International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319 – 6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 7; July 2017; Page No. 4811-4819
DOI: http://dx.doi.org/10.24327/ijcar.2017.4819.0589

Research Article

AUTOGENOUS BONE HARVESTING AND GRAFTING: INTRAORAL SITES AND TECHNIQUES

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A R T I C L E I N F O

Article History:

Received 24th April, 2017
Received in revised form 14th May, 2017
Accepted 20th June, 2017
Published online 28th July, 2017

Key words:

Autogenous Bone Grafting, Intraoral Sites, Harvesting Techniques, Donor Sites, Bone Graft

A B S T R A C T

One of the important objectives of periodontal surgery is restoration of alveolar bone. Although there is no ideal bone graft, autogenous bone remains the gold standard for alveolar reconstruction as it doesnot produce adverse reactions, has optimal biocompatible remodeling patterns and osteogenic and osteoinductive capabilities. The current trend when implant surgery is done to partially edentulous resorbed dentoalveolar ridges is to harvest bone from an intra-oral donor site. The use of the dental implants for the reconstruction of edentulous jaws has been a progressively growing treatment modality since the late 1970´s. The first reports of intra-oral bone harvesting and bone grafting for dental implants were published at the beginning of the1990´s. The most commonly utilized intra-oral bone harvesting donor sites in dental implant related surgery are the mandibular symphysis and ramus. Smaller amounts of particulated bone graft may be harvested from the maxillary tuberosity, extraosseoustori or with residual alveolar ridge osteoplasty. Today, clinicians have a much better understanding of the requirements for bone regeneration. There has been remarkable development in bone grafting techniques in recent years. This review highlights donorsites and techniques in intraoral autogenous bone harvesting and grafting.

INTRODUCTION

One of the important objectives of periodontal surgery is restoration of alveolar bone. Although there is no ideal bone graft, autogenous bone remains the gold standard for alveolar reconstruction as it doesnot produce adverse reactions, has optimal biocompatible remodeling patterns andosteogenic and osteoinductive capabilities. (Bunger M.H *et al*. 2003, Hu Z.M *et al*. 2004). In 1923, Hegedus attempted to use intraoral autogenous bone grafts for the reconstruction of bone defects produced by periodontal disease. (Nabers CL *et al*. 1965)The use of the extra-oral bone harvesting donor sites, such as the anterior and posterior iliac crest, is still the standard when large reconstructions are performed in the maxillo-mandibular region for example after tumor surgery or in dental implant treatment to totally edentulous jaws. However, the current trend when implant surgery is done to partially edentulous resorbed dentoalveolar ridges is to harvest bone from an intra-oral donor site.(Jensen J *et al*. 1991, Misch CM 1997, Cordaro L *et al*. 2002, Cordaro L 2003).The use of the dental implants for the reconstruction of edentulous jaws has been a progressively growing treatment modality since the late 1970´s.The first reports of intra-oral bone harvesting and bone grafting for dental implants were published at the beginning of the 1990´s. (Jensen J *et al*.1991, Misch CM *et al*. 1992).

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Most of these reports highlighted the intra-oral harvesting sites as having convenient surgical access. The ischemic time of the bone graft has reported to be short. Furthermore, since both the donor and recipient sites are intra-oral, there was no morbidity from a second surgical site. The morbidity associated with intra-oral donor sites was also found to be lower compared to extra-oral donor sites and the use of a transoral approach does not cause visible scarring. Breine and Brånemark, Kahnberg, Sailer and Adell reported results on prosthetic reconstruction of the resorbed edentulous jaws with autologous bone grafts and dental implants. (Breine U *et al*. 1980, Kahnberg KE *et al*. 1989, Sailer HF 1989, Adell R *et al*. 1990). Boyne and James were the first to report experiences with inlay bone grafting of the maxillary sinus for dental implants (Boyne PJ *et al*. 1980). One major disadvantage of intra-oral bone harvesting was also found - the limited amount of available bone (Jensen J *et al*.1991, Misch CM *et al*. 1992, Sindet-Pedersen S *et al*. 1988, ten Bruggenkate CM *et al*. 1992, Jensen J *et al* 1994). The most commonly utilized intra-oral bone harvesting donor sites in dental implant related surgery are the mandibular symphysis (Jensen J *et al*.1991, Misch CM *et al*. 1992,) and ramus (Misch CM 1996). Smaller amounts of particulated bone graft may be harvested from the maxillary tuberosity, extraosseous tori or with residual alveolar ridge osteoplasty (ten Bruggenkate CM *et al*. 1992, Misch CM 1999). Today, clinicians have a much better understanding of the requirements for bone regeneration. There has been remarkable development in bone grafting techniques in recent years. This review highlights donor sites and techniques in intraoral autogenous bone harvesting and grafting.

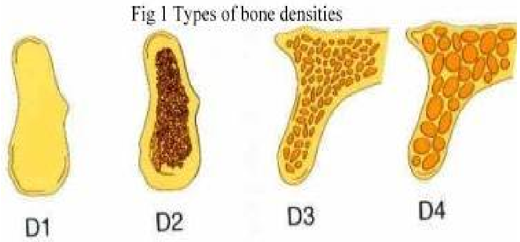
Principles of Autogenous Bone Grafting Robert M, Mark S outlined four basic principles of autogenous bone grafting. (Robert M *et al*. 2010).

Selecting the least morbid harvest site, and harvesting it with least morbidity. As an autograft represents a cellular transplant, its cells must survive by maintaining their viability even after they have been placed at the recipient site. Graft cells must imbibe nutrients from the recipient tissue bed by diffusion for the first 3 to 5 days. Capillary ingrowth into the graft begins during day 3 and is usually complete by day 21. These vessels ingrow from the surrounding soft tissue in the recipient bed and are dependent on the number of vessels present at the time the graft is placed.

As bone graft is not completely revascularized for 14 to 21 days, immunoglobulins and white blood cells have little accessto the graft site, making the graft prone to infection during this period. Grafts placed into a site that contains microrganisms or that become exposed to the oral environment during the first 2 weeks have a high rate of infection, resulting in partial or complete loss.

