Zygomatic Bone: An Additional Donor Site for Alveolar Bone Reconstruction. Technical Note

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This article describes a procedure to harvest bone from the zygoma for alveolar bone reconstruction. A detailed description of the bone harvesting procedure and a preliminary report of 3 patients undergoing alveolar bone reconstruction and simultaneous dental implant placement in the maxillary anterior area is presented. The technique is indicated when a modest amount of bone is needed, for example, to cover exposed implant threads and expand a narrow alveolar ridge. It also could be used as an additional source of bone with other intraoral donor sites. Surgical access to the zygoma is simple and can be performed using local anesthesia. Postoperative complications after zygomatic bone harvest are minimal. (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:723–728)

Key words: *alveolar ridge augmentation, autogenous bone graft, bone harvesting, endosseous dental implants, intraoral donor sites, zygomatic bone*

Bone grafts in the maxillomandibular region are needed mostly to facilitate the placement of dental implants in adequate bone. Several materials have been introduced and tested as bone graft substitutes that can function as replacements for autogenous bone, which remains the "gold standard" for maxillomandibular reconstruction. Autogenous bone has osteoinductive and osteoconductive properties and it is immunologically safe.[1]

The most commonly used donor sites for bone reconstruction in the maxillofacial area are the ilium, rib, calvarium, tibia, mandible, and maxilla. Extraoral harvesting usually requires general anesthesia and hospitalization. Postoperative morbidity and ambulatory disturbances from iliac crest donor sites are well-known complications.[2]

Intraoral bone harvesting can usually be accomplished under local anesthesia in a routine dental office setting or on a hospital outpatient basis. The advantages of intraoral donor sites are their convenient surgical access and close proximity of donor and recipient sites, which reduce operative time. It has also been shown that a 4-month healing period is sufficient for mandibular bone grafts,[3,4] whereas a 6- to 9-month healing period is needed for bone grafts of endochondral origin.[5] The morbidity of intraoral donor sites is usually relatively low, and the use of a transoral approach does not result in a visible scar.[6–8] The disadvantage of intraoral donor sites is a limitation in the amount of available bone.[7,9,10] Possible complications with intraoral donor sites include altered sensation of teeth, neurosensory disturbances, and infections.[11]

A variety of intraoral donor sites have been introduced in oral and maxillofacial surgery. The

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lateral aspect of the mandibular ramus and retromolar area is a source of mostly cortical bone.[11,12] Mandibular symphyseal bone has been used in secondary alveolar cleft bone grafting,[6,7] maxillary sinus grafting,[13] alveolar defect reconstruction before the placement of dental implants,[3,11,14,15] reconstruction of the orbital floor,[16] and in conjunction with Le Fort I osteotomy.[17] Both cortical and cancellous bone can be obtained from the mandibular symphysis. Bone harvested from the maxillary tuberosity has been used to fill alveolar defects before dental implant placement.[18] The coronoid process of the mandible has been used for paranasal augmentation[19] and reconstruction of the orbital floor.[20] Bone from the zygomatic eminence and arch area has been used to graft the maxillary step osteotomy and interdental osteotomy gaps.[21]

Alveolar bone augmentation can also be accomplished by using alloplastic materials, which work as a scaffold for bone regeneration from surrounding host bone. Bone substitutes, such as hydroxyapatite, demineralized freeze-dried bone, and bovine bone, have been used successfully for alveolar bone reconstruction.[22–24] The principle of guided bone regeneration using barrier membranes is also a predictable surgical technique for alveolar ridge augmentation. Autografts have been used to support a membrane for lateral ridge augmentation procedures.[25]

Zygomatic bone has not been previously reported as a donor site for reconstruction of alveolar bone. The zygoma consists of frontal and temporal processes and an orbital surface. It is surrounded by the maxilla and the frontal, sphenoid, and temporal bones. The zygomatic arch is partly zygomatic and partly temporal bone. In the middle section of zygomatic bone, about 5 mm caudal to the inferolateral corner of the orbital rim, are the zygomaticofacial foramen and nerve. The zygomaticotemporal nerve is superior to the zygomaticofacial nerve and is on the posterior surface of the temporal process of the zygomatic bone. The infraorbital nerve is on the medial side of the zygomatic bone and close to the orbital floor. On the dorsal side of the zygoma is the infratemporal fossa, where the maxillary artery (which divides into the infraorbital artery and superior alveolar arteries), maxillary veins, pterygopalatine nerve ganglion, maxillary nerve, zygomatic nerve, and temporalis muscle are located.

