# Maxillary Sinus Grafting with Anorganic Bovine Bone: A Clinical Report of Long-term Results

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***Purpose:*** *The aim of the present retrospective study was to evaluate the survival rate of titanium plasma spray-coated cylindric and machined screw-type implants placed in sinuses grafted with anorganic bovine bone mixed with demineralized freeze-dried bone allograft (DFDBA) or with anorganic bovine bone alone.* ***Materials and Methods:*** *The patients included in this study were treated with a 1- or 2-stage technique, according to the volume of residual bone. This determined the possibility of primary stabilization and the duration of the treatment, which was 9 or 12 months, respectively.* ***Results:*** *The overall implant survival rate was 94.5% after a mean functioning period of 6.5 ± 1.9 years. The implant survival rate was better in sinuses grafted with anorganic bovine bone alone than with a mixture of anorganic bovine bone with DFDBA (96.8% versus 90%). The implant survival rate was similar for cylindric and screw-type implants in sinuses grafted with anorganic bovine bone alone.* ***Discussion:*** *Because of the good bone quality, the implant survival rate was similar for cylindric and screw-type implants in sinuses grafted with anorganic bovine bone.* ***Conclusion:*** *Anorganic bovine bone used alone appears to be a suitable material for sinus floor augmentation.* (INT J ORAL MAXILLOFAC IMPLANTS 2003;18:556–560)

**Key words:** *bovine bone, dental implants, maxillary sinus*

The presence of the maxillary sinus often poses problems for the placement of implants in the posterior maxillary region. This has led some authors[1] to propose that this area should be grafted using autogenous grafts from the iliac crest to facilitate implant placement. The technique has been repeated by other authors using either the iliac crest[2] or other graft sites, including an intraoral site,[3] the cranial vault,[4] or the chin.[5,6] However, autogenous bone transplantation may be poorly accepted by the patient because it involves 2 surgical locations and general anesthesia in the case of extraoral harvesting. These objections have led many surgeons to use other materials, including hydroxyapatite,[7] allografts,[8] and composite grafts composed of a mixture of allografts, xenografts, and alloplastic materials.[9–11] Among these different materials, natural bone mineral of bovine origin (Bio-Oss; Geistlich, Wolhusen, Switzerland) has shown good osteoconductive properties[11–14] for such procedures. The aim of this retrospective study was to compare long-term implant survival, prior to and after loading, with respect to the graft material, surgical technique, and implant type.

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## MATERIALS AND METHODS

Two surgical techniques were used in the present patient sample. With the 1-stage technique, if the patient presented residual ridge height of 5 mm or more beneath the floor of the sinus, the graft and

the implants were placed simultaneously, and the implants were uncovered after 9 months. The 2-stage technique was performed if the patient presented a bone height of less than 5 mm beneath the floor of the sinus. In these cases, primary stabilization of the implants was not possible, so the graft was put in place and allowed to heal. After 6 months the implants were placed; they remained buried for a further 6 months before being placed into function.

Fifty-nine patients consecutively treated between 1991 and 1999 were divided into 4 groups. Group 1 consisted of patients treated between 1991 and 1994 with the 1-stage technique. The graft used was a 1:1 mixture of demineralized freeze-dried human bone allografts (DFDBA) and anorganic cancellous bovine bone (Bio-Oss) with a granulometry of 0.25 to 1 mm. Group 2 consisted of patients treated between 1991 and 1994 with the 2-stage technique. The grafting material was identical. Evidence obtained in June 1994 showed that DFDBA was not very effective.[11] This material was therefore abandoned, and Bio-Oss was used alone as the graft material. Group 3 consisted of patients treated between June 1994 and 1999 with the 1-stage technique, with the graft consisting only of Bio-Oss. In group 4, the patients were treated between June 1994 and 1999 with the 2-stage technique.

In this study, usually only nonsmoking patients presenting with partial edentulism, Kennedy Class 1 or 2, were included. Only 1 patient (group 1) was completely edentulous.

