THREE-YEAR ANALYSIS OF TAPERED SCREW VENT IMPLANTS PLACED INTO MAXILLARY SINUSES GRAFTED WITH MINERALIZED BONE ALLOGRAFT

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With an increase in the number of patients presenting for dental implant treatment, it is becoming more common for clinicians to encounter inadequate bone volume. Several surgical techniques have been advocated for placing dental implants in the posterior maxilla, including the lateral window sinus elevation technique. This article reports the results of implants placed into maxillary sinuses grafted with particulate mineralized cancellous bone allograft alone or in combination with resorbable hydroxyapatite over a 3-year period. A total of 56 sinuses were grafted, and 136 dental implants were placed into the grafted sites after a 4- to 8-month healing period. All reentries revealed a bony hard structure acceptable for osteotomy preparation. Of these implants, 124 have been restored with fixed prosthesis and 12 with removable overdentures for a total of 136 loaded implants. A total of 3 implants required removal (failure) resulting in a 97.7% implant success rate (2.3% failure rate). A conclusion was made that mineralized human allograft, placed into lateral window sinus elevations, is a clinically predicable method acceptable for implant placement and restoration.

Key Words: bone grafting, sinus grafting, sinus lift, augmentation, allograft, mineralized bone, dental implants

INTRODUCTION

In many patients, the edentulous posterior maxilla does not have enough vertical height to allow for implants to be placed without intruding the maxillary sinus. This scenario often creates a challenge to clinicians performing implant tooth replacement. Various techniques to treat the posterior sinus have been described.[1,2]

The classic lateral antrostomy pioneered by Tatum[3] appears to be the most commonly used sinus lift procedure for the severely deficient posterior maxilla. The procedure consists of demarcating a window or door-hinge osteotomy in the lateral maxillary sinus wall. With careful manipulation, the window is luxated or fractured inward and upward to form the "new" sinus floor, although some clinicians favor removal.[4] Meticulous separation of the Schneiderian membrane from the inner wall of the sinus, avoiding perforation, is essential and can be accomplished with specific instruments.[5,6] The newly formed space is then filled with a graft material, and the surgical site is primarily closed.[6,7]

Implant placement can be performed at the time of sinus grafting, if there is enough existing bone height for primary stability of the implants (usually 4 to 5 mm) or delayed for several months (4 to 9 months) to allow for adequate graft maturation.[8] The sinus graft procedure has become one of the most predictable methods to grow bone height with results of up to 20 mm of bone height and implant survival rate greater than 98%.[9–11]

Bone grafting materials

Bone substitute materials have played an important role in dentistry for many years. Today there exists a

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wide array of graft materials used either alone or in combination that can fill the elevated sinus.[2–4,9] Bone graft materials such as autogenous bone, allografts, xenografts or alloplasts have all been advocated for this procedure.[2] Of the various bone augmentation materials available, allografts provide easily procured graft materials.[12] Unlike autogenous bone, allografts do not contain live bone cells, but they do provide type I collagen, which is composed mostly of the organic component of bone.

Allografts contain bone morphogenic proteins (BMPs), which help stimulate bone growth. These proteins, 13 of which have been identified so far (BMP1 through BMP13), are considered osteoinductive compounds.[13,14] Osteoinductive materials encourage new bone formation by acting as a signaling agent in initiating and regulating specific tissue formation. This activity leads to a series of developmental processes that result in the differentiation of mesynchemal cells into osteoblasts.[4]

Materials and Methods

A total of 42 patients underwent sinus grafting procedures. Patients were treated if they were determined to have no contraindication for minor oral surgery with local anesthesia and/or conscious sedation. Both smokers and nonsmokers were included in this study. A total of 56 sinuses were tabulated for these patients.

Each patient was given a complete hard- and soft-tissue exam, periodontal evaluation, and oral examination as indicated. Diagnostic radiographs, including periapical and panoramic views, were taken. The sinus area was evaluated carefully for mucosal thickening, polyp formation, and the presence of any septum (Figure 1). Diagnostic study models and photographs were obtained preoperatively as required.

Patients were administered preoperative surgical antibiotic prophylaxis (amoxicillin 2 g by mouth 1 hour before surgery or clindamycin 600 mg by mouth 1 hour after surgery) and preoperative corticosteroid therapy (Medrol Dose Pack, Pharmacia & Upjohn, Peapack, NJ, dispense one pack and follow pack instructions) started on the morning of surgery.

