HUMAN HISTOLOGIC EVIDENCE OF INTEGRATION OF FUNCTIONALLY LOADED HYDROXYAPATITE-COATED IMPLANTS PLACED SIMULTANEOUSLY WITH SINUS AUGMENTATION: A CASE REPORT 2½ YEARS POSTPLACEMENT

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KEY WORDS
Antral augmentation
Immediate implant with sinus lift
HA-coated implant
Xenograft
Anorganic bovine bone
Osseous integration

This article histologically and clinically presents a case report showing two retrieved implants that were placed simultaneously at the time of the antral augmentation. These implants were retrieved 2.5 years after placement and 2 years after loading. To our knowledge, this is the first human histological case report of implants that were simultaneously placed with a sinus lift and loaded.

INTRODUCTION

The sinus lift procedure has become a well-accepted technique for increasing the height of bone in the posterior maxilla when inadequate bone exists for the placement of dental implants. Successful placement of implants into the grafted maxillary sinus goes back to the late 1950s and early 1960s, as indicated by the work of Linkow. Further improvements in the technique were developed in the 1970s by Tatum and Boyne and continue through the present time. Since then, many case reports have documented the clinical outcomes of the operation on patients and the histological response to the graft that has been placed to augment the sinus floor. Autogenous bone, allografts, xenografts, and alloplasts have all been used either alone or in combinations. Cases have been reported with the placement of implants simultaneously as well as after various months of healing of the grafts. Most authors prefer to do a staged approach if there is a minimal existing amount of natural bone below the floor of the sinus. Although both techniques have been documented with clinical case reports, only two articles in the literature reported with histological documentation of successfully integrated implants that were removed. For obvious reasons, successful implants are not removed, so the histological data of these few implants that were placed simultaneously into grafted sinuses are very rare. Whitta-
ker et al and Jensen et al wrote the only articles that histologically documented the augmentation procedure performed. Whittaker et al reported an autopsy specimen that was 8 months after placement. These implants were never loaded. Jensen et al reported a smaller diameter implant that was placed with the patient knowing it was an extra implant that would be removed at stage II uncovering. This implant was also never under any functional load.

**Case Presentation**

GG, a 39-year-old white female, was referred by her general dentist for evaluation of posterior maxillary subantral augmentation resulting from severe atrophy of the maxillary ridge and hyperneumatization of the sinuses bilaterally. The patient had been edentulous in the maxilla for approximately 20 years and was wearing a full upper denture. Past medical history was significant for smoking two packs per day, thyroid hyperplasia requiring partial thyroidectomy and gout. The panorex and periapical radiographs taken preoperatively showed minimal residual bone of approximately 2.5–3.5 mm bilaterally. The decision was made to perform bilateral antral augmentation, and if no problems occurred, simultaneous placement would be done. On February 19, 1992, 8 maxillary implants were inserted into the bilateral maxillary grafts simultaneously and two in areas of natural adjacent residual bone (Fig 1). A standard lateral approach with a midcrestal incision was used. No complications were encountered, the membranes were intact, and no associated anatomical structures were injured. The sites were grafted with a combination of freeze dried de-mineralized bone 25% (Pacific Coast Tissue Bank, Los Angeles, Calif) and OsteoGraf/N 700 75% (CeraMed Dental, Lakewood, Colo), along with small amounts of local autogenous bone harvested from the osteotomy sites. The implants selected for use were hydroxyapatite (HA)-coated, threaded, and cylinder implants (Steri-Oss, Yorba Linda, Calif). The threaded implants were self-tapped into the sinus grafts, whereas the cylinders were placed into the natural nonaugmented host bone in the canine areas. Postoperatively the patient did well but complained of some right-sided pain and swelling. Her prophylactic regimen included a medrol dose pack and penicillin started the day before surgery and given for 7 days thereafter. Her medication was empirically changed to augmentin and Afrin nasal spray after complaints of some discomfort were noted. Sutures were removed at 1 week and healing followed uneventfully. On July 14, 1992, approximately 5 months after the procedure, the implants were uncovered and prosthetic reconstruction began. All implants had clinically integrated and the soft tissues appeared to be healthy. Occasional discomfort persisted from the time the implants were placed in the areas of 5 and 6. No sensitivity on palpation or clinical mobility was noted at stage II. The patient appeared to have a nonspecific atypical facial pain associated with the implants in this area. Exploration of the site was done on two separate occasions by both authors. No pathology was seen nor was any reason indicated for the removal of the implants. Computerized tomography (CT) scans were performed and revealed excellent consolidation of the grafts and healing of the implant sites. Of note was the fact that one implant had extended slightly less than 1 mm beyond the graft material into the sinus. A significant delay occurred in the fabrication of the final prosthesis because of the patient’s esthetic needs and concern for occasional persistent discomfort. She had worn a provisional fixed prosthesis that was in function for 28 months and served her well under function. On June 28, 1994, the implants placed in the areas of 5 and 6 were removed with a trephine for psychological reasons. All other remaining implants are still present and functioning at this time. The following is a histological and clinical assessment of the implants, graft, and integration of these removed implants.