This article describes a method for harvesting bone from the zygoma for alveolar bone reconstruction. A description of the surgical procedure and a preliminary report of 3 patients are presented.

SURGICAL PROCEDURE FOR HARVESTING ZYGOMATIC BONE

Palpation of the zygomatic bone is performed preoperatively. A prominent zygoma is easier to harvest and will give a greater quantity of bone than a flat one. Anteroposterior, axial, and Townes projection radiographs of the skull could be used to evaluate the form of the zygomatic bone. An axial or coronal computed tomographic scan of the head is helpful to estimate the volume of zygomatic bone and provides a good view of the anatomy. Three-dimensional imaging can also be used to visualize the shape of the zygomatic bone.[26]

Preparation of the recipient site should be done before harvesting of the bone graft. This allows for the determination of the amount of bone graft needed and the final selection of the appropriate donor site. Following application of local anesthesia to the infraorbital nerve, posterior and middle superior alveolar nerves, and zygomaticofacial nerve area, the zygomatic bone is exposed through a vestibular incision. The incision is made through the alveolar mucosa about 5 mm above the mucogingival junction, starting between the first and second molars, and proceeds anteriorly to the first premolar area. Periosteal elevators are used to elevate a mucoperiosteal flap. The dissection extends to the inferior aspect of the infraorbital nerve and around the inferior half of the body of the zygoma (Fig 1a). The lateral border of the maxillary sinus is visualized and the inferior border of the orbital rim is palpated.

Bone harvesting is started just above the inferior border of the zygomatic rim and lateral from the maxillary sinus. A trephine bur, round bur, or thin fissure bur on a straight handpiece can be used to harvest bone from the anterior aspect of the zygomatic bone (Fig 1b). All drilling of the bone must be done under copious saline irrigation, and a suction trap should be used to collect bone chips. The drill is kept at an angle of approximately 45 degrees to the occlusal plane and should not be drilled deeper than 12 to 14 mm. The drill should be kept parallel to the lateral sinus wall and lateral surface of the zygomatic bone. The anterolateral corner of the zygomatic bone should be left intact. Care should be taken to avoid entering the orbital floor or infratemporal fossa with the drill. A 4.6-mm trephine drill or 2.3- to 3-mm round burs have been used to create a window in the anterior zygoma. Between 2 and 5 corticocancellous bone plugs can be harvested with a trephine bur (Fig 1c).

Once the cortical bone has been removed, cancellous bone, if present, can be curetted. A suction

Fig 1a The zygomatic bone is exposed through a vestibular incision. A periosteal elevator is placed under the zygomatic bone to retract the soft tissues.

Fig 1b Zygomatic bone harvesting with the trephine bur on a straight handpiece.

Fig 1c Two trephine holes (4.6 mm outer diameter) are drilled lateral to the maxillary sinus.

trap should also be used during curetting to prevent any loss of bone. If the bone is too hard to curette, a round bur and suction trap can be used for further bone harvesting. Cortical bone blocks can be minced in a bone mill or with rongeurs. When harvesting has been completed, the area is rinsed with saline, and a resorbable hemostatic agent may be applied to the donor site. The incision is closed with running or interrupted resorbable sutures, and antibiotic treatment is recommended for 1 week. Usually nonsteroidal anti-inflammatory drugs, or acetaminophen combined with codeine, are satisfactory for postoperative pain relief. A chlorhexidine mouth rinse should be administered postoperatively.

CASE REPORTS

Three patients who underwent simultaneous dental implant placement and bone harvesting of zygomatic bone are presented. All patients had had previous bone grafts and 2 patients had failed dental implants in the grafted areas. Patients gave consent for intraoral bone grafting from the mandibular symphysis or zygomatic bone. The decision to proceed with zygomatic bone harvest was made during the surgical intervention.