The growth factor-promoted cellular replication during the first 14-21 days of a graft is vulnerable to shear forces. Disruption of the capillary ingrowth results in death of graft cells, leaving a sterile but nonregenerative graft. Such stability can be obtained in many ways, depending on the location and size of the graft: classic maxillomandibular fixation, titanium plates, titanium mesh, mini or micro screws, reinforced and even nonreinforced membranes, occlusal splints, relieving the occlusion, and temporarily discontinuing dentures among others.

Fig 1 Types of bone densities



Intraoral Bone Characteristics[20]

The quality of bone in the jaws is dependent on location and position within the dental arches and alveolus respectively. The most dense bone is observed in the anterior mandible, followed by anterior maxilla and posterior mandible. The least compact bone is typically found in the posterior maxilla. Misch classified these bone densities into a spectrum of four categories, ranging from D1 through D4. D1 bone primarily consists of a dense cortical structure. D4 on the other hand, is the softest, consisting primarily of cancellous bone with a fine trabecular pattern with minimal crestal cortical anatomy.

Types of Autogenous Bone Graft

Autogenous bone classification (Carranaza1999)	
Bone from intraoral site- Osseous coagulum Bone blend Intraoral cancellous bone marrow transplant Bone swaging	Bone from extraoral sites- Iliac crest Tibia

According to structure- Cortical Bone Graft

Autogenous cortical bone graft, which provides an osteoconductive medium with minimal osteoinductive and osteogenic properties, is best suited for structural defects for which immediate mechanical stability is required for healing. (Finkemeier CG 2002, Gazdag AR *et al*. 1995, Sen MK *et al*. 2007)

Cancellous Bone Graft

Cancellous bone graft is the most commonly used source of autogenous graft6. It provides an osteoinductive, osteoconductive, and osteogenic substrate, and the porous trabeculae are lined with functional osteoblasts, resulting in a graft that is highly osteogenic. (Sen MK *et al*. 2007, Khan SN *et al*.2005). Additionally, the large surface area leads to rapid remodeling and incorporation.

Corticocancellous Bone Graft

Corticocancellous bone grafts intuitively offer the advantages of both cortical and cancellous bone: an osteoconductive medium and immediate structural stability fromcortical bone and the osteoinductive and osteogenic capabilities of cancellous bone.

Armamentarium required for harvesting and grafting

The equipments (figure2) used commonly include Bone mill(2a)(Dennis R. Hunt *et al*. 1999), Trephine drills (2b) (available in sizes 6, 8, 10 mm), Peizo tips(2c)(Ylikontiola LP *et al*.2016), Micro saw (2d), Scrapper(2e) (Christopher Ogunsalu.2011,Zaffe D *et al*. 2007), Bone trap (2f)(George K.B) [30], Ronguers, Stainless steel 1.8-mm-diameter round bur, 2-mm-diameter spiral bur covered with titanium on a low-speed handpiece (1,000 rpm) under continuous irrigation with sterile physiologic solution. Osteotomes are required to lift the bone graft from recipient bed.

The bone scraper and trephine bur would seem to be the most appropriate harvesting instruments for bone regenerative therapies. Both the trephine bur and the bone scraper produced mostly vital fragments of medium and large size.

Hoegel *et al*. 2004 have shown that a higher percentage of viable cells were encountered in unmilled and spongy bone when compared with milled and cortical bone, respectively. (Hoegel *et al*. 2004)Yikontiola *et al* 2016 concluded that peizosurgical harvesting of bone at the anterior iliac crest avoids the trauma and heat generation associated with conventional instrumentation. (Yikontiola *et al* 2016).

Intraoral Autogenous Bone Harvesting- sites andtechniques:

Maxillary tuberosity

It is possible to harvest small amounts of bone from the edentulous maxillary tuberosity, but if the second orthird molars exist, this procedure is difficult. This procedure is useful if additional bone is requiredto “extend” bone volumes in conjunction with other intraoral grafts. For example this may occur with maxillary sinus floor augmentation where it is quite simple to extend the incision and harvest more bonefrom the tuberosity area with drilling and a bone trap or by rongeurs. It is often trimmed (excised) by surgical specialists to remove undercuts and facilitate conventional denture prosthetics.

fig 2a Bone Mill fig 2b Trephine fig2c Peizotips fig 2d Microsaw

fig 2e Bone Scrapper fig 2f The suction trap

Fig 2

In many implant reconstruction cases involving the partial or complete arch, an enlarged maxillary tuberosity is often overlooked as a potential source of autogenous block bone graft. [33]

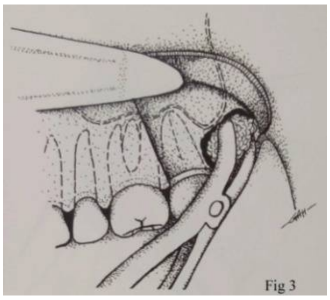


Fig 3

According to Robert and Mark, the maxillary tuberosity contains a limited amount of bone (1 to 3mL) and can be utilized in socket grafting for ridge preservation and for periodontal and peri-implant bony defects, small sinus augmentation procedures. (Robert M *et al.*2010). A midcrestal incision is made beginning in the hamular notch and then carried forward to the second molar, where a crevicular incision to the medial aspect of the second molar extends the access of the reflected mucoperiosteal flap a modest amount for a harvest under direct vision. A rongeur is used to bite off a segment or all of the tuberosity, allowing 2 mm clearance from the maxillary sinus.

Zygomatic Buttress

Fig 4

The zygomatic buttress is a strong bony support that provides pressure absorption in the midfacial skeleton. The zygomatic buttress is accessed by vestibular incision along the buccal aspect from canine to first molar teeth. The mucobuccal flap is reflected in a superolateral direction. The infraorbital nerve is identified and secured. The anterior and lateral aspects of zygomatic buttress are visualized.Four complete osteotomies are made with a small fissure bur: 2 horizontal and 2 vertical. The superior and inferior vertical osteotomies of 10 to 12 mm in length are made in the superoinferior direction at the donor site. The complete osteotomy is made by using a small flat chisel. The zygomatic buttress graft is carefully split from the donor site. After bone harvesting from this area, postoperative trismus as well as injury to the adjacent soft tissues with hemorrhage can occur. Limiting factors are the mucous membrane of the adjacent maxillary sinus and the close relationship to the infraorbital foramen. However, direct visualization of the infraorbital region allows nerve identification and preservation during bone graft harvesting.