Patients were scheduled for sinus grafting with local anesthesia with or without conscious sedation. Thus, 0.5% bupivicaine with 1:200 000 epinephrine or 2% lidocaine with epinephrine 1:100 000 (Cook-Waite, Abbott Labs North Chicago, Ill) was administered via infiltration and greater palatine nerve blocks.

A full-thickness mucoperiosteal flap was elevated with an incision over the crest of the ridge and vertical releasing incisions anterior and posterior to the sinus cavity. The sinus area was located, and a lateral window osteotomy was outlined with an 8 round surgical bur and irrigation. The bony plate was fractured, and the sinus mucosa was carefully elevated (Figure 2). A collagen membrane (Biomend, Zimmer Dental, Carlsbad, Calif) was placed onto the newly elevated sinus floor before graft placement (Figure 3).

The sinuses were then carefully filled with cancellous mineralized bone allograft material 1- to 2-mm particle size (Puros, Tutogen Medical, Alachua, Fla) (Figure 4). Larger sinus cavities were grafted with a mixture of Puros and resorbable HA (Osteogen, Impladent, Hollisworth, NY, or Osteograft N-300, Dentsply Friadent Ceramed, Lakewood, Colo).

A collagen membrane (Biomend, Zimmer Dental) was placed over the lateral window before closure to produce a "caging effect."[15] Closure was made with 3-0 or 4-0 silk, chromic gut, or Vicryl (Ethicon, Piscataway, NJ) sutures.

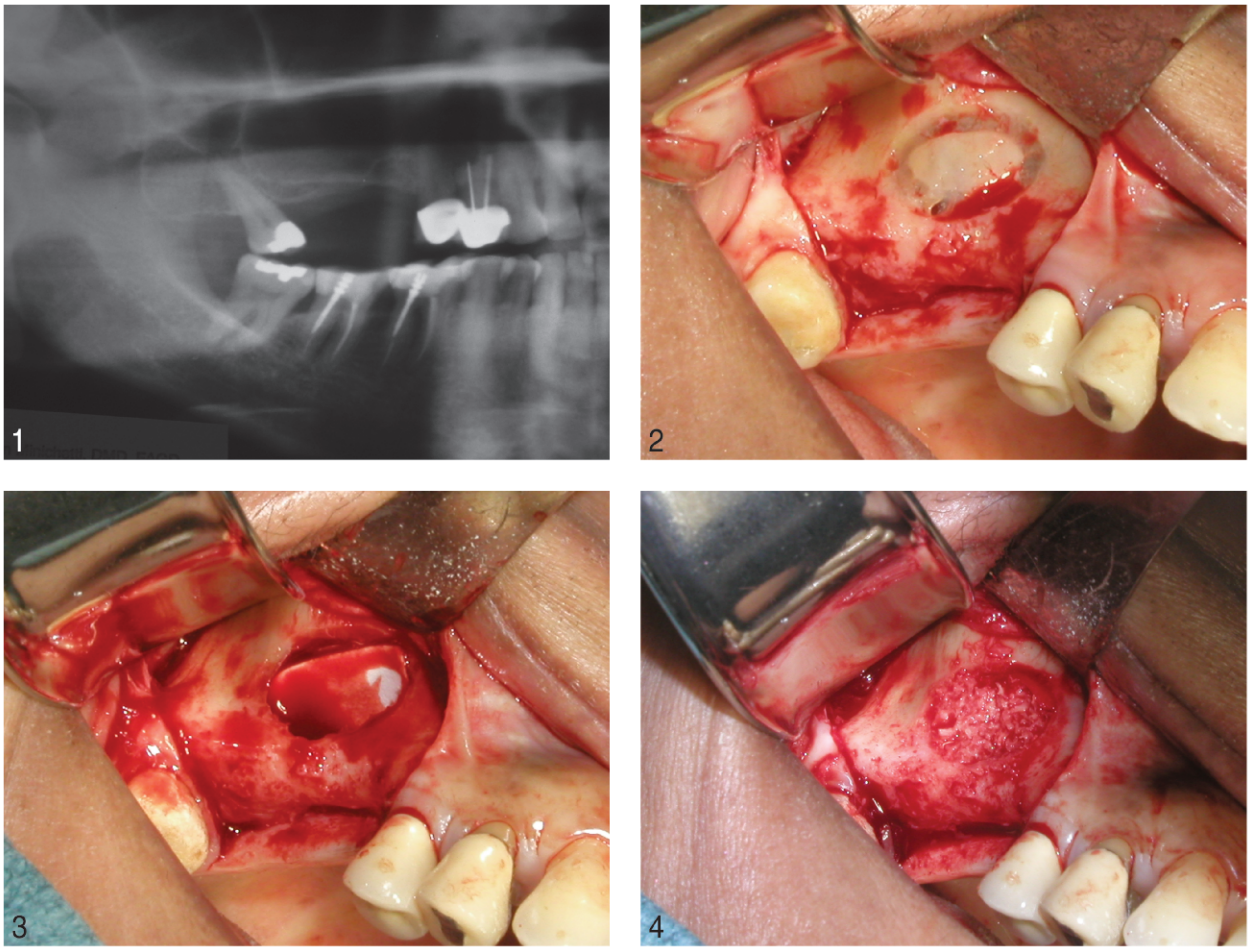
Patients were given postoperative instructions. Prescriptions for 500 mg amoxicillin 3 times daily for 5 days (clindamycin 150 mg for those allergic to amoxicillin) and analgesics for 3 days (oxycodone 5 mg/325 acetaminophen every 4 hours as necessary) were given to the patients. Grafted sinuses grafted were allowed to heal for 4 to 6 months, depending on the size of the area grafted. Grafted sinuses were evaluated radiographically several months after surgery (Figure 5).

