Maxillary Sinus Augmentation With Autogenous Tibial Bone Graft as an In-Office Procedure

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This retrospective study evaluates the efficacy of maxillary sinus grafting using autologous tibial bone in an outpatient setting. Twenty-seven patients undergoing lateral proximal tibial bone graft with subsequent sinus lifts were involved in this study. All surgeries were performed by the same surgeon in a private practice setting. A total of 28 tibial bone grafts and sinus lifts were performed on 27 patients. All subjects had minimal morbidity without any major complications. At the 1-year follow-up all implants that were placed into the grafted sites maintained stability, and no implants were lost. Two patients complained of hypertrophic scars at the site of bone harvesting (7.4%). One patient complained of leg pain for 10 weeks after the procedure, which resolved completely (2.7%). Overall complication rate was 10.1%. We conclude that the surgical harvesting of proximal tibial bone is associated with a low incidence of overall complications, mild postoperative pain, relative ease of harvest, minimal operative time, immediate ambulation, and rapid recovery, which make it an ideal office procedure when a significant amount of corticocancellous bone is required for maxillary sinus grafting.

Key Words: sinus lift, tibial bone graft, maxillary sinus, dental implants

Introduction

Today, autologous bone still constitutes the gold standard for grafting and augmentation in oral and maxillofacial surgery. For the past several decades, different anatomic donor sites have been used to harvest autologous bone with varying success. These include anterior and posterior iliac crest, proximal and distal tibia, mandibular ramus, mandibular symphysis, calvarium, and scapula. Thus far, there is a substantial body of evidence of a relatively positive track record in the use of autologous bone from most anatomic locations.

Compared with xenografts, allografts, and synthetic grafts, which are mainly used as osteoconductive lattices, autografts display both osteoinductive and osteoconductive potential. This in turn translates into significantly superior results with faster graft incorporation into the anatomic location, decreased chance of graft rejection,

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decreased and slower graft shrinkage, all because of the faster establishment of new blood supply. These are the necessary characteristics for successful bone grafting in maxillary sinus.

For years, anterior superior iliac crest has been the most frequently used donor site by oral and maxillofacial surgeons for harvesting large quantity of autologous, corticocancellous bone for sinus lifting procedures. This popularity is invariably because of the easy access and availability of large quantities of cortical and cancellous bone, reported up to 70 mL.[1] The most frequent donor-site complications are sensory nerve damage and hematoma; however, several studies have documented serious complications that include chronic pain, cosmetic deformity, iliac fracture, and peritoneal/abdominal injuries.[2] In a recent review of 1020 patients who underwent iliac crest bone harvesting, Gupta and colleagues[3] reported an overall complication rate of 31%.

Posterior iliac crest provides significantly larger amount of available bone, averaging up to 140 mL,[1] and it is frequently used by orthopedic surgeons for various augmentations, such as posterior spinal fusion surgery. It is not a donor site of choice for most oral and maxillofacial surgery procedures, however, because it requires adjusting patient position during surgery. In addition, it is comparatively difficult to access the posterior crest, and alternative procedures are available that take less time and carry fewer complications. Minor complications of posterior iliac crest graft, such as pain, hematoma, and sensory nerve palsy, have been reported in up to 39% of patients.[4] Major complications, which include superior gluteal artery injury, sciatic nerve injury, deep wound infection, neuralgia parasthetica, and unstable pelvic fracture, were found in 0% to 10% of patients.[4,5] Both anterior and posterior approaches to the iliac crest predictably provide large amounts of corticocancellous bone. The requirements for specific patient positioning, general anesthesia, and management of potential serious complications dictate that each approach be performed in the hospital operating room setting.

Intraoral donor sites have been successfully used by oral and maxillofacial surgeons and other dental specialists for a long time. Benefits include close proximity of donor and recipient sites, which reduces the duration of surgery and anesthesia; short healing time; and acceptable stability of graft volume.[1] Grafts harvested from symphysis and ramus are more cortical in nature and are appropriate for augmenting areas that require block grafting, such as alveolar defects or build-up for atrophic ridge. However, both donor sites lack a sufficient amount of cancellous marrow and are not the best choice for the particulated graft material that is commonly used for sinus augmentation (Figure 1).