The mucous membrane of the adjacent maxillarysinus can be visualized and involved in graft harvesting site. Ideally, the patient should not have any sinus problems. As an additional caution, use of ultrasound-based dissection with piezosurgery might further reduce the danger of perforating the sinus membrane. (Barone A *et al.* 2008, Su YC *et al.*2007, Vercellotti T 2001).

Mandibular Symphysis

It has the form of a semiarc, and can be used as following: onlay (on the edge), inlay (within the cavity), sandwich (inside and outside of the remaining edge, usually in the maxillary sinus) or ground (to fill spaces between blocks or small defects and/or inside the maxillary sinus).There are 2 incision designs for mandibular symphysis harvest. One is sulcular incision and another is vestibular incision. (Fig 5)

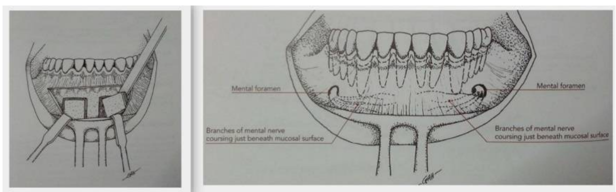


Fig 5

Robert and Mark prefer to position the initial incision through the labial mucosa 1 cm apical to the junction between the attached gingiva and unattached mucosa extending from the posterior aspect of one canine to the other. (Robert M*et al.*2010) The vestibular incision is made through the mentalis muscle and preserves the gingival, periosteal, and mentalis insertion attachments superior to the chin. The incision is closed in 2 layers, thus preventing mentalis or chin ptosis.The vestibular incision is associated with wound dehiscence, scar band formation, more pain, and possible chin ptosis compared with sulcular incision. (Alfaro FH 2006). The vestibular incision causes more bleeding from the mentalis muscle but provides less access than the sulcular incision.

Although sulcular flap has advantage of avoiding the labial branch of the mental nerve and not dissecting through the mentalis muscle, it may result in an apical repositioning of the flap, creating root exposures of the incisor and canine teeth. The oblique releasing incision can be made at a distal line angle of the second lower premolar. For harvesting the graft, the superior osteotomy line should be made at least 5 mm below the root apices. An osteotomy in the mandibular symphyseal region should completely penetrate the labial cortical plate. The access to the chin bone has been described as being easier than that to the mandibular ramus. (Misch CM 1997).

Approximately one third of the patients who undergo chin bone harvesting complain about an altered chin contour that cannot be verified on clinical examination. (Clavero J *et al*. 2003). Cordaro concluded that the yield of the bone graft was enough for bilateral sinus augmentations in all eight cases in his study (Cordaro L 2003).

Fig 6 Three dimensional crestal bone augmentation using bone rings. Immediate implant placement in the anterior maxilla.

Bone ring technique

Three dimensional bone augmentations with immediate dental implant placement can be done using this technique. Using trephine burs corresponding to the extraction socket diameters, bone rings can be harvested from the chin or iliac crest regions. The harvested rings can then be secured to the extraction socket using the dental implants restoring the deficient bone at the crestal portion in a 3D fashion. (Stevens M. R. *et al* 2010).

Mandibular Ramus and Body

Incision for mandibular ramus bone harvesting is made distal to the most posterior tooth and continues up the ascending ramus, stripping off the temporalis muscle; however, a vertical releasing incision is often necessary when thisincision is used. Alternatively, superior starting point of the incision can be made at the level of the maxillary occlusal plane and directly over the palpable external oblique ridge. This will avoid damage to the long buccal artery and nerve in most cases.

Fig 7

The authors Robert and Mark use a tapered fissured bur to make a series of bur holes from posterosuperiorly and stopping 5 mm from the distal root of the third molar to avoid creating a periodontal defect which may cause a healing complication. (Robert M *et al*. 2010). The holes made with the fissured bur are made only through the cortex to outline the desired graft length and thickness. The same bur is then used to connect these holes and to make cortical osteotomies through the external oblique ridge at each end of the graft. These cortical osteotomies should extend through the ramus cortex posterosuperiorly and through the buccal cortex at the anterior extent of the graft. The last osteotomy is made through the lateral ramus cortex posterolaterally to complete a rectangular cortical bone outline. Once the cortical osteotomies are completed, a bibeveledosteotome is inserted at a lingual to buccal angulation and malleted inferiorly and posteriorly (Fig 7). This angulation will ensure that the blade of the osteotome remains against the inner cortical surface of the buccal/lateral cortex to give maximum protection to the inferior alveolar neurovascular bundle.

Postoperative morbidity, mainly temporary paresthesia, differs among the sites used for harvesting: for the chin it ranges from 10% to 50%, (Clavero J *et al*. 2003, Chiapasco M *et al*. 1999), whereas for the mandibular ramus it ranges from 0% to 5%.

Mandibular Coronoid Process

The coronoid process is a membranous bone with a thick cortical region. Choung and Kimreported that the thickness of the coronoid process ranges from 4 to 7 mm. (Choung PH *et al*. 2001). The region 5 mm below the sigmoid notch may be safely used without damage to the inferior alveolar neurovascular bundles. The lateral coronoid process is accessed via a vertical incision over the ascending ramus, beginning at the level of the occlusal surface of the last molar and extending to the midpoint ofthe ramus. The temporalis muscle is completely stripped and dissected from its attachment. The coronoid process is stabilized with bone forceps during cutting with a reciprocating saw or drill.

Fig 8

Kim *et al* reportedits difficulty to harvest under local anesthesia. (Kim YK *et al*. 1999). Furthermore, they observed a risk of temporary temporomandibular joint (TMJ) symptoms postoperatively which can be resolved through conservative management or even without treatment. Cautions include preoperative TMJ evaluation because the dissection and harvesting procedure willtemporarily alter the ipsilateral temporalis muscle function, which may be of concern in patients withTMJ dysfunction.