After the patients were administrated local anesthesia, a full-thickness periosteal flap was elevated. The sinus windows were evaluated for the density of bone, and surgical rotary instruments were used with or without osteotomes (Salvin Dental, Charlotte, NC) to prepare the osteotomy sites for implant surgery. Dental implants were placed into their proper tooth positions. The implants were submerged in a standard 2-stage surgical protocol for patients wearing a removable prosthesis and in a single-stage surgical procedure for others (Figure 6).

Implants were allowed to heal for 3 to 6 months, at which time radiographs were taken and implant exposure was performed. Hand reverse torque of the implant was applied to implants before abutment placement. Implants were then restored with either fixed cementable porcelain fused to metal prosthesis or screw retained bar overdentures (Figure 7).

Results

Patients' ages ranged from 26 to 77 years old. The greatest number of patients was between the ages of



FIGURES 1–4. FIGURE 1. Preoperative radiograph illustrating large pneumatized maxillary right sinus. FIGURE 2. Elevation of muccoperiosteal flap with access to demarcated lateral window osteotomy site before elevation of Schneiderian membrane. FIGURE 3. Collagen membrane (Biomend) placed onto newly elevated sinus floor before graft placement. FIGURE 4. Sinus grafting with mineralized allograft (Puros).

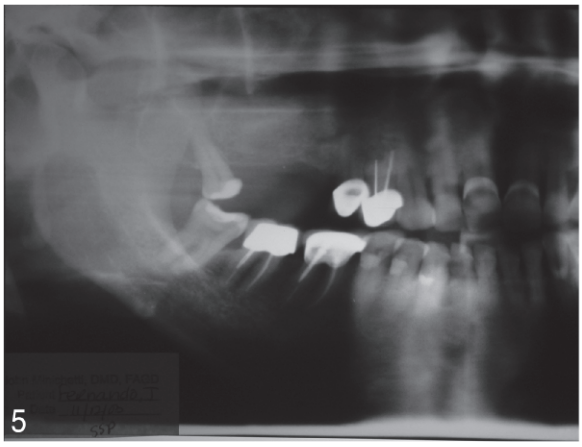
51 to 60 years. Of all the patients involved, the largest number of males patients were 51 to 60 years old and the 41 to 50 years old, and the largest number of women were 61 to 70 years old (Figure 8).

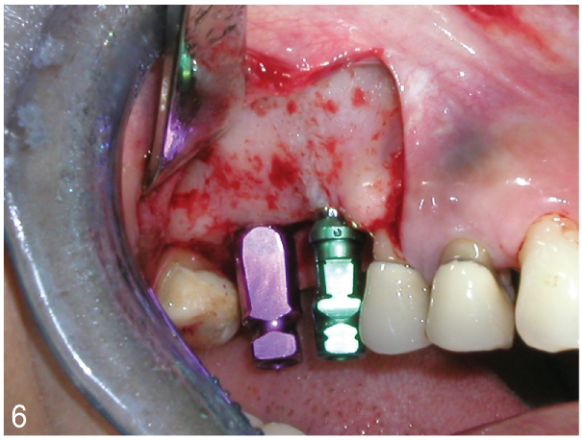
An analysis of the patient's results were tabulated (Table). The results of the analysis revealed a total of 42 patients treated with sinus graft surgery. Of the 42 patients, 56 sinuses were grafted with mineralized bone allograft over a 36-month period. Most of the patients had slight to moderate postoperative pain and swelling after surgery. Some patients mentioned bruising a few days after surgery.