Two types of implants were used: cylindric implants coated with titanium plasma (IMZ; Friadent, Mannheim, Germany) and screw-type implants with a machined surface (Brånemark System; Nobel Biocare, Göteborg, Sweden). The composition of the groups is described in Table 1.

## Surgical Technique

To provide objective assessment of any possible pathology at the sinus level, patients were subjected to tomodensitometry. This scanner examination indicated the localization of possible septa, as well as the floor of the sinus and the bone height available below the sinus. Patients were prepared and draped to ensure strict asepsis. The oral cavity and the skin of the face were disinfected with Betadine solution (Sarget, Merignac, France). Local anesthetic (Alphacaine N; Spad, Paris, France) with vasoconstrictor was delivered buccally and palatally. A crestal incision, positioned slightly toward the palatal aspect, was performed throughout the entire length of the edentulous area. An anterior releasing incision was made at the level of the mesial aspect of the most anterior tooth bordering on the edentulous area. Posteriorly, the releasing incision was placed anterior to the tuberosity. A full-thickness flap was then elevated, exposing the lateral wall of the sinus. Based on the tomodensitometric studies, the limits of the sinus were located. An elliptically shaped window was prepared using a round diamond bur mounted on a high-speed contra-angle. This buccal window measured 3×1.5 cm. Following exposure of the Schneiderian membrane, the buccal window was gently mobilized toward the medial aspect of the sinus. A curette was inserted at the level of the inferior border to begin separating the sinus membrane from adjacent bone. If small tears appeared in the sinus membrane, a collagen membrane (Bio-Gide, Geistlich) was used for repair. With curettes of different shapes and sizes, the sinus membrane was gradually separated up to the medial wall of the sinus. The bony window was then horizontally repositioned.

At this stage, the graft was placed. The posterior part of the cavity was grafted first, followed by the anterior portion and finally the central area. Care was taken not to obstruct the middle nasal meatus to allow free sinus drainage. The mucoperiosteal flap was then replaced and sutured with multiple horizontal mattress sutures.

All patients received antibiotic therapy, specifically 1.5 g amoxicillin + clavulanic acid (Augmentin; Beecham, Marly, France) for 1 week, commencing 1 hour before the procedure. In cases of penicillin allergy, erythromycin (Erythrocine 1000; Abbot, Rungis, France), 2 g per day, was prescribed for the same period. Postoperatively, all patients received an intramuscular injection of 120 mg prednisolone (Solu-Medrol; Upjohn, St Quentin, France). An analgesic compound of acetaminophen and codeine (Efferalgan Codeine; Upsa, La Défense, France) was prescribed for pain. Topically, 0.12% oral rinses with chlorhexidine mouthwash (Paroex; Médicadent, Levallois, France) were prescribed, commencing the day after the procedure.

In groups 2 and 4, the sinus was allowed to heal for a period of 6 months prior to implant placement. Implants remained submerged for 6 months. In groups 1 and 3, implants were placed at the same time as the graft and remained buried for 9 months. After the osseointegration period the implants were exposed, and osseointegration was verified by an attempt to move the implants. Some of the implants were progressively loaded for 3 months, as described below.

## Implant Loading

In all patients, the implants were loaded as follows: During the first month, healing abutments were in