Mandibular tori

Fig 9

Mandibular tori can be used for alveolar augmentation with cortical bone. Considerable amounts of bone can be harvested from tori with a suction trap (Kainulainen V *et al*. 2003). If a torus is removed as a block it can be particulated with a bone mill or used as a block graft. Mandibular tori are composed of very dense cortical bone and are not ideal for use as block onlay or inlay grafts. The tori are difficult to shape, mortise and fixate to the host bone. Bilateral tori have been used as the donor site in conjunction with dental implant placement (Ganz SD 1997).

Socket grafting

Placement of implants into fresh extraction sockets is not always possible. Bone loss occurs in vertical and horizontal planes, with the horizontal loss exceeding vertical bone loss. As much as 60% of the alveolar width and 40% of the height may be lost in the first 6 months after tooth extraction. (Lin KY *et al*. 1990). Socket grafting has been shown to be superior in bone quantity and quality than extraction alone (Phillips JH *et al* 1990).

Table 1 Comparison of intraoral donor sites. References are used where available.

Intraoral Donor Sites	Size of Block	Volume (mL)	Complications
Symphysis (Montazem A et al. 2000,Misch CM 1997)	20.9 x 9.9 x 6.9 mm^3	4.71	Endodontic problems, mental nerve paresthesia, wound dehiscence
Ascending Ramus (Misch CM 1997, Gungormus M et al. 2000)	37.6 x33.17 x22.48 x9.15 mm^4	2.36	Inferior alveolar nerve paresthesia
Lateral Ramus (Misch CM 1997, Li KK 1996)	1.3 cm x 3 cm^2	-	Inferior alveolar nerve paresthesia
Coronoid Process (Choung PH et al. 2001, Ylikontoila L et al. 2001)	18 x17 x5 mm^3	0.7 ml	Inferior alveolar nerve paresthesia
Zygomatic Buttress (Kainulainen VT et al.)	1.5 x2.0 cm^2	0.5-1.5 ml	Sinus perforation
Maxillary tuberosity (Barone A et al. 2008)	10 x 10 mm^2	0.5 – 1 ml	Sinus perforation
Mandibular, palatinal torus	Dependent on size of torus	Dependent on size of torus	Mucosal dehiscence, lingual nerve paresthesia

Applications

Sinus Augmentation

Various authors reference H Tatum Jr as the first to be performing sinus augmentations in the mid to late 1970´s. (Smiler DG *et al*.1992).Boyne and James were the first to report their 4-year experience with autogenous bone placed into the sinus, which was allowed to heal for 6 months, followed by the placement of blade implants (Boyne PJ *et al* 1980). In this technique, the maxillary sinus floor membrane is elevated through a lateral window.

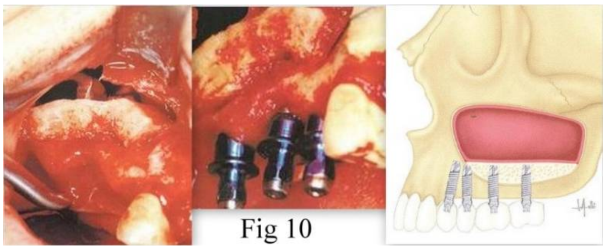


Fig 10

Autogenous bone has been shown to have a better bone regenerative potential in sinus augmentation when compared with bone substitutes. (Moy PK *et al*. 1993). The yield of bone graft from intra-oral donor sites is usually enough to perform a simple augmentation of the maxillary sinus in partially edentulous patients. It has even been stated that the extra-oral bone harvesting may be considered an over-treatment in such cases (Cordaro L 2003).

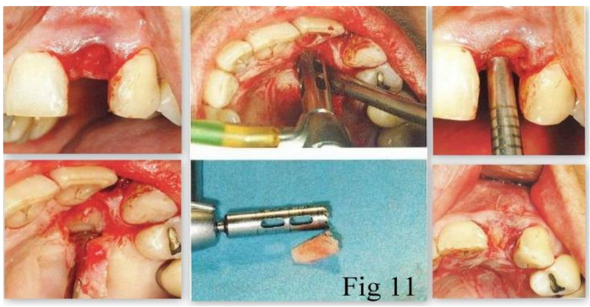


Fig 11

Onlay grafting of the alveolar bone

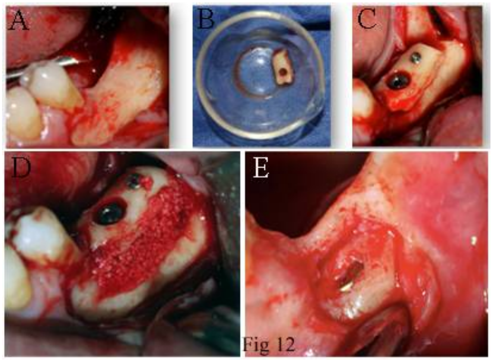


Fig 12

Resorption after tooth-loss occurs in a predictable pattern. Maxillary onlay grafting with mandibular bone grafts have been shown to be a very predictable procedure with minimal graft resorption.(Misch CM 1997, Cordaro L *et al*.2002). The excessive resorption of the intraorally harvested bone grafts has also been reported.

To reduce the amount of onlay graft bone resorption, it is advisable to fix the graft securely in place with osteosynthesis screws. Rigid fixation is the method of choice in all circumstances where onlay bone grafts may be exposed to motion, shear, and torsional forces. (Triplett RG *et al* 1996, Sethi & Kaus 2001, Su YC *et al* 2007, Cordaro L *et al* 2002).

Favourable long term results with mandibular blockgrafts have also been shown.(Misch CM 1997, Vercellotti T *et al*. 2001).

Particle size

Many studies on graft particle size have been reported. Small particles showed more rapid resorption, greater surface area, and enhanced osteogenesis compared with large particles (Thorwarth M, *et al*. 2006, Ullmark G 2000, Cushing M 1969, Marchetti C *et al*. 2007). Studies observed that large chips increase a graft's space-maintaining effect and improve osteoblast attachment, but they may undergo bone sequestration or take a long time to be remodeled (Ullmark G 2000, Berengo M *et al*. 2006). It has been suggested that particulate is superior to bone-block grafting (Marx, R.E. *et al*. 1984, Shirota, T. *et al*. 1996).