The proximal portion of the tibia has become a popular graft choice since the beginning of the 1990s, when Catone and colleagues[6] first published a report of using proximal tibial bone for maxillofacial procedures. Several factors make proximal tibia a graft of choice for procedures such as sinus augmentation that require 10–20 mL of corticocancellous bone. It is a technically easy procedure to perform, it provides from 20 to 40 cm^3 of noncompressed cancellous bone, the complications are minimal, and it can easily be performed in an outpatient setting under intravenous sedation and local anesthesia. In a retrospective study of 40 proximal tibial grafts, Chen and colleagues[7] found no major complications at the 6-month follow-up. They reported that early minor complications, such as ecchymosis and temporary sensory loss, occurred in 15% of patients; a late minor complication, that is, gait disturbance at the 2-month follow-up occurred in 2.5% of patients.[7] An unsightly scar was the only long-term

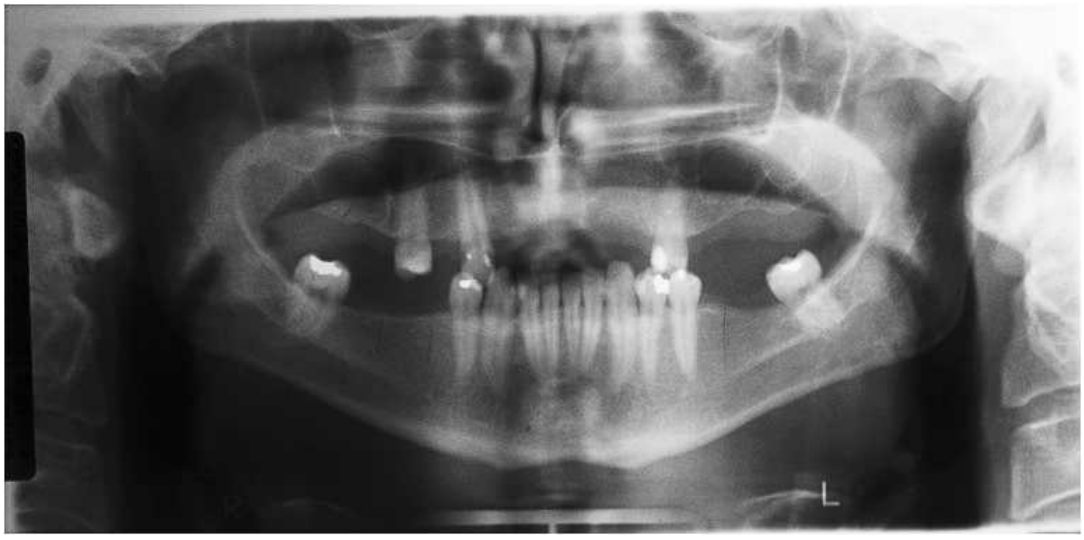

Figure 1. Preoperative panoramic radiograph showing significant maxillary ridge resorption and a pneumatized maxillary sinus on the left side.

complication, reported in 2.5% of patients.[7] In another study, by Mazock and colleagues,[8] 44 patients who underwent proximal tibial bone graft were reviewed. They reported 7 minor complications (15.9%) that included ecchymosis, and minimal postoperative pain, and 5 major complications (11.4%) which were wound necrosis, joint pain, persistent seroma, and transient paresthesia. In 2005, Kushner[9] published a summary of the clinical data of 141 patients who underwent tibia graft harvest procedure during a 9-year period at the Department of Oral and Maxillofacial Surgery, University of Louisville. No major complications were reported, and the minor complication rate was only 1.4%, which was limited to wound dehiscence and superficial infection.

The purpose of this study is to report the results of bone graft harvesting from the proximal lateral tibia and maxillary sinus augmentations in 27 patients who subsequently had implants placed into the grafted sites.

Materials and Methods

Twenty-seven cases were chosen for this study. Patients' ages ranged from 35 to 76 years old (mean age, 55 years). All subjects in this study were relatively healthy (ASA-I and ASA-II) and had no significant systemic conditions. Patients were excluded based on uncontrolled diabetes, smoking, ongoing maxillary sinus infection, and compromised immunity. The same surgeon performed all surgeries, and all of the surgeries were performed in an in-office setting with intravenous sedation.

A total of 28 sinus lift augmentations were performed on 27 patients. Twenty-six patients received a unilateral sinus lift, and one patient received bilateral sinus lift augmentations.