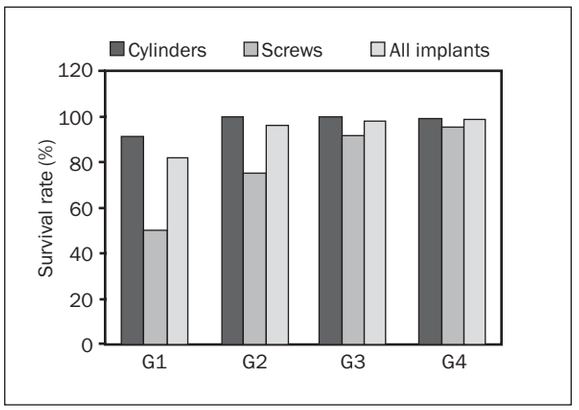


**Fig 1** Implant survival rate among groups.

place and a temporary removable prosthesis was relined with resilient resin (Rebasil, Dexter, Paris, France). As soon as they became functional, the implants were considered loaded. In groups 1, 2, and the first 15 patients of group 4, progressive loading was used as follows. After uncovering, a temporary screw-retained acrylic resin prosthesis without occlusal contact in the anterior and lateral excursions was fabricated, and progressive loading was used for 3 months. After this period, the definitive metal-ceramic screw-retained prosthesis with functional occlusion was placed. For group 3 and the other patients of group 4, a metal-ceramic screw-retained prosthesis was fabricated as soon as soft tissue healing had been achieved. All patients had periodic follow-up examinations by the surgeon at 6 months, 12 months, and 18 months after the implants became functional. Periapical radiographs were taken to examine the bone-to-implant interface. During these follow-up appointments, mobility of the implants was tested after the prosthesis had been removed. All patients were followed once a year after the second year.

### Criteria for Clinical Evaluation

The sinus graft was considered a success if implants of at least 11 mm, and ideally 13 mm in length, could be placed.[15] The following criteria[16] were used in this study for evaluating the clinical results for implants. Any implant removed for any reason by an experienced clinician was considered a failure, and the remaining implants were categorized as survivors. Therefore, survival rates for implants and success rates for grafts were presented.

## RESULTS

The results reported below are based on an evaluation carried out in January 2002 and are presented together in Table 2 and Fig 1.

In the first 3 groups, no infection of the graft was observed, but 1 case of aspergillosis was seen in group 4. Of all the patients treated and followed, only 1 (in group 2) withdrew from the study (Table 1), and all the implants, although integrated into the bone, were removed, as the patient had to undergo an aortic valvuloplasty. The results therefore pertain to a total of 183 implants (Table 2). A total of 10 implants were lost, which corresponds to a survival rate of 94.5% for a mean duration of functioning of 6.5 ± 1.9 years (range 2.3 to 9.4 years).

In group 1, 5 implants were lost of the 28 placed. Two screw-type implants were not integrated into the bone when they became functional, 1 screw-type implant showed loss of osseointegration 3 months after it was rendered functional, and 2 cylindric implants were removed because of peri-implantitis 4 years after they became functional. At the time of evaluation, the global survival rate in this group was 82.1%, for a mean duration of functioning of 8.6 ± 0.3 years (range 8.1 to 9.0 years). The survival rate of the cylindric implants was 90.9% and that of the screw-type implants was 50%.

In group 2, only 1 implant was lost, a screw-type implant that was not integrated at the time it was rendered functional. On the day of the evaluation, the global survival rate in this group was 96.4%, for a mean duration of function of 8.9 ± 0.6 years (range 7.5 to 9.4 years). The survival rate of the cylindric implants was 100% and that of the screw-type implants was 75%.

In group 3, 2 implants were lost before they became functional. These were 2 screw-type implants that developed an operculum under a temporary removable prosthesis. No implant was lost after being rendered functional. On the day of the evaluation, the global survival rate in this group was 92.6%, for a mean duration of function of 4.7 ± 1.4 years (range 3.2 to 6.9 years). The survival rate of the cylindric implants was 100% and that of the screw-type implants was 91.3%.

In group 4, 1 cylindric implant was removed for prosthetic reasons. One screw-type implant was not integrated when it was rendered functional. On the day of the evaluation, the global survival rate in this group was 98%, for a mean duration of function of 5.7 ± 1.0 years (range 3.7 to 7.2 years). The survival rate of the cylindric implants was 98.7% and that of the screw-type implants was 95.2%.

**Table 1 Distribution of Implants Among Groups**

| Group | No. of patients | No. of sites | No. of screws | No. of cylinders | Total no. of implants |
|---|---|---|---|---|---|
| 1 | 10 | 12 | 6 | 22 | 28 |
| 2* | 10 | 16 | 4 | 28 | 32 |
| 3 | 11 | 13 | 23 | 4 | 27 |
| 4 | 28 | 37 | 21 | 79 | 100 |
| Total | 59 | 78 | 54 | 133 | 187 |

One patient, representing 4 cylinders, withdrew from the study.