Springer 2004 concluded bone chips obtained from trabecular bone provided a higher cell number than those raised from cortical bone (Springer ING *et al*. 2004). Particle sizes ranged from about 100 X 200 μ for bone blend samples to 780 X 1560 μ for material retrieved with hand chisels. Minimum pore size between particles of greater than 100 μ is needed to allow proper vascularization and bone formation (Klawitter, J. J. *et al* 1971, Pederson, K. N *et al*. 1974, Nathanson D *et al*. 1978, Bobyn. J. D. *et al*. 1982).

Healing

The dense cortical matrix results in relatively slow revascularization and incorporation, as resorption must occur before deposition of new bone, and limited perfusion and donor osteocytes make this option poorly osteogenic .(KhanSN *et al* 2005, Bauer TW *et al* 2000). Within the first six months after implantation, these nonvascularized cortical grafts become progressively weaker, secondary to resorption, but regain structural strength within twelve months (FinkemeierCG 2002, Gazdag AR *et al*. 1995, Dell PC *et al*. 1985).In cancellous autografts the vascular response is much greater than in cortical grafts. After implantation, a portion of the donor osteocytes survives, and these osteocytes, combined with graft porosity and local cytokines, promote angiogenesis and host mesenchymal stem-cell recruitment. These recruited mesenchymal stem cells have the potential to differentiate into osteoblasts (Khan SN *et al*. 2005, Cypher TJ *et al*. 1996). Thus, the graft may be fully vascularized within two days (Ebraheim NA *et al*. 2001, Mendicino RW *et al*. 1996). New bone formation is observed within a few weeks and typically is remodeled by eight weeks, with complete graft turnover by one year (Kakar S *et al*. 2006, Bauer TW *et al*. 2000). This turnover occurs by the process of creeping substitution, defined as concomitant osteoblast deposition of new osteoid and osteoclast resorption of necrotic donor trabeculae (Kakar S *et al*. 2006, Cypher TJ *et al*. 1996). This graft material offers rapid incorporation but no immediate structural stability.

It remains controversial whether cortical or spongy bone is the material of choice (Girdler NM *et al*. 1992, Schwipper V *et al* 1997, Chen NT *et al*. 1994).

It has been proposed that cancellous bone has an increased vascularity and rate of resorption than cortical bone transplant (Chen NT *et al*. 1994).

Future trends

A recent trend is toward minimally invasive surgical procedures to reduce complications, decrease discomfort, and facilitate faster recovery. Reduced-diameter or shorter implants may be utilized when minimal available bone volume is present, thus eliminating bone grafting (Cullum DR *et al*. 2016). In the atrophic maxilla, tilted implants or zygomatic implants can be used to avoid the maxillary sinus (Bedrossian E *et al*. 2006, Stellingsma K *et al*. 2014, Krekmanov L *et al*. 2000).As long as biomechanical support is not compromised, fewer implants may also be considered for a fixed prosthesis (4 to 6 versus 8 to 10) (Gallucci GO *et al*. 2016). The introduction of cone-beam computed tomography to the dental office has been integral to this minimally invasive trend. The ability to more accurately diagnose available bone and visualize anatomy enables the clinician to manage cases with marginal conditions. It also permits the use of computer-guided surgery with a flapless approach to further decrease morbidity. De Stavola *et al* 2015 in a case report demonstrated the feasibility of performing mandibular bone harvesting with a computer guided approach (De Stavola L *et al*. 2015).

Tissue engineering may be used to regenerate bone by combining cells from the body with growth factors and scaffold biomaterials. Another promising technique for growth factor delivery is the application of gene therapy (Caplan A 2000). Genetic material is transferred into the genome of the target cells, causing them to produce a functional protein, such as BMP, at physiologic amounts and timelines. Research is ongoing to develop biodegradable scaffolds that maintain space, allow vascular in growth, and promote cell adhesion (Dimitriou R *et al* 2011). In the future, custommaderesorbable scaffolds will routinely be fabricated using 3-dimensional printers adhesion (Dimitriou R *et al* 2011). Recently, additive manufacturing techniques, such as 3D printing, selective laser sintering, and stereolithography are being applied to tissue regeneration to fabricate scaffolds with intended macrostructures and microstructures (Mota C *et al*. 2015, Giannitelli SM *et al*. 2015). The printed porous scaffold may then be seeded with osteoblasts or mesenchymal stem cells. Mesenchymal stem cells from bone marrow, adipose tissue, and cryopreserved umbilical cord blood have shown the ability to form new bone tissue (Bhumiratana S, *et al*. 2012). In vitro cultural expansion can further generate a larger number of progenitor cells (Dimitriou R *et al*. 2011). With 3D printing, there is the potential to obtain autografts without harvesting them from a donor site. Clinicians will need to weigh the higher costs of newer tissue engineering techniques against the benefits of simplified surgery, enhanced biologic response, and potential for reduced morbidity.

CONCLUSION

Autogenous bone grafting offers a well-proven predictable method for ridge augmentation and defect repair for dental implant placement. There are several advantages to using autogenous bone grafts (Misch CM. 2011). Autogenous block bone grafts have a shorter healing period (usually only 4 months of healing before implants may be inserted) than other approaches such as guided bone regeneration using bone substitutes. The cost of autogenous bone is obviously much less than using bone substitutes, membranes, and/or recombinant growth factors. Block bone grafts may be preferred to osteotomy techniques (ridge splitting, interpositional grafts) because they can 3-dimensionally reconstruct the lost anatomic ridge contour. Each donor site has its own inherent problems and potential complications. Therefore, the discomfort experienced from different donor sites is difficult to compare. Intraoral bone grafts are primarily cortical and used for veneer grafting narrow ridges or modest vertical augmentation.

What clearly distinguishes autogenous bone grafts from any other grafts is the presence of viable cells. With adequate training and experience, bone graft harvest from distant sites has a very low incidence of complications. A thorough understanding of the relevant anatomy, various harvest techniques, and potential morbidity associated with each harvest site will aid the surgeon in selecting the optimal bone graft source.

