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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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.1 Further improvements in the technique were developed in the 1970s by Tatum2 and Boyne3 and continue through the present time. Since then, many case reports have documented the clinical outcomes of the operation on patients4-7 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.8,9 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\textsuperscript{10} and Jensen et al\textsuperscript{11} 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\textsuperscript{11} 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 hyperpermeatization 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 bovine 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 parti-
cles 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 im-
plant (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 in-
tegration 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 sep-
araed from the coated surface. Figure
3B shows a slide of an area in which
the HA is also missing, as seen in Fig-
ure 2B. Bone appears to have grown in
direct contact with the underlying ti-
nantium 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 substanti-
ate 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 in-
terest is that the mineralized xenograft
material was still present at 2.5 years
postaugmentation. This case differs
from those of Wallace et al., who re-
ported resorption of the graft material
over a similar time period in their case
reports. These cases illustrate the dif-
ference between patients with respect
to their ability to undergo bone remod-
eling. 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 re-
 mains unclear. As discussed by Ed-
monte and Yukna, the coating may
have stripped off from imperfect man-
ufacture 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 thick-
ness may also be variables in yielding
results.

**CONCLUSIONS**

This case report histologically verifies
that osseous integration can occur
when implants are placed simultane-
ously at the time of antral augmenta-
tion. This report also brings into
question the time it takes for some of
the graft particles to resorb and the ef-
fect of loading on the graft as it is un-
dergoing remodeling. It also histologi-
cally verifies osseous healing adjacent
to lost HA surface material on endos-
seous root form implants.

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