Each patient was premedicated with a wide-spectrum antibiotic (oral amoxicillin at 500 mg or oral clindamycin at 300 mg) the morning of the procedure. The tibial bone harvesting procedure was carried out using a protocol described by Kushner.[9] With that patient in a recumbent position and after successful induction of intravenous sedation, a leg was exposed and draped to approximately 10 inches above and below the lateral tibial epicondyle. The tibial operative site was then prepped with 10% povidone-iodine (Betadine, Purdue Products LP, Stamford, Conn) solution. Gerdy's tubercle was

palpated and marked (Figure 2). A 0.5% bupivacaine with 1:100,000 epinephrine was injected in the area over Gerdy's tubercle down to the level of periosteum. A 3-cm incision was then made and carried sharply down through the periosteum. Periosteum was then bluntly elevated at both sides of the incision to expose the cortical bone plate at Gerde's tubercle. With retractors in place, a surgical drill with 702 fissure bur was used to make a square hole, and the cortical bony segment was then removed and ground up (Figure 3). Multiple curettes were then used to harvest cancellous bone from the tibial plateau and proximal tibial shaft (Figure 4). After the bone harvesting, the operative site was copiously irrigated with 0.9% saline and closed in layers using 4-0 chromic gut for iliotibial tract and 5-0 nylon for skin closure (Figure 5). A single donor site was used in each patient. After the bone harvesting, the sinus lift augmentations were performed in a

Figures 2–6. Figure 2. Preoperative view of lateral tibal epicondyle. Marked circle indicates the position of Gerdy's tubercle. Incision line is marked inside the circle. **Figure 3.** Osteotomy site in the area of Gerdy's tubercle showing an entrance into the tibial plateau. **Figure 4.** Cancellous bone obtained. **Figure 5.** Immediately after surgery. **Figure 6.** Postoperative view of maxillary buccal mucosa following a sinus lift augmentation with tibial bone graft.

Figure 7. Panoramic radiograph from the same patient as in Figure 1. Adequate amount of bone is present in the left maxillary sinus and implants in length that could not have been achieved without maxillary sinus graft.

traditional manner by accessing the maxillary sinus via the lateral window approach, elevating the Schneiderian membrane and packing the harvested tibial corticocancellous graft in the sinus floor. Finally, 3.0 chromic gut sutures were used to close oral mucosa (Figure 6).

After the surgery, all patients were able to walk without any personal assistance, canes, or crutches. Patients were instructed to abstain from vigorous physical activity for a minimum of 2 weeks. All patients kept the leg elevated when possible for first 2 weeks. Patients were placed on maxillary sinus precautions and were prescribed postoperative antibiotics and analgesics.

The patients were followed up to 1 years after the sinus lift procedure at the following intervals: 1 week, 6 weeks, 3 months, 6 months, and 1 year after a sinus lift procedure. After the postoperative visit and at 3 months and 1 year, a panoramic radiograph was taken to determine if there were any changes to the graft. In addition, all implants that were placed in the graft were tested for stability. Implants were placed either at the same time as grafting, if adequate bone for primary stability was present (2–3 mm), or 3 months later.

Results

Implants were placed for all sinus lifts. A total of 89 implants were placed in the sinus lift graft sites: 36 implants were placed at the same time as the sinus lift procedure and 53 implants were placed 12 weeks after sinus lift procedure. No implants were lost. The patients had minimal morbidity. No major complications were reported. Two patients complained of hypertrophic scars at the site of bone harvesting (7.4%). Another patient complained of leg pain for 10 weeks after sinus lift, which resolved (2.7%). The overall complication rate was 10.1%. All patients were followed up radiographically with a panoramic X ray at the day of surgery and at the 3-month and 1-year follow-ups. There was no significant reduction in bone height (Figure 7). In addition, implant osseointegration was tested during each postoperative visit, and all implants were found to be in sound bone with no clinical mobility. This implant success rate is comparable to that of nongrafted implant placement.

Discussion

Bone grafting is an essential part of today's oral and maxillofacial surgery. In addition to using bone grafts in implant surgery, we also often require them for reconstruction of traumatic injuries, pathology, congenital abnormalities, and facial esthetics. To date, autogenous bone has been the only source of osteogenic cells; therefore, it is considered a gold standard for oral and maxillofacial reconstruction. During the past several decades various donor sites of autogenous bone have been described. Most of the donor sites, such as ilium, tibia, calvarium, and intraoral bone, have been used all over the world with high success.