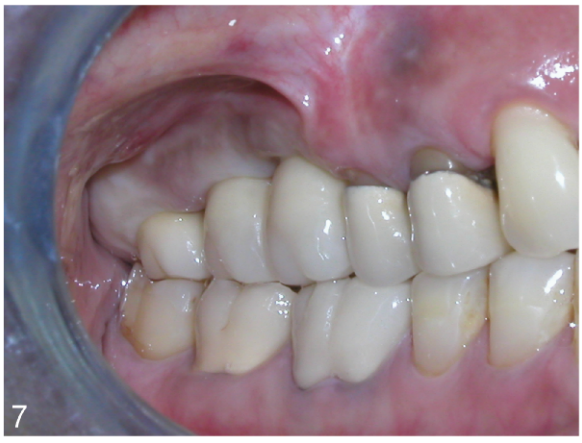
Postoperative follow-up visits revealed most surgical sites healing well over a 1- to 2-week period. One sinus graft complication occurred when a patient in this group presented with an infection 2 weeks after surgery. The patient was placed on amoxicillin/clavulanate potassium 875 mg 2 times a day for 10 days and healed uneventfully.

After a 4- to 6-month healing period, grafted sites deemed to be implant surgical sites were reentered via a full-thickness muccoperiosteal flap. Examination of the lateral windows grafted appeared to be bony hard in consistency. The grafted sites were not penetrable with the periosteal elevator. Into 52 grafter sinuses were placed 136 tapered screw vent implants (Zimmer Dental). Of the 136 implants placed, all were uncovered and restored to date, except for 3 implants, making a total of 133 restored implants (Figure 9).

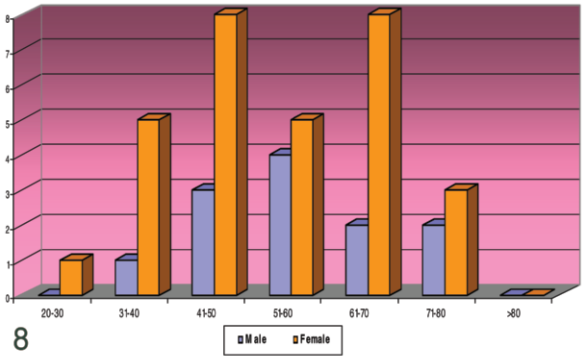
Loading with either a fixed prosthetic restoration or bar overdenture was performed over a 4- to 6-month period. Implants were evaluated as a failure if they resulted in pain, clinical mobility, peri-implant

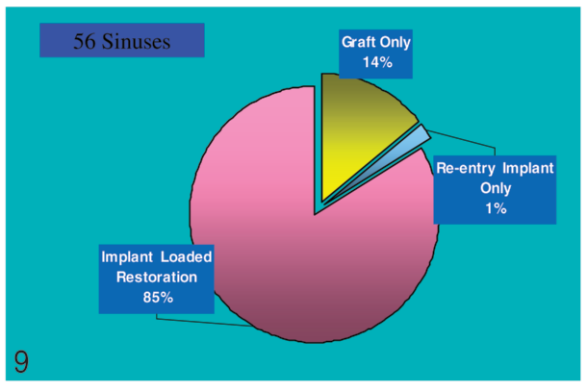


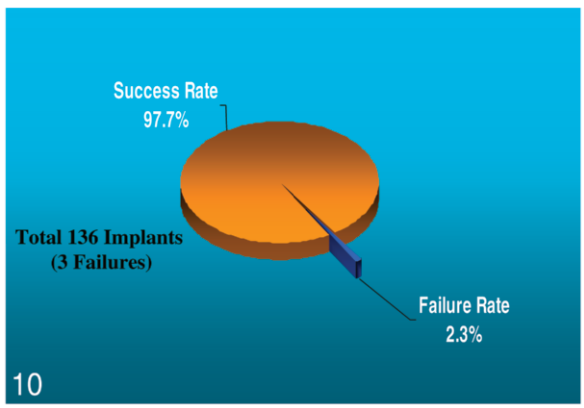




Figures 5–7. Figure 5. Postoperative radiograph taken 6 months after grafting illustrating radiopacity of newly formed bone. Figure 6. Reentry 6 months later illustrates complete bone growth of the lateral window site and placement of 2 tapered screw implants. Figure 7. Final prosthetic restoration of porcelain fused to high noble metal cementable crowns inserted onto implants 3 months after exposure.







