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Augmentation Grafting of the Maxillary Sinus and Platelet Rich Plasma

Bone grafting the sinus floor to increase vertical height and improve bone quality for implant placement has become increasingly successful and is an excellent and predictable procedure for treating patients with the moderately atrophic posterior maxillae. In 1997, a modified technique was published by Garg and Quinones,[1] in which an oval window was created and the greenstick fractured area at the superior aspect was eliminated. This procedure differs in the initial surgical approach, the type or site of grafting material,[2] and the type of implant material[3] from the originally proposed sinus grafts of the 70's, 80's and early 90's.

Sinus lift grafting and implant placement can be accomplished as either a one-step or two-step procedure. Good initial results have been reported with both approaches. The one-step approach offers the advantages of minimizing total treatment time by eliminating a second surgical procedure and of allowing a coordinated consolidation of the graft around the implant. In the past, available host bone measuring less than 5 mm in height was deemed insufficient to mechanically maintain an endosteal implant. Thus, simultaneous bone graft and implant placement in these cases were contraindicated in favor of the two-step approach, in which implant placement is delayed until 4 to 6 months after graft placement. In recent years, this concept has been challenged, with success reported using the one-step approach for posterior maxillary ridges measuring as little as 1 mm in height.

Because few vital anatomic structures encroach the surgical site, the risks with sinus lift grafting are negligible, morbidity is low, and postoperative complications can be easily treated with either medical or surgical intervention. Bone response is excellent, and appropriate graft materials produce bone that is demonstrable on histologic examination. The graft and new bone appear to remodel in response to functional loading. Fixed or fixed/removable prosthetic reconstructions can be placed predictably over implants within the sinus graft.

Mechanisms of Bone Grafting

"Transplanted osteogenesis" is another way to define bone grafts since the phrase emphasizes the fact that bone is dynamic and forms by cellular regeneration which produces osteoid that becomes mineralized.[4] A graft is not a solid bone block that heals into place. The attributes of an ideal graft are that it be nontoxic, nonantigenic, noncarcinogenic, strong, resilient, easily obtained, able to allow for tissue growth, resistant to infection, readily available, and inexpensive.

Autogenous Bone

To date, there is no official consensus as to which graft material or combination of materials is best for augmenting the sinus antral void created by the sinus lift operation. However, data suggests that autogenous sinus grafts may be best due to formation of better quality and quantity of bone to accommodate implant placement compared with allografts and alloplasts.

Autogenous bone has long been considered the "gold standard" among grafting material because of its highly osteogenic, osteoinductive, and osteoconductive properties, a combination not found in other graft options. These properties allow bone to form more rapidly and in conditions where significant bone augmentation is required.

The donor site is usually chosen depending on the volume and type of bone desired. In cases involving extremely healthy patients, minimal sinus resorption, or patient refusal to undergo an extraoral bone graft harvest, it may be appropriate to expand the volume of autogenous bone harvested intraorally by combining it with other graft materials, such as allografts or alloplasts.

Allografts

Bone allografts may be cortical or trabecular, freeze dried or demineralized freeze dried. They are obtained from cadavers, processed under complete sterility, and stored in bone banks. Advantages of allografts include ready availability, minimizing the amount of autogenous bone harvested from the patient, reduced anesthesia and surgical time, decreased blood loss, and fewer complications.[5] Disadvantages are primarily the lower ability for allografts to produce bone as compared to autogenous bone, and perhaps the theoretical disadvantages associated with tissues transplanted from another individual.

Alloplasts

Alloplasts, may be natural or synthetic materials and, heal through osteoconduction. The most commonly used alloplasts are bioactive ceramics, which include synthetic calcium phosphate materials and those derived from natural sources. Ceramics, such as hydroxyapatite, are safe and well tolerated, but have little ability to encourage new bone formation. Non-resorbable HA has also been criticized as being of modest value for grafting the maxillary sinus for implant placement. These calcium phosphate ceramics act primarily as filler materials, with new bone formation taking place along their surface. The objective in using them is to help provide a scaffold for enhanced bone tissue repair and growth. Newer alloplasts that have a cell attracting peptide (P-15) attached to them work not only as a scaffold but also to attract bone forming cells to the graft site.

Preoperative Evaluation

Before undertaking sinus lift and grafting procedures, a thorough medical history is obtained. In particular, the patient should be evaluated for seasonal allergies, allergic rhinitisis, or sinus stuffiness on waking in the morning, which may all indicate potential sinus pathology. A patient with sinusitis, sinus disease, or invasive lesions should be referred to the appropriate specialist for treatment before surgery proceeds

The patient should also be asked about tobacco use and the ability to refrain from use before and after surgery, as this can severely impact the success of bone grafting. Nicotine impairs bone healing, diminishes osteoblast function, causes autogenous bone graft morbidity, and decreases graft biomechanical properties.

