

Mandibular Block Autografts for Alveolar Ridge Augmentation

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Reconstruction of alveolar ridge deficiencies requires bone augmentation before implant placement. Osseous defects occur as a result of trauma, prolonged edentulism, congenital anomalies, periodontal disease, and infection, and they often require hard and soft tissue reconstruction. Autogenous bone grafts have been used for many years for ridge augmentation and are still considered the gold standard for jaw reconstruction. The use of autogenous bone grafts with osseointegrated implants originally was discussed by Brånemark and colleagues, who often used the iliac crest as the donor site. Other external donor sites include calvarium, rib, and tibia. For repair of most localized alveolar defects, however, block bone grafts from the symphysis and ramus buccal shelf offer advantages over iliac crest grafts, including close proximity of donor and recipient sites, convenient surgical access, decreased donor site morbidity, and decreased cost.

This article reviews indications, limitations, presurgical evaluation, surgical protocol, and complications associated with mandibular block autografts harvested from the symphysis and ramus buccal shelf for alveolar ridge augmentation. The author draws from 14 years of experience with more than 500 mandibular block autografts.

Indications

Block bone grafts harvested from the symphysis can be used for predictable bone augmentation up to 6 mm in horizontal and vertical dimensions. The range of this cortical cancellous graft thickness is 3 to 11 mm, with most sites providing 5 to 8 mm (Figs. 1 and 2). The density of the grafts is D-1 or D-2, and up to a three-tooth edentulous site can be grafted (Box 1; Table 1).

In contrast, the ramus buccal shelf provides only cortical bone with a range of 2 to 4.5 mm (with most sites providing 3–4 mm) (Figs. 1 and 2). This site is used for horizontal or vertical augmentation of 3 to 4 mm. One ramus buccal shelf can provide adequate bone volume for up to a three- and even four-tooth segment. Bone density is D-1 with minimal, if any, marrow available. Some sites require extensive bone graft volume, which necessitates simultaneous bilateral ramus buccal shelf and symphysis graft harvest. For graft volume of more than 6 to 7 mm thickness, a secondary block graft can be used after appropriate healing of the initial graft (Box 2; Table 1).

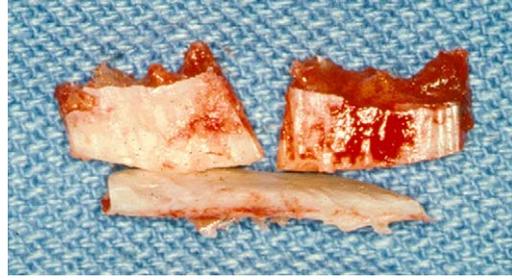


Fig. 1. Symphysis and ramus buccal shelf block grafts harvested from same mandible. Note relative greater cortical thickness of the symphysis grafts.

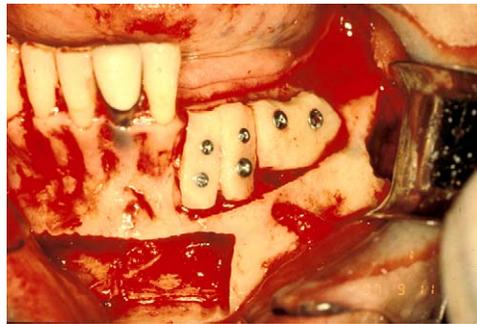


Fig. 2. Fixation of symphysis and ramus block grafts. The two anterior vertical blocks are from the symphysis; the posterior block is from the ramus buccal shelf. Note donor sites.

Presurgical considerations

The recipient site must be evaluated for hard and soft tissue deficiencies, aesthetic concerns, and overall health of the adjacent teeth. Some cases require soft tissue procedures to be performed before or simultaneously with block grafting and in conjunction with implant placement or stage II surgery. These cases include use of connective tissue grafts, palatal epithelial grafts, and human dermis. Conventional radiographs are obtained and include periapical, occlusal, panoramic, and lateral cephalometric views. CT is also used for many cases. Mounted models are used to evaluate interocclusal relationships and ridge shape, and they provide valuable information for implant placement. A diagnostic wax model of the simulated reconstructed ridge and dentition is a useful guide in obtaining presurgical information concerning graft size and shape along with evaluating the occlusion. It also provides a base for template fabrication.

Principles for predictable block bone grafting

Recipient site: soft and hard tissue considerations

Incision design at the recipient site for block grafting varies depending on location within the arches. Maxillary anterior sites require a midcrestal incision that continues in the sulcus for a full tooth on either side of the defect. Bilateral oblique release incisions are made approximately one tooth removed, and a full-thickness mucoperiosteal flap is reflected (Fig. 3).

