Autogenous graft harvesting; bone potential comparison of piezosurgery, bone mill, and bone scraper
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Abstract
The osteogenic potential of autogenous bone grafts is superior to that of allografts and xenografts because of their ability to release osteoinductive growth factors and provide a natural osteoinductive surface for cell attachment and growth. There are different techniques for harvesting intraoral bone for augmentation, but new bone formation on the transplanted site with each of these methods needs to be carefully analyzed. This paper presents three cases of bone augmentation done by piezosurgery, bone mill and bone scraper methods and further reviewed the complexity and bone gain potential of each procedure.

Keywords: Autogenous bone grafts, bone regeneration, particulated bone grafts, particle size

Introduction
Placement of an end osseous implant requires sufficient bone volume for complete bone coverage. The use of intraoral block bone grafts from intraoral sources has increased over the years. Possible sources for autogenic bone are the calvarium, tibia, and the iliac crest (frequently used for major jaw reconstruction). However, these sources are not always recommended because of their morbidity, altered ambulation, and the need for hospitalization, as well as significant resorption associated with corticocancellous block grafts from endochondral donor sites. These disadvantages, together with the fact that dental implants do not demand large amounts of bone, have led to the increasing use of intraoral block bone grafts from intraoral sources, especially from the mandibular symphysis and mandibular ramus. Bone from the mandibular symphysis, retromolar area, mandibular ramus, and the maxillary tuberosity can serve as a good treatment alternative for alveolar ridge augmentation with a high success rate for long-lasting augmentation, up to complete jaw augmentation or extensive bone reconstruction. The mandible, as a preferable donor site, has advantages that include no cutaneous scar formation, good bone quality, convenient surgical access, and little volume loss, good incorporation with a short healing time, high biocompatibility, embryological proximity, and decreased morbidity. The corticocancellous nature of bone harvested from this site facilitates faster vascular in-growth once the block has been placed, resulting in more rapid integration and less potential resorption during healing. Until recently, rotary instruments were used for autogenous block graft harvesting. However, accessing the bone harvesting site with bur or oscillating saw is a delicate procedure that requires great technical skills. Piezosurgery is an osteotomy system used in medical and dental surgery. Many studies have proven clinical advantages of piezosurgery in terms of quality of cut, maneuverability, ease of use, and safety. It represents an innovative technique, as it offers the surgeon the opportunity of making precise bone cuts without damaging the soft tissue, minimizes the invasiveness of the surgical procedure. Compared to traditional methods, it enables optimal healing because it reduces post-surgery swelling and discomfort. A collection of cortical bone chips can be obtained by either by particulating previously harvested bone blocks from intra- or extra-oral sites with a bone mill or by using a bone collector device during osteotomy procedures. Bone scrapers are capable of collecting adequate amounts of cortical bone chips from different intraoral sites. The procedure is effective for treating alveolar defects of small size. The manual collection tool furnishes autologous bone, avoiding the need for traditional
incision based techniques and corticocancellous bone block harvesting with associated post-operative discomfort.

**Bone Scraper**

The 502 expanded bone grafter is intended for bone removal and autogenous bone grafting. The instrument is comprised of a reusable stainless steel handle and blade. The blade shaves bone from cortical surfaces producing short convoluted ribbons. While being cut, shavings combine with blood and flow into the handle’s head. This graft material, an osseous coagulum, is then delivered with the handle directly to the recipient site, or to a bowl. Handles are available with three head angles to enable the clinician to select one that is suitable for the given anatomy. The three head angles are straight; 30° up; and 30° down. Handle selection is based on keeping the angle formed by the bottom of the blade and the bone surface between 10° and 45°. Blades are standardized so that can be used with any 500 handle [Figure 1a,b,c,d].