Patient 1

A healthy 51-year-old woman with a previously repaired cleft lip and palate required revision of her maxillary alveolar bone graft. The operation was done under general anesthesia. The implant site was exposed and the alveolar crest was noted to be too narrow buccolingually for implant placement without a bone graft. A SLA solid-screw dental implant (Straumann, Waldenburg, Switzerland) was placed in the right lateral incisor area. On the palatal aspect, 5 mm of the implant threads were exposed, and an implant tip perforated the buccal cortex. Bone was harvested according to the technique described above using a 4.6-mm trephine bur (Nobel Biocare, Göteborg, Sweden). Three corticocancellous bone plugs were harvested with the trephine bur, and cancellous bone was obtained from the zygomatic bone by dental curettes. A small perforation of the maxillary sinus was noted after harvesting (Fig 2a). Bone was minced with a bone mill (Osteodisc, GenSci, Irvine, CA) and bone chips were placed on the buccal and palatal sides of the implant. The amount of bone was found to be sufficient to treat this site and the quality of bone was clinically good (Figs 2b and 2c).

On the first postoperative day the patient experienced mild swelling and pain. Two weeks postoperatively, the intraoral wound had healed and the majority of the swelling had resolved. No sensory disturbances were noted along the distribution of the infraorbital or zygomaticofacial nerves. The patient described mild "tenderness" in the area during the first 2 postoperative weeks, and it was noted that the donor site was not palpable extraorally.

Patient 2

Bone grafting from the right zygomatic bone was performed on a healthy, 21-year-old man. The patient had an implant placed in the maxillary right central incisor area 5 months previously, which appeared to be failing. The implant was removed and the area was thoroughly curetted. The residual alveolar crest was found to be narrow and, at this stage, a bone graft harvested from the mandibular symphysis was used to treat the defect. Five months later the area was exposed under local anesthesia

Fig 2a Zygomatic harvesting procedure in patient 1. Bone graft was harvested from the right zygomatic bone with the trephine bur and curette. A perforation to the maxillary sinus was present at the anteromedial corner of the donor site.

Fig 2b Particulated bone graft was placed to the palatal and labial aspects of the implant.

Fig 2c Mucosal wounds closed. Note the close proximity of the donor and recipient site.

Fig 3a A solid-screw Straumann implant was placed at the site of the right central incisor. The implant surface was exposed on the labial and palatal aspects (patient 2).

Fig 3b Particulated bone graft from the bone collector was placed and packed over the defects (patient 2).

combined with nitrous oxide sedation, and it was noted that some of the bone had been resorbed. However, a narrow solid-screw implant, 14 mm in length (Straumann), was placed. Primary stability was achieved, but threads were exposed on both sides of the implant (6 to 7 mm on the labial and 5 mm on the palatal) (Fig 3a). A bone graft from the right zygomatic bone was harvested using a trephine, round burs, and curettage. Bone chips from drilling were collected by a suction trap as described previously by the authors.[27,28] A small perforation of the maxillary sinus was noted after bone harvesting. Cortical bone blocks were particulated with the bone mill. Particulated bone and harvest from a suction trap were used to cover the implant surface on both the labial and palatal aspects (Fig 3b). The amount of bone harvested was sufficient for this application. The patient was also able to compare the zygomatic bone harvest to that of the symphysis and found the zygomatic bone operation more comfortable and recovery significantly less morbid. At the follow-up visits, the zygomatic donor site was not palpable extraorally and was not tender. No sensory disturbances were noted.