When deciding on a donor site, a surgeon must be able to answer two questions:

- How much grafted bone is needed to reconstruct the defect?
- Does the graft need to be rigid and self supportive?

Because various donor sites provide different quality of bone, it is imperative to be familiar with each location to be able to offer the best possible treatment. Bone harvested from calvarium, rib, and intraoral sites, which include mandibular symphysis, ramus, and zygomatic buttress is made up mostly of cortical bone with minimal cancellous component. The advantage of using cortical bone graft is its high osteoconductive potential, resistance to resorption, and structural rigidity, which allows it to be used as a block graft.

In contrast, bone harvested from iliac crest and tibia is mostly cancellous with mixed cortical components. It is therefore very rich in osteoprogenic cells and shows very early vascularization, which promotes the survival time of donor osteoblasts. The drawbacks of using cancellous bone graft include the lack of structural rigidity, which makes it unsuitable for 3-dimensional reconstruction unless some kind of supportive tray is used. It is also less resistant to resorption.

Corticocancellous bone grafting has been used successfully to augment the posterior maxilla. The 2 most widely used donor sites for harvesting moderate to large amounts (>10 mL) of cancellous bone have been the anterior superior iliac crest and proximal lateral tibial metaphysis. The anterior ilium is a predictable harvest site with a long track record and relatively minor complications.[1] The limitations of using this site is that the procedure has to be carried out in a hospital setting under general anesthesia, there is significant postoperative pain; it requires a longer incision; and may result in perforation of bowel, iliac fracture, and cosmetic deformity.[2] The proximal tibia has only been an option since the early 1990s, but it has been recognized as an alternative donor site for providing a large amount of corticocancellous bone.[10] In addition, this procedure does not require general anesthesia and can be easily performed on an outpatient basis under intravenous sedation or local anesthesia alone.[10] Recent studies have advocated regular use of proximal tibial bone harvesting based on the amount of available bone and low risk of complications compared with the iliac crest graft.[11]

Gerressen and colleagues[12] used 15 freshly preserved adult cadavers to compare tibial versus iliac bone grafts. They reported that from both donor sites approximately equal amounts of bone were available, but the iliac graft required a 6-cm incision compared to a 3.5-cm incisions in a tibial graft.[12] In addition, they found higher density of bone in iliac graft that was age dependent, which would favor tibia graft in elderly patients.[12] As previously mentioned, cancellous bone is also being used for reconstruction of congenital defects, among many other procedures. Sivarajasingam and colleagues[13] have compared 40 patients, half of whom received iliac bone graft and half of

whom received bone harvested from tibia. They concluded that over the 3-month postoperative period both grafts had similar optical density.[13] However, they noted that iliac crest grafts required a significantly longer hospital stay, an average of 5 days compared to 3 days with tibial grafts.

The safety and minimal postoperative morbidity of tibial bone harvesting has been documented in the literature. Even though the incidence of major complications such as tibial fracture has been described, there are only a handful of documented reports.[14] Most published articles report relatively mild postoperative complications ranging from ecchymosis to hypertrophic scarring. In a retrospective study of 19 patients who underwent tibial graft harvesting for sinus lifts, ambulation was immediate in all patients, and ecchymosis was the only reported complication.[15]

Frohberg and Mazock[16] reviewed records of 63 patients who underwent the tibial bone harvest procedure over a 4-year period. They reported that all patients developed transient postoperative ecchymosis and gait disturbances, which resolved quickly.[16] More serious complications, which were seen in 12% of patients, were prolonged pain, paresthesia, seroma, scarring, and joint perforation.[16] Most of the major complications that have been reported in tibial bone harvesting can be avoided by careful operative technique. Perforation of the knee joint can be prevented by being familiar with pertinent anatomy and being careful when curetting superiorly inside the tibial metaphysis. Tibial fractures can be prevented by careful ambulation and minimizing the chance of direct physical injury to the tibia for the first several postoperative months.

In summary, tibial bone harvesting is a predictable and safe procedure for obtaining corticocancellous bone for maxillary sinus augmentation.[17] The most common complications reported are ecchymosis and minor postoperative pain. Some of the more serious complications, such as joint perforation and tibial fracture, can be prevented with careful operative technique and proper adherence to postoperative protocol. Overall, tibial bone harvesting can be easily and safely performed in an in-office setting and therefore should be considered as a standard anatomic location for harvesting large amounts of corticocancellous bone for intraoral grafting.

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