**Bone Mill**

The mill is an innovative electronic bone mill designed to deliver uniform and consistent bone yield. It allows targeted crushing of compact bone fragments. Particle size can be varied by the degree of pressure applied. The bone chips can be easily removed from the collecting dish. The fragment of cortical bone removed is introduced in the mill inlet aperture immediately after extraction and pressed against the roller via pressure unit screwed into the lid. The bone material is crushed by turning the roller. Entirely in accordance with the requirement to use the autologous bone for augmentation whenever possible, the mill allows straightforward, time-saving extraction of bone material of an appropriate size [Figure 2a,b,c,d].

**Piezosurgery**

Piezosurgery is performed by means of a device that uses micro vibration at a frequency capable of cutting bone. Its mechanism of action is based on the ability of certain ceramics and crystals to deform when an electric current is passed across them, resulting in micro vibration at ultrasonic frequency. The vibration is then applied to a nitride hardened or diamond-coated insert which moves at 25-30 KHz, a frequency that allows selective cut of bone tissue. Delicate bony structures can be cut easily and with great precision, without destruction of soft tissue. Histologically, however, the study of biology and post-intervention bone tissue healing showed a lower loss of bone with piezoelectric instruments than with conventional devices, as well as a better healing quality by reducing patient’s post-surgery morbidity. The use of piezoelectric devices seems thus to simplify different sinus lift surgical procedures and to allow greater predictability, although some studies reveal that there are not substantial differences in the comparison of long-term results between conventional and piezoelectric instruments and also criticize their increase in operation time [Figure 3a,b,c,d,e,f].

**Discussion**

It has been demonstrated that particle size, graft volume, and graft surface are important factors for graft material. Autografts with small particle sizes have reduced mechanical stability and higher osteoclastic activity when compared with large particle size. Further research demonstrated that particles packed too tightly lack the space for cells to migrate and potentially inhibit new vessel and bone formation.[20] Autogenous bone grafts can be used in blocks or in particulate form. Particulates are preferred to blocks, it is expected that there will be pronounced revascularization around graft particles and larger release of growth and differentiation factors from the graft in an early stage. In addition, the total surface area of the particles is much larger than that of block graft. Consequently osteoclastic activity is facilitated, resulting in more resorption. It has been proposed...
that particulate bone grafts should be preferred to blocks for many grafting procedures. From these studies, it is impossible to conclude whether small or large bone particles should be preferred in cranio maxillofacial region. In addition, resorption of small particles was more pronounced as compared to large particles after 4 weeks. These observations could be related to an increased release of growth and/or differentiation factors from the larger surface of the small particles. Recent research suggests that it is osteocytes that control and regulates bone formation and not osteoblasts present on the bone surface. These cells seem to play a fundamental role in bone remodeling by secreting signaling factors implicated in the mechanisms of chemo taxis, differentiation, and apoptosis that appear to communicate with the bone surface by controlling the cellular activity of osteoblasts, osteoclasts and bone lining cells. It was interestingly, discovered that osteocytes not exposed to the appropriate physical signals shift the balance of secreted factors to favor resorption.

Based on this study, it can be hypothesized that the method by which autogenous bone is procured influences the growth factors important for osteoblasts to differentiate and induce new bone formation at the bone surface. Further optimized that Autogenous bone graft particles with a size of 0.5-2 mm³ seem preferable to 10 mm³ particles for bone regeneration because of the larger amount of newly formed bone around the particles, combined with the more pronounced remodeling of the newly formed bone.

**Conclusion**

In summary, the present review analyzes more bone gain when autogenous bone grafts are harvested from the bone mill and bone scraper as compared to piezosurgery. The ideal bone graft should be osteoinductive to stimulate osteogenesis and osteoconductive to provide a scaffold for establishing optimal conditions for in growth of blood vessels and cells with osteogenic potential. Particulate bone grafts are preferred to blocks because it has be more pronounced revascularization around the graft particles and a larger release of growth and differentiation. This assumption, however, needs to be confirmed in histometric preclinical studies.

**References**

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