Patient 3

Grafting from the zygomatic bone was performed for a 19 year-old woman who 8 months previously had had alveolar crest reconstruction using an iliac crest graft to repair a traumatic defect in the anterior maxilla. All maxillary incisors had been lost in an accident. The alveolar crest reconstruction had been accompanied by the simultaneous placement of four 13-mm-long dental implants (Nobel Biocare). Eight months following the initial surgery, during the second-stage procedure, the right lateral incisor implant was found to be loose and was removed. The procedure was performed under local anesthesia and nitrous oxide sedation. The site was curetted and a 12-mm SLA implant (Straumann) was placed in the same location. Primary stability was excellent; however, 8 mm of the implant threads were exposed on the labial surface. This surface was covered with bone harvested from the right zygomatic bone. The zygomatic bone area was exposed, a round bur was used to create a window to the zygoma, and a suction trap was used to collect the bone chips. A dental curette was used to harvest the cancellous bone. No maxillary sinus perforations were noted and the bone quantity was

more than adequate for the intended procedure. The harvested bone was placed on both labial and palatal aspects of the implant. The patient tolerated the procedure well and found that zygomatic bone harvesting could be accomplished without pain. At her 4-week follow-up appointment, the wound had healed well and the donor site was not palpable. The patient reported that she had had moderate swelling in the region of her right maxilla on the first postoperative day, which was resolved by the third postoperative day. She also had minor bruising under her right eye, but her discomfort and pain were minimal and controllable with oral analgesics (500 mg of acetaminophen and 30 mg of codeine).

DISCUSSION

To the authors' knowledge, the use of zygomatic bone as donor tissue for alveolar bone grafting has not been previously reported. In 1985, Wolford and Cooper[21] described a technique to harvest cortical bone block from the zygomatic eminence and arch during Le Fort I osteotomies. They found it to be easy to harvest a 1×1.5-cm graft from this area without untoward esthetic or functional deficits in the donor site.[21] Harvested zygomatic bone in this case series included both cancellous and cortical bone, as well as particulated bone, which was retrieved using a bone collector connected to the suction tubing. Bone plugs obtained using a trephine drill can be particulated using a bone mill or rongeurs, or they can be placed as such into a defect. Bone chips from a suction trap can be combined with particulated corticocancellous bone to create an easily moldable paste-like material. This kind of material is also suitable for guided bone regeneration using barrier membranes.[25]

The first patient described was treated using general anesthesia, but the second and third patients underwent the harvest under local anesthesia. Both patients reported the procedure to be painless and easy to tolerate under local anesthesia. Postoperative complications were not severe, but included swelling and mild pain or tenderness. No postoperative paresthesia was noticed in the maxillary nerve area.

With the described technique, it is possible to harvest approximately 0.5 to 1 mL of bone without causing damage to surrounding tissues. This amount of bone is sufficient to cover exposed implant threads, for example, and it can be used as an onlay graft to fill alveolar defects at 1 or 2 implant sites. Because the amount of bone harvested from the zygoma is smaller than that from mandibular donor sites, this technique is best suited for those situations where only moderate amounts of bone are needed, especially when implant surgery is undertaken in the maxilla. Furthermore, zygomatic bone is easier to harvest than either the mandibular symphysis or retromolar sites. The gain from the zygomatic bone is too small to be used alone for augmentation of the maxillary sinus. However, it can be used as an additional source of bone graft when, for example, the harvest from the mandibular symphysis is found to be inadequate.

Perforation to the orbit can be avoided with careful surgery, but opening to the maxillary sinus occurred here in 2 of the 3 patients. During maxillary osteotomies, large perforations to the maxillary sinus can occur; usually these heal without problems. Perforation of the sinus membrane during sinus floor augmentation generally does not cause infection if proper antibiotic coverage is used.[29,30]

Contraindications for zygomatic bone harvesting include atrophy of the zygomatic area related to a syndrome or congenital abnormality, as well as previous surgery or trauma to the area. Osteosynthesis materials can also interfere with a surgeon's ability to harvest zygomatic bone, especially when miniplates have been used previously. One of the described patients had undergone Le Fort I osteotomy in which stainless steel wire was used; however, this did not preclude bone procurement.

CONCLUSION

Zygomatic bone is a suitable donor site for treatment of bone defects at 1 or 2 dental implant sites, covering exposed implant surfaces, and as an additional source of bone together with other intraoral donor sites. Surgical access to the zygoma is fairly simple and can be performed using local anesthesia. In the limited experience presented here, postoperative complications after zygomatic bone harvesting appear to be minimal.

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