**Table 2 Results**

| Group | No. of failures | | | No. of infections | Mean time of functioning (y) | Range of functioning (y) |
|---|---|---|---|---|---|---|
| | Total | Screws | Cylinders | | | |
| 1 | 5 | 3 | 2 | 0 | 8.6 + 0.3 | 8.1–9.0 |
| 2 | 1 | 1 | 0 | 0 | 8.9 ± 0.6 | 7.5–9.4 |
| 3 | 2 | 2 | 0 | 0 | 4.7 ± 1.4 | 3.2–6.9 |
| 4 | 2 | 1 | 1 | 1 | 5.7 ± 1.0 | 3.7–7.2 |
| Overall | 10 | 7 | 3 | 1 | 6.5 ± 1.9 | 2.3–9.4 |

Six implants were lost in groups 1 and 2, and 4 were lost in groups 3 and 4. At the time of the evaluation, one third of the cylindric implants that were implanted in the different groups were affected or had been affected by peri-implantitis.

## DISCUSSION

The results showed a different survival rate of the implants according to the different groups. When this technique was first used, especially for groups 1 and 2, the cylindric implants with a rough surface gave better results, as previously reported.[17] Because of the inefficacy of the DFDBA in inducing bone formation,[17] the new bone tissue formed by osteoconduction was insufficient to ensure osseointegration of the screw-type implants with a machined surface. The coated cylinders therefore behaved better than the screw-type implants[18] in this poor-quality bone.

One third of the cylindric implants used showed vertical bone loss that could be visualized radiographically; this was always accompanied by suppuration. All the implants were stable, except for 2 in group 1, which were removed. The implants that remained stable were subjected to surgical treatment, consisting of elimination of the titanium plasma-spray coating, decontamination of the surface of the implant with an aeropolisher, and closing the site again with an apical repositioning flap to reduce the pocket. With this treatment, combined with strict plaque control, it was possible to stabilize the bone loss and render these implants compatible as survivors. However, if these implants are lost in the coming years because of recurrence of the peri-implantitis, their loss would be the result of a cause unrelated to the sinus graft procedure reported in this article. No pathology of this type was observed with the screw-type implants. The lower incidence of this type of complication for the screw-type implants and the bone[18] obtained with anorganic bovine bone led to greater use of screw-type implants, with a considerably greater survival rate in groups 3 and 4 than in groups 1 and 2 (Fig 1). This survival rate appears to be comparable with that reported in previous studies using autogenous bone as the graft material.[19] The acceptance of screw-type implants with a machined surface in sinuses grafted with xenograft has been reported recently, with similar survival rates.[13,14]

In groups 3 and 4, no implant was lost after loading. The follow-up radiographs carried out several years after the implants became functional showed good volumetric stability of the grafts, as well as the bone trabeculae adaptation response to the loading. Regarding the loading technique (whether progressive or direct), no differences in the implant survival rate have been observed.

These results must be weighted by the fact that the period of observation was longer in groups 1 and 2 and that over the years the surgeons have become more skilled in this field. However, it appears that of the total of 10 implants that were lost, 7 were not integrated with the bone at the time they were uncovered, and 1 that was integrated with

the bone had to be removed because it could not be used prosthetically. Analysis of the results showed survival rates that were 96.8% when the anorganic bovine bone was used alone and 90% in the case of mixture with DFDBA. These results compare favorably with the conclusions of the 1996 Sinus Consensus Conference[20] on the use of DFDBA in combination with other biologic materials. On the basis of this study, it is difficult to compare the 1-stage technique with the 2-stage technique, since the indications were different and made it difficult to achieve standardization in a retrospective study.

## CONCLUSION

This study confirmed the validity of the use of bone substitutes in sinus grafting procedures. Screw-type implants with a machined surface showed survival rates slightly lower than those for cylindric implants, but they presented fewer long-term complications. These complications were not associated with the grafting procedure.

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