**Histological results**

The posterior of the two implants appears to be integrated along most of its surface (Fig 2A). Dense lamellar bone is present that is in direct contact with the threaded HA surface of the implant. Of great interest is the presence of xenograft, OsteoGraf/N 700, material in all the histological sections. The OsteoGraf/N 700 has obviously not completely resorbed at this stage of 2.5 years after placement. However, these graft particles, which are anorganic bone, are all surrounded by the patient’s own new bone. No osteoclasts...
are present in any of the areas around the graft particles, and the graft particles do not seem to be undergoing any type of resorption or remodeling. Of interest are some small areas where the HA coating is not present on the implant (Fig 2B). This area of the implant has bone directly in contact with the underlying titanium surface. Figure 3A shows the anterior cylinder implant, which also shows excellent osseous integration histologically. This implant was not placed in the sinus graft area and, as a result, shows no sign of graft material as seen on the other slides. A fragment of HA does appear to be separated from the coated surface. Figure 3B shows a slide of an area in which the HA is also missing, as seen in Figure 2B. Bone appears to have grown in direct contact with the underlying titanium of the implant surface.

**DISCUSSION**

The significance of this report is that histological verification now exists that an implant placed simultaneously at the time of a sinus lift procedure can integrate and stay integrated after over 2 years of loading. This article is only the third in the literature to substantiate this procedure with histological documentation in humans. Compared with the other two cases reported in the literature, this case is the longest duration and the only one that was loaded following the procedure. Of interest is that the mineralized xenograft material was still present at 2.5 years postaugmentation. This case differs from those of Wallace et al, who reported resorption of the graft material over a similar time period in their case reports. These cases illustrate the difference between patients with respect to their ability to undergo bone remodeling. The fact that there are areas on the implants that, despite the absence of HA, still integrated with direct bone contact is of significance. It verifies that the integration can take place even if some of the HA coating is dislodged or resorbed upon placement.

Another significant observation is that loss of small areas of HA from the implant did not appear histologically to interfere with osseointegration. The cause of the loss of the HA coating remains unclear. As discussed by Edmonte and Yukna, the coating may have stripped off from imperfect manufacturing or the trauma of friction at the time of insertion. The lack of fibrous tissue in this human specimen is also of significance. The quality of the HA, coating application process, and thickness may also be variables in yielding results.

**CONCLUSIONS**

This case report histologically verifies that osseous integration can occur when implants are placed simultaneously at the time of antral augmentation. This report also brings into question the time it takes for some of the graft particles to resorb and the effect of loading on the graft as it is undergoing remodeling. It also histologically verifies osseous healing adjacent to lost HA surface material on endosseous root form implants.

**REFERENCES**