Figures 8–10. Figure 8. Analysis of patients according to sex and age groups. Figure 9. Pie chart illustrating grafted extraction sites with implants placed and restored. Figure 10. Pie chart illustrating implant success rate vs failure rate.

pocket depths greater than 5 mm, or peri-implant radiolucency requiring removal.

A total of 3 implants were considered failures and removed. The remaining 133 implants were clinically successful. Radiographic examination of all remaining implants did not show any peri-implant radiolucency. An analysis of the findings was made, and the total failure rate was concluded to be 2.3%. Results of this

TABLE

Patients involved in the analysis

Patient	Age	Sex	Date of Sinus Graph	Months	Implant Placed	Crowns Replaced	No. of Sinuses	Number Implants	Failures
1	73	M	5/24/2001	45	Y	Y	2	5	0
2	77	M	5/1/2001	45	Y	Y	2	8	0
3	59	F	6/27/2002	32	Y	Y	2	6	0
4	60	F	9/20/2001	40	Y	Y	1	3	0
5	36	F	9/17/2002	28	Y	Y	2	5	0
6	39	F	4/1/2002	34	Y	Y	1	2	0
7	62	F	3/8/2002	35	Y	Y	1	2	0
8	74	F	1/31/2002	37	Y	Y	2	2	1
9	59	M	8/6/2002	30	Y	Y	1	4	0
10	51	M	2/28/2003	24	Y	Y	2	8	0
11	49	M	4/19/2002	34	Y	Y	1	2	0
12	38	M	5/21/2003	21	N	N	1	0	0
13	54	F	7/25/2001	42	Y	Y	1	3	0
14	67	F	5/20/2002	33	Y	Y	1	3	0
15	68	M	5/2/2003	21	Y	Y	1	2	0
16	36	F	5/11/2002	21	Y	Y	1	1	0
17	55	F	11/2/2001	40	Y	Y	2	6	0
18	69	F	5/29/2002	33	Y	Y	1	3	0
19	70	F	12/3/2002	26	Y	Y	1	2	0
20	50	F	11/30/2001	38	Y	Y	2	5	0
21	50	F	6/3/2002	32	N	N	1	0	0
22	47	F	1/14/2002	37	Y	Y	2	6	0
23	39	F	6/23/2003	20	Y	N	1	1	0
24	75	F	4/28/2003	22	Y	Y	1	3	0
25	69	F	7/2/2003	19	Y	Y	2	6	0
26	54	F	2/21/2002	36	Y	Y	1	2	0
27	46	M	2/28/2003	18	Y	N	1	1	0
28	54	M	2/12/2001	48	N	N	1	0	0
29	66	F	1/23/2002	37	Y	Y	1	1	0
30	33	F	1/13/2003	25	Y	Y	2	7	0
31	44	F	7/17/2003	19	Y	Y	1	3	0
32	67	M	9/27/2003	17	Y	Y	2	6	0
33	26	F	7/30/2003	19	Y	Y	1	1	0
34	50	F	12/28/2001	38	N	N	1	0	0
35	46	M	6/5/2002	32	Y	Y	2	6	0
36	56	M	1/16/2002	37	Y	Y	1	3	0
37	65	F	3/14/2003	23	Y	Y	1	3	1
38	61	F	6/25/2001	44	Y	Y	1	2	0
39	48	F	2/24/2003	24	Y	Y	2	5	0
40	45	F	8/7/2001	42	Y	N	1	3	1
41	44	F	8/7/2002	20	Y	Y	1	2	0
42	79	F	12/11/2001	46	Y	Y	1	3	0

analysis revealed a total implant success rate of 97.7% (Figure 10).