References

Adell R, Lekholm U, Grondahl K, Branemark PI, Lindstrom J &Jacobsson M (1990) Reconstruction of severely resorbed edentulous maxillae using osseointegrated fixtures in immediate autogenous bone grafts. *Int J Oral Maxillofac Implants* 5: 233-246

Alfaro FH, editor. (2006) Bone grafting in oral implantology: techniques and clinical applications. 1st edition. Barcelona, Spain: Quintessence Publishing. p. 1-234.

Barone A, Santini S, Marconcini S, *et al*. (2008) Osteotomy and membrane elevation during the maxillary sinus augmentation procedure. A comparative study: piezoelectric device vs. conventional rotative instruments. *Clin Oral Implants Res* 19(5):511-5.

Bauer TW, Muschler GF. (2000) Bone graft materials. An overview of the basic science. *ClinOrthopRelat Res.* 371:10-27.

Bedrossian E, Rangert B, Stumpel L, Indresano T. (2006) Immediate function with the zygomatic implant: a graftless solution for the patient with mild to advanced atrophy of the maxilla. *Int J Oral Maxillofac Implants.* 21(6):937-942.

Bhumiratana S, Vunjak-Novakovic G. (2012) Concise review: personalized human bone grafts for reconstructing head and face. *Stem CellsTransl Med.* 1(1):64-69.

Bobyn. J. D., Wilson, G. J„ MacGregor, D. C, *et al*. (1982) Effect of pore size on the peel strength of attachment of fibrous tissue to porous-surfaced implants. *J Biomed Mater* Res 16: 571

Boyne PJ & James RA (1980) Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg* 38: 613-616.

Breine U &Branemark PI.(1980) Reconstruction of alveolar jaw bone. An experimental and clinical study of immediate and preformed autologous bone grafts in combination with osseointegrated implants. *Scand J PlastReconstrSurg* 14: 23-48.

Bunger M.H., Langdahl, B.L., Andersen, T., Husted, L., Lind, M., Eriksen, E.F. & Bunger, C.E. (2003) Semiquantitative mRNA measurements of osteoinductive growth factors in human iliac-crest bone: expression of LMP splice variants in human bone. *Calcified-Tissue-International* 73: 446-454

Caplan A. Mesenchymal stem cells and gene therapy. (2000) *ClinOrthopRelat Res.* 379 Suppl:S67-S70.

Carranaza FA, Newman MG. Reconstructive Osseous Surgery. In: Clinical Periodontology. Philadelphia, USA: WB Saunders Company; 1999; 8:622-39.

Chen NT, Glowacki J, Bucky LP, Hong HZ, Kim WK, Yaremchuk MJ.1994PlastReconstr Surg. The roles of revascularization and resorption on endurance of craniofacial onlay bone grafts in the rabbit. Apr; 93(4):714-22; discussion 723-4

Chiapasco M, Abati S, Romeo E, *et al*. Clinical outcome of autogenous bone blocks or guided bone regeneration with e-PTFE membranes for the reconstruction of narrow edentulous ridges. *Clin Oral Implants Res* 1999; 10(4):278-88.

Choung PH, Kim SG. The coronoid process for paranasal augmentation in the correction of midfacial concavity. *Oral Surg Oral Med Oral Pathol Oral RadiolEndod* 2001; 91(1):28-33.

Christopher Ogunsalu. (2011) Chapter 6 Bone Substitutes and Validation. Implant-dentistry-the-mostpromising-discipline-of-dentistry Edited Volum. InTech, DOI: 10.5772/964

Clavero J, Lundgren S. (2003) Ramus or chin grafts for maxillary sinus inlay and local onlay augmentation: comparison of donor site morbidity and complications. *Clin Implant Dent Relat Res* 5:154-160.

Cordaro L, Amade DS &Cordaro M (2002) Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement. *Clin Oral Implants Res* 13: 103-111.

Cordaro L (2003) Bilateral augmentation of the maxillary sinus floor with particulated mandible. Report of a technique and preliminary results. *Clin Oral Implants Res* 14: 201-206.

Cullum DR, Deporter D. *Minimally Invasive Dental Implant Surgery.*1st ed. Hoboken, NJ: Wiley Blackwell; 2016.

Cushing M. (1969) Autogenous red marrow grafts: Their potential for induction of osteogenesis. *J Periodontol* 40:492-497.

Cypher TJ, Grossman JP. 1996. Biological principles of bone graft healing. *J Foot Ankle Surg.*, 35:413-7.

De Stavola L, Fincato A, Albiero AM. 2015. A computer-guided bone block harvesting procedure: a proof-of-principle case report and technical notes.. *Int J Oral Maxillofac Implants,* 30:1409-1413. doi: 10.11607/jomi.4045

Dennis R. Hunt, Sascha A. Jovanovic. 1999. Autogenous Bone Harvesting: A Chin Graft Technique for Particulate and Monocortical Bone Blocks. *Int J Periodontics Restorative Dent*, 19:105-173

Dell PC, Burchardt H, Glowczewskie FP Jr. 1985. A roentgenographic, biomechanical, and histological evaluation of vascularized and non-vascularized segmental fibular canine autografts. *J Bone Joint Surg Am.*, 67:105-12.

Dimitriou R, Jones E, McGonagle D, Giannoudis PV. 2011. Bone regeneration: current concepts and future directions, *BMC Med.*, 9:66.

Ebraheim NA, Elgafy H, Xu R. 2001. Bone-graft harvesting from iliac and fibular donor sites: techniques and complications. *J Am AcadOrthop Surg*., 9:210-8.

Finkemeier CG. 2002. Bone-grafting and bone-graft substitutes. *J Bone Joint Surg Am.*, 84:454-64.

Gallucci GO, Avrampou M, Taylor JC, *et al*. 2016. Maxillary implantsupported fixed prosthesis: a survey of reviews and key variables for treatment planning. *Int J Oral Maxillofac Implants.*, 31 suppl:192-197.

Ganz SD (1997) Mandibular tori as a source for onlay bone graft augmentation: a surgical procedure. *Pract Periodontics Aesthet Dent* 9: 973-982.

