Dent* 1992, 68:3–5.

Two telescoped teeth that were not cemented into an implant-supported fixed bridge migrated apically after insertion of the bridge. This phenomenom is still unexplained and is one of the potential problems in partially edentulous patients.

9. ZABLOTSKY MH, DIEDRICH DL, MEFFERT RM: **Detoxification of endotoxin-contaminated titanium and hydroxyapatite-coated surfaces utilizing various chemotherapeutic and mechanical modalities.** *Implant Dent* 1992, 1:154–158.

10. WITTRIG EE, ZABLOTSKY MH, LAYMAN DL, MEFFERT RM: **Fi-**
•• **broblastic growth and attachment of hydroxyapatite-coated titanium surfaces following the use of various detoxification modalities: Part 1: Noncontaminated hdyroxyapatite.** *Implant Dent* 1992, 1:189–194.

Tetracycline hydrochloride treatment resulted in significantly greater cellular surface area coverage compared with the other treatments. Citric acid and the plastic Cavitron (Dentsply Intl., York, PA) tip also stimulated cell attachment, although the results with the Cavitron tip were not significantly different from those with citric acid or other treatments. The remainder of the modalities and the untreated cellular control specimens experienced similar cellular coverage.

11. ZABLOTSKY MH, WITTRIG EE, DIEDRICH DL, LAYMAN DL,
•• MEFFERT RM: **Fibroblastic growth and attachment on hydroxyapatite-coated titanium surfaces following the use of various detoxification modalities: Part II: Contaminated hydroxyapatite.** *Implant Dent* 1992, 1:195–202.

Citric acid-treated strips showed greater cell growth than resulted from other treatments. The plastic ultrasonic scaler tip and the polymyxin B-treated samples exhibited greater cell coverage than the sterile control specimens. The use of citric acid, a modified plastic sonic scaler tip, or both together may be a valuable adjunct when surgical repair of an ailing durapatite-coated dental implant is contemplated.

12. BURCHARD WB, COBB CM, DRISKO CL, KILLOY WJ: **The effects of chlorhexidine and stannous fluoride on fibroblast attachment to different implant surfaces.** *Int J Oral Maxillofac Implants* 1991, 6:418–426.

13. ROSENBERG ES, TOROSIAN JP, SLOTS J: **Microbial differences**
•• **in 2 clinically distinct types of failures of osseointegrated implants.** *Clin Oral Implant Res* 1991, 2:135–144.

This study showed a difference in the bacteria found around implants that failed due to trauma as opposed to infection. Failures from trauma had flora associated with healthy implants.

14. HICKEY JS, O'NEAL RB, SCHEIDT MJ, STRONG SL, TURGEON D, VAN DYKE TE: **Microbiologic characterization of ligature-induced peri-implantitis in the microswine model.** *J Periodontol* 1991, 62:548–553.

15. BERGLUNDH T, LINDHE J, MARINELLO C, ERICSSON I, LILJENBERG B: **Soft tissue reaction to de novo plaque formation on implants and teeth: an experimental study in the dog.** *Clin Oral Implant Res* 1992, 3:1–8.

16. LINDHE J, BERGLUNDH T, ERICCSON I, LILJENBERG B,
•• MARINELLO C: **Experimental breakdown of peri-implant and periodontal tissue: a study in the beagle dog.** *Clin Oral Implant Res* 1992, 3:9–16.

While contained in the connective tissue around teeth, the inflammatory infiltrate was found directly in the bone around implants that had experimentally induced periimplantitis.

17. KONDELL A, SODER PO, LANDT H, FRITHIOF L, NNEROTH G, ENGSTROM PE, OLSSON ML: **Gingival fluid and tissues around successful titanium and ceramic implants.** *Acta Odontol Scand* 1991, 49:169–173.

18. APSE P, ZARB GA, SCHMITT A, LEWIS DW: **The longitudinal effectiveness of osseointegrated dental implants: the Toronto study: peri-implant mucosal response.** *Int J Periodontol Rest Dent* 1991, 11:95–111.

19. GARBER DA: **Implants: the name of the game is still maintenance.** *Compend Contin Educ Dent* 1991, 12:876–886.

20. • JENSEN RL, JENSEN JH: **Peri-implant maintenance.** *Northwest Dent* 1991, July-Aug:14–23.

Excellent literature review of peri-implant maintenance.

21. •• GANTES BG, NILVEUS R: **The effects of different hygiene instruments on titanium surfaces: SEM observations.** *Int J Periodontol Rest Dent* 1991, 11.

The authors researched a new plastic tip for an ultrasonic scaler.

22. •• PROBSTER L, LIN W, HUTTERMAN H: **Effect of fluoride prophylactic agents on titanium surfaces.** *Int J Oral Maxillofac Implants* 1992, 7:390–394.

Acidulated fluoride prophy paste can cause corrosion of titanium and should therefore not be used around implants.

23. BUSER D, WEBER H, BRAGGER U, BALSIGER C: **Tissue integration of one-stage ITI implants: 3-year results of longitudinal study with hollow-cylinder and hollow-screw implants.** *Int J Oral Maxillofac Implants* 1991, 6:405–412.

24. LUM LB, BERINE OR, CURTIS DA: **Histologic evaluation of hydroxyapatite-coated versus uncoated titanium blade implants in delayed and immediately loaded applications.** *Int J Oral Maxillofac Implants* 1991, 6:456–462.

25. •• GOTTLANDER M, ALBREKTSSON T: **Histomorphometric studies of hydroxylapatite-coated and uncoated CP titanium threaded implants in bone.** *Int J Oral Maxillofac Implants* 1991, 6:399–404.

This study documented in rabbit tibias that the percentage of integration of apatite-coated implants and commercially pure titanium implants changes over the first year. Hydroxylapatite coatings were initially better at 6 weeks, but titanium was better at 1 year.

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