Discussion

Patients often need to be evaluated for the amount of bone in the posterior maxilla.[16] The posterior maxilla often presents a challenge to implant dentists because of inadequate bone volume from the crest of the bone to the floor of the maxillary sinus. Unpredictable bone loss can occur after tooth extraction, particularly if there is an existing bony defect or radiolucency.[17] Early tooth loss often leads to pneumated sinuses. The lack of bone in the posterior maxilla is a challenge to clinicians placing dental implants.[16]

Many techniques have been advocated for treating the posterior maxilla, including subperiosteal implants,[18] tuberosity implants,[19] zygomatic implants,[20] osteotome sinus elevation (Summer's technique),[21] and hydraulic sinus condensation techniques.[22] The lateral window osteotomy technique, as first described by Tatum,[3] is a highly predictable method to introduce bone augmentation material to the elevated sinus floor. Although many augmentation materials have been described in the literature, there is a risk that any graft material may not become mature living bone at the time of reentry.[23] Although alloplastic and xenograftic materials are plentiful and inexpensive, concerns arise as to their predictability in achieving bone replacement before implant placement.[24] Often

a fibrous connective tissue encapsulation of the residual graft particles occurs, which can delay or complicate dental implant placement.[25] The use of human allograft has been long established as a good alternative to patient autogenous grafting, as it avoids the need for bone grafting from the other sites.[13]

Mineralized human allograft has the advantage of providing both the BMPs and minerals necessary to achieve osteoinductive properties.[26] Recent reports have demonstrated that mineralized allograft is a predictable material for grafting extraction sockets and for sinus elevation procedures.[27,28]

This report demonstrates a reliable method for regenerating bone predictably in sinuses elevated before implant surgical placement. The results obtained in this study show that placing dental implants after grafting with mineralized allograft allows for maturation of bone that can support fixtures for prosthetic load.

The authors of this article have placed particular mineralized bone allograft into 56 sinuses. The mineralized allograft was easy to use and resulted in good healing of the grafted areas. Most grafted sites were allowed to heal for 4 to 6 months before reentry for dental implant placement. After healing, the graft material appears clinically to form a dense bony structure within the grafted site, which allows the surgeon to place implants in a conventional manner. The cases in which resorbable HA was mixed with mineralized allograft did not appear to exhibit any difference in clinical healing. Upon reentry for dental implant surgery the material generally appeared hard and resistant to periosteal probing on the lateral wall preparation.

This material was clinically useful to develop bone volume prior to implant placement. The grafted sinus sites were sufficiently dense enough to withstand osteotomy drilling procedure in a period of 4–6 months. The density of bone was usually of D3 or D4 quality. Tapered shaped root form implants were placed on these patients to provide compression into immature bone in the for greater implant stability.[29]

After a 4–6 month healing period, examination of the lateral windows grafted appeared to have a bony hard in consistency. Sites re-entered at 4 months revealed bone firm enough for osteotomy preparation and implant placement. One hundred thirty six tapered screw vent implants were placed into 52 grafted sinuses. Some of the patients included in the study were not able to return for implant restoration, therefore of those 136 implants placed 133 were uncovered and restored to date. The total failure rate was concluded to be 2.3%. A total implant success rate was 97.7% was established (Figure 10). These success rates are within those found in comparable studies (30, 31).[30,31]

The implants placed in this study ranged from 27 months to 54 months post implant placement. Although this is a short time frame for statistical survival rate follow up, the graft material appeared to be beneficial in creating new bone to allow for successful implant placement. After hydration with saline the graft material was easy to handle and there were minimal complications. This material demonstrated a fairly predictable graft source for the formation of a bony hard environment with re-entry at a 4–6 month time frame.

Conclusion

In many patients, the edentulous posterior maxilla does not have enough vertical height to allow for implants to be placed without intruding the maxillary sinus. Given the abundant scientific literature of bone grafting materials there are many different bone grafting materials available to the implant dentist.[11–13,24]

Mineralized bone allograft (Puros) alone or mixed with resorbable hydroxyapatite (Osteogen or Osteograft N-300) are easily procured materials. A total of 56 sinuses were grafted with mineralized bone allograft over a 36-month period, and 136 tapered screw vent dental implants were placed into the grafted sites after a 4- to 8-month healing period. All reentries revealed a bony hard structure acceptable for osteotomy preparation. Of these implants, 124 have been restored with fixed prosthesis and 12 with removable overdentures for a total of 136 loaded implants. A total of 3 implants required removal (failure) resulting in a 97.7% implant success rate (2.3% failure rate).

The authors concluded that mineralized human allograft, placed into lateral window sinus elevations, is clinically useful to provide bony hard structure acceptable for implant placement and restoration. Further long-term controlled studies are recommended for this material as evidence of its efficacy and safety.

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