Gazdag AR, Lane JM, Glaser D, Forster RA. 1995. Alternatives to autogenous bone graft: efficacy and indications. *J Am AcadOrthop Surg.*, 3:1-8.

George K.B. Sándor, David K. Lam, Leena P. Ylikontiola, Vesa T. Kainulainen, Kyösti S. Oikarinen, and Cameron M.L. Clokie. 2010. Chapter 23 Autogenous Bone Harvesting Techniques. Book- Oral and Maxillofacial Surgery edited by Lars Anderson, Karl-Erik Kahnberg, M. Anthony Pogrel

Giannitelli SM, Mozetic P, Trombetta M and Rainer A. 2015. Combined additive manufacturing approaches in tissue engineering. *Acta Biomater.* Sep;24, 1, 2015. Epub 2015 Jun 30.

Girdler NM & Hosseini M (1992) Orbital floor reconstruction with autogenous bone harvested from the mandibular lingual cortex. *Br J Oral MaxillofacSurg* 30:36-38.

Gungormus M, Yavuz MS. 2002. The ascending ramus of the mandible as a donor site in maxillofacial bone grafting. *J Oral MaxillofacSurg*, 60(11):1316-8.

Hany A. Emam and Mark R. Stevens.Chapter 23 Concepts in Bone Reconstruction for Implant Rehabilitation .A Textbook of Advanced Oral and Maxillofacial Surgery Edited Volume page 618 InTech. DOI: 10.5772/3316

Hoegel, F., Mueller, C. A., Peter, R., Pfister, U. &Suedkamp, N. P. (2004) Bone debris: dead matter or vital osteoblasts. *Journal of Trauma* 56, 363-367

Hu Z.M., Peel, S.A., Sandor, G.K. &Clokie, C.M. (2004) Theosteoinductive activity of bone morphogenetic protein (BMP) purified by repeated extracts of bovine bone. *Growth Factors* 22: 29-33.

Jensen J &Sindet-Pedersen S (1991) Autogenous mandibular bone grafts and osseointegrated implants for reconstruction of the severely atrophied maxilla. *J Oral MaxillofacSurg* 49: 1277-1287.

Jensen J, Sindet-Pedersen S & Oliver AJ (1994) Varying treatment strategies for reconstruction of maxillary atrophy with implants: results in 98 patients. *J Oral MaxillofacSurg* 52: 210-216.

Kahnberg KE, Nystrom E &Bartholdsson L (1989) Combined use of bone grafts and Branemark fixtures in the treatment of severely resorbed maxillae. *Int J Oral Maxillofac Implants* 4: 297- 304.

Kakar S, Tsiridis E, Einhorn T. 2006. Bone grafting and enhancement of fracture repair. In: Bucholz RW, Heckman JD, Court-Brown C, Tornetta P, Koval KJ, Wirth MA, editors. Rockwood and Green's fractures in adults.6th ed. Vol 1. Philadelphia: Lippincott Williams and Wilkins p 313-31.

Kainulainen V, Sàndor G, Oikarinen K &Clokie C (2003a) Useful intra-oral bone harvesting sites for osseous reconstruction in oral and maxillofacial surgery. *Oral Health*, May: 10-24.

Kainulainen VT, Sandor GKB, Clokie CML, Keller A, Oikarinen KS. Bone Harvesting from zygomatic bone and mandible for maxillofacial reconstruction- A quantitative anatomic study. Unpublished.

Khan SN, Cammisa FP Jr, Sandhu HS, Diwan AD, Girardi FP, Lane JM. 2005. The biology of bone grafting. J *Am AcadOrthop Surg.*, 13:77-86.

Kim YK, Kim HT, Yeo HH.2006. Use of a variety of facial bone grafts in oral and maxillofacial surgery. *J Korean Dent Assoc* 1999; 37:221-227.

Klawitter, J. J., and Hulbert, S. F. 1971.Application of porous ceramics for the attachment of load bearing internal orthopedic applications. *J Biomed Mater Res Sympos*. No. 2, (Part I), 161

Krekmanov L, Kahn M, Rangert B, Lindstrom H. 2000. Tilting of posterior mandibular and maxillary implants for improved prosthesis support. *Int J Oral Maxillofac Implants.* 15(3):405-414.

Len Tolstunov (2009) Maxillary Tuberosity Block Bone Graft: Innovative Technique and Case Report. *J Oral MaxillofacSurg* 67:1723-1729.

Li KK, Schwartz HC. 1996. Mandibular body bone in facial plastic and reconstructive surgery. *Laryngoscope*, 106(4):504-6.

Lin KY, Bartlett SP, Yaremchuk MJ, Fallon M, Grossman RF & Whitaker LA (1990) The effect of rigid fixation on the survival of onlay bone grafts: an experimental study. *PlastReconstrSurg* 86: 449-456.

Marchetti C, Pieri F, Trasarti S, Corinaldesi G, Degidi M. 2007. Impact of implant surface and grafting protocol on clinical outcomes of endosseous implants. *Int J Oral MaxillofacImplants*, 22:399-407.

Marx, R.E., Miller, R.I., Ehler, W.J., Hubbard, G. &Malinin, T.I. (1984) A comparison of particulate allogeneic and particulate autogenous bone grafts into maxillary alveolar clefts in dogs. *Journal of Oral and Maxillofacial Surgery* 42: 3-9.

Mendicino RW, Leonheart E, Shromoff P. 1996. Techniques for harvesting autogenous bone graft of the lower extremity. *J Foot Ankle Surg.*, 35:428-35.

Misch CM (1997) Comparison of intraoral donor sites for onlay grafting prior to implant placement. *Int J Oral Maxillofac Implants* 12: 767-776.

Misch CM, Misch CE, Resnik R & Ismail YH (1992) Reconstruction of maxillary alveolar defects with mandibular symphysis grafts for dental implants: A preliminary procedural report. *Int J Oral Maxillofac Implants* 7: 360-366.

Misch CM (1996) Ridge augmentation using mandibular ramus bone grafts for the placement of dental implants: presentation of a technique. *Pract Periodontics Aesthet Dent* 8:127-135.