Panoramic radiographs are necessary and should be supplemented with sinus radiographs and computed tomography scans to help the clinician determine the available maxillary alveolar bone height, the location of sinus floor convolutions, and the surgical entry site. [6]

The interdental space is evaluated for the available space between the gingiva and the proper plane of occlusion, which should be greater than 5 mm. If there is less than 5 mm of vertical space present for prosthetic reconstruction, a gingivectomy, vertical osteotomy of the maxillary posterior alveolar process, and/or mandibular plane correction is indicated. If greater than 20 mm of vertical space is available for prosthetic reconstruction, ridge augmentation in addition to sinus grafting should be considered. All remaining upper teeth should be evaluated to ensure there is no periodontal disease extending from the tooth into the maxillary sinus. The presence of any of these entities contraindicates performing the procedure until they are corrected. After the relevant patient workup has been accomplished, the surgical procedure can be performed.

Surgical Technique

Appropriate preoperative antibiotics should be administered. The patient's oral/facial area should be prepared and draped. The surgery can be performed with local anesthesia or with the patient lightly sedated with intravenous medication.

A horizontal incision is made on the crest or palatal aspect of the edentulous ridge, with extensions beyond the areas of the osteotomy and with consideration to the amount of attached gingiva on the alveolar crest. The incision is carried forward beyond the anterior border of the sinus. A vertical releasing incision in the canine fossa helps to reflect the flap and expose the bone and also ensures soft-tissue closure over the bone. The lateral wall of the maxilla is exposed by reflecting the mucoperiosteal flap superiorly to the level of the malar buttress. Elevation of the periosteum adjacent to the implant site should be minimized to preserve the blood supply to the alveolar crest. The periosteum should be reflected superiorly just beyond the height of the superior aspect of the anticipated opening into the maxillary sinus (approximately the level of the zygoma).

After the lateral maxillary wall has been completely exposed, a No. 8 round diamond bur should be used in an oval configuration at low speed and high torque to make an oval osteotomy in the lateral wall of the maxillary sinus. We recommend an oval- shaped osteotomy to avoid sharp edges that may tear the Schneiderian membrane. A brush-stroke type of touch is used to penetrate through the bone, but not through the Schneiderian membrane.[7] To ensure that the bone has been penetrated all the way around the oval osteotomy, it should be tapped gently and any movement should be noted. At this point, the underlying Schneiderian membrane is exposed. Meticulous care should be taken to reflect the Schneiderian membrane superiorly without perforating it. A curette is gently introduced along the margin of the created access window, with the curved portion of the curette placed against the Schneiderian membrane and the sharp edges.

Autogenous bone is harvested from the predetermined site and, if necessary for adequate volume, mixed with reconstituted freeze-dried bone in a 1:2 ratio and/or with an appropriate alloplastic material (PepGen P-15). This mixture should then have Platelet Rich Plasma (PRP) added to it improve the consistency for handling and minimizing particulate migration as well as to add increased platelets (i.e. increased growth factors) into the area.[8]

If desired, a one-step procedure can be performed in which the graft and implant are placed simultaneously. When this approach is selected, essential surgical modfications to plan for include a wide lateral window opening, the use of a bone mill to homogenize the graft material, meticulous condensation of the graft, and clinical measurements to ensure implant parallelism are critical. During this procedure, it is important to protect the sinus membrane. After preparing the implant sites and grafting the medial portion of the sinus, the implants are placed.

Bone is then packed against the anterior and posterior maxillary walls, molding the bone against and over the implant. During this part of the procedure, it is important to maintain the implant in the proper position to avoid compromising subsequent prosthetic restoration. Next, the lateral portion of the surgical site should be firmly packed with the bone graft. If the diameter of the implant is greater than the alveolar crest, bone should be placed and secured outside the sinus against the lateral surface of the implants. Then the area of the access window should be covered with a membrane barrier to prevent soft tissue ingrowth, the mucoperiosteal flap repositioned, and the incisions closed with interrupted nonresorbable sutures. The graft can mature while the implant is integrating.

If a two-step surgical approach is used (grafting and implant placement surgeries performed separately), the maxillary sinus is completely filled with graft material to the desired level and then the window covered with a resorbable membrane barrier as with the one-step procedure. The mucoperiosteal flap is then repositioned and the incisions are closed with interrupted resorbable sutures. After the bone has matured (roughly 4-9 months depending on the graft material used, the graft size, and the patient's systemic health), it is evaluated to ensure there is sufficient bone height for implant placement. The implants can then be placed in the mature graft material, following the surgical protocol for the particular implant system being utilized, and allowed to integrate.

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