Misch CM &Misch CE (1999) Intraoral autogenous donor bone grafts for implant dentistry. 497-508. In: Misch CE. Contemporary implant dentistry 2nd edition. St Louis, Missouri. Mosby.

Misch CM. 2011. Autogenous bone grafting for dental implants Chapter 24, 2nd edition. p344-70

Montazem A, Valauri D, St-Hilaire H, Buchbinder D. 2000. The mandibular symphysis as donor site in maxillofacial bone grafting: a quantitative anatomic study. *J Oral MaxillofacSurg*, 58: 1368-1371.

Mota C, Puppi D, Chiellini F and Chiellini E. 2015. Additive manufacturing techniques for the production of tissue engineering constructs. *J Tissue Eng Regen Med.* Mar;9(3), 174. Epub 2012 Nov 22.

Moy PK, Lundgren S & Holmes RE (1993) Maxillary sinus augmentation: histomorphometric analysis of graft materials for maxillary sinus floor augmentation. *J Oral MaxillofacSurg* 51:857-862.

Nabers CL, O'leary TJ. 1965. Autogenous bone transplants in the treatment of osseous defects. *J Periodontol*, 36:5-14.

Pederson, K. N., Haanaes. H. R., and Lyng, S. 1974. Tissue ingrowth into mandibular intrabony porous ceramic implants. *Ini J Oral Surgi*: 158.

Phillips JH &Rahn BA (1990) Fixation effects on membranous and endochondral onlay bone graft revascularization and bone deposition. *PlastReconstrSurg* 85: 891-897.

Robert M, Marx S (2010) Atlas of oral and extraoral bone harvesting. Quintessence, UK

Sailer HF (1989) A new method of inserting endosseous implants in totally atrophic maxillae. *J CraniomaxillofacSurg* 17: 299-305.

Schwipper V, von Wild K, Tilkorn H (1997) Reconstruction of frontal bone, periorbital and calvarial defects with autogenic bone. Mund Kiefer Gesichtschir 1 (suppl 1): S71-74

Sen MK, Miclau T. 2007. Autologous iliac crest bone graft: should it still be the gold standard for treating nonunions? *Injury*., 38:S75-80.

Sethi&Kaus. 2001. Ridge augmentation using mandibular block bone grafts: preliminary results of an ongoing prospective study. *Int J Oral Maxillofac Implants* 16: 378-388.

Shirota, T., Ohno, K., Motohashi, M. &Michi, K. (1996) Histologic and microradiologic comparison of block and particulate cancellous bone and marrow grafts in reconstructed mandibles being considered for dental implant placement. *Journal of Oral and Maxillofacial Surgery* 54: 15-20.

Sindet-Pedersen S &Enemark H (1988) Mandibular bone grafts for reconstruction of alveolar clefts. *J Oral MaxillofacSurg* 46: 533-537

Smiler DG, Johnson PW, Lozada JL, Misch C, Rosenlicht JL, Tatum OH Jr & Wagner JR (1992) Sinus lift grafts and endosseous implants. Treatment of the atrophic posterior maxilla. *Dent Clin North Am* 36: 151-186.

Springer ING, Terheyden H, Geiß S, Ha¨rle F, Hedderich J, Ac¸il Y. 2004. Particulated bone grafts - effectiveness of bone cell supply. *Clin.Oral Impl. Res*. 15, 205-212

Stellingsma K, Raghoebar GM, Visser A, *et al*. 2014. The extremely resorbed mandible, 10-year results of a randomized controlled trial on 3 treatment strategies. *Clin Oral Implants Res.*, 25(8):926-932.

Stevens, M. R, *et al*. 2010. Implant bone rings. One-stage three-dimensional bone transplant technique: a case report. J Oral Implantol, Vol. XXXVI;No. One:69-74

Su YC. 2007. [Development and clinical application of ultrasonic osteotomy in dentistry]. Shanghai Kou Qiang Yi Xue 16(1):1-7 [in Chinese].

ten Bruggenkate CM, Kraaijenhagen HA, van der Kwast WA, Krekeler G &Oosterbeek HS (1992)Autogenous maxillary bone grafts in conjunction with placement of I.T.I. endosseous implants. A preliminary report. *Int J Oral MaxillofacSurg* 21: 81-84.

Thorwarth M, Schlegel KA, Wehrhan F, Srour S, Schultze-Mosgau S. 2006. Acceleration of de novo bone formation following application of autogenous bone to particulatedanorganic bovine material in vivo. *Oral Surg Oral Med Oral Pathol Oral RadiolEndod* 101: 309-316.

Triplett RG &Schow SR (1996) Autologous bone grafts and endosseus implants: Complementary techniques. *J Oral MaxillofacSurg* 54: 486-494.

Ullmark G. 2000. Bigger size and defatting of bone chips will increase cup stability. *Arch Orthop Trauma Surg*, 120:445-447.

Vercellotti T, De Paoli S, Nevins M. 2001. The piezoelectric bony window osteotomy and sinus membrane elevation: introduction of a new technique for simplification of the sinus augmentation procedure. *Int J Periodontics Restorative Dent*, 21(6):561-7.

Ylikontiola LP, Lehtonen V, Sándor GK. 2016. Piezo harvesting of bone grafts from the anterior iliac crest: A technical note. *Ann MaxillofacSurg*, 6:94-6.

Ylikontoila L, Huumonen S, Soikkonen K, Oikarinen K. 2001. Comparison of three radiographic methods to locate the mandibular canal.Conference of the Kuwait Ass Dent Res Abstract 14.

Zaffe D, D'Avenia F. 2007. A novel bone scraper for intraoral harvesting: a device for filling small bone defects. *Clin. Oral Impl. Res*. 18, 525-533 doi: 10.1111/j.1600-0501.2007.01368.x

How to cite this article:

Tanvi Shah *et al* (2017) 'Autogenous Bone Harvesting and Grafting: Intraoral Sites and Techniques', *International Journal of Current Advanced Research*, 06(07), pp. 4811-4819. DOI: http://dx.doi.org/10.24327/ijcar.2017.4819.0589

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