Box 1. Symphysis block graft: indications

- Horizontal augmentation 4–7 mm (up to three-tooth defect)
- Vertical augmentation 4–6 mm (up to three-tooth defect)

Table 1

	Range block graft thickness	Average block graft thickness obtained	Graft type	Bone density
Symphysis	3–11 mm	4–8 mm	Cortical—dense marrow	D-1, D-2
Ramus buccal shelf	2–4.5 mm	3–4 mm	Cortical only	D-1

I do not recommend papilla-sparing release incisions because they overlie the interface of recipient and donor bone and can result in wound dehiscence. The mandibular anterior site is handled in the same manner with care to avoid injury to the mental neurovascular bundle.

Maxillary posterior sites also require a midcrestal incision that continues in the sulcus one tooth anterior to the defect with an oblique release incision. A posterior oblique release incision is made at the base of the tuberosity and it extends apically to the zygomatic buttress, which allows for complete mucoperiosteal flap reflection and relaxation in an anterior and crestal direction (Figs. 4–8).

Mandibular posterior edentulous sites require a midcrestal and sulcular incision continued to the first bicuspid or canine tooth with an anterior oblique release incision to allow for complete visualization of the mental neurovascular bundle. The incision continues posteriorly up the ascending ramus and can be released obliquely into the buccinator muscle (Fig. 9). If the defect is between teeth, the incision continues in the sulcus of the posterior tooth and then distally. In both cases, the incision is made in the lingual sulcus for three to four teeth anteriorly, which allows for lingual flap reflection via mylohyoid muscle stripping (Figs. 10 and 11).

Recipient site preparation is critical for predictable incorporation of block grafts and includes decortication and perforation into underlying marrow. This preparation provides access for trabecular bone blood vessels to the graft and accelerates revascularization. Surgical trauma created also allows for the regional acceleratory phenomenon to occur, which results in tissue healing two to ten times faster than normal physiologic healing. There is also massive platelet release along with associated growth factors and osteogenic cells. Finally, graft union to the underlying host bone is accomplished more readily, which allows for intimate contact to facilitate graft incorporation.

The addition of platelet-rich plasma to the recipient site after decortication and perforation allows for growth factors to accelerate wound healing by stimulating angiogenesis and mitogenesis (see Fig. 7; Fig. 12). Platelet-rich plasma studies have revealed at least three important growth factors in the alpha granules of platelets: platelet-derived growth factor, transforming growth factor- β_1 , and transforming growth factor- β_2 . These growth factors have been shown to act on receptor sites of cancellous bone. Platelet-derived growth factor is considered one of the primary healing hormones in any wound and is found in great abundance within platelets. These growth factors enhance bone formation by increasing the rate of stem cell proliferation and inhibiting osteoclast formation, which decreases bone resorption. Bone and platelets contain approximately 100 times more transforming growth factor- β than do any other tissues. Although addition of platelet-rich plasma to the block bone graft protocol has resulted in greater bone incorporation, the stage I surgery time table has not changed. The soft tissue effects of accelerated wound healing are especially advantageous because patients typically exhibit less pain, swelling, and ecchymosis.

For horizontal defects, decortication creates an outline for close graft approximation. Bone burnishing with a large round fissure bur (Brasseler, H71052) from crest of ridge to approximately 4 to 5 mm apically is done initially. Decortication continues apically with a 702L straight fissure bur in a more aggressive fashion to create extra walls to the defect in the form of a rectangular inlay preparation (Figs. 13–15). The site is perforated with a 0.8-mm bur

Box 2. Ramus buccal shelf block graft: indications

- Horizontal augmentation 3–4 mm (up to four-tooth defect)
- Vertical augmentation 3–4 mm (up to four-tooth defect)



Fig. 3. Anterior maxillary recipient site incision design. Note distal oblique release incisions.

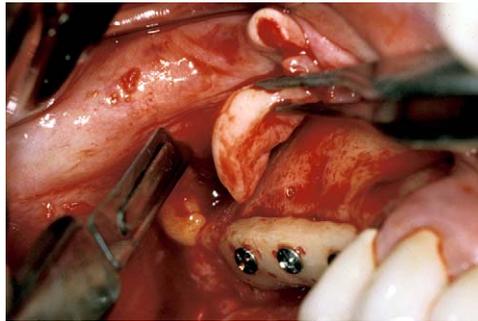


Fig. 4. Posterior oblique release incision made at base of tuberosity. Forceps is grasping anterior aspect of the flap.

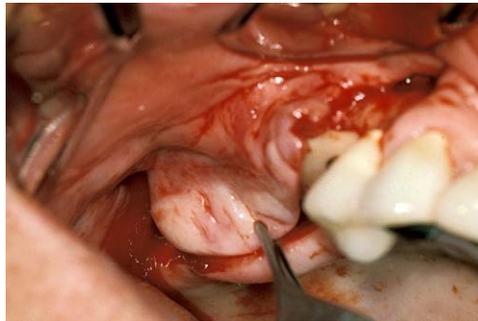


Fig. 5. Note complete relaxation of the buccal flap secondary to periosteal release and oblique release incisions. This flap will be repositioned anteriorly and inferiorly for tension-free closure.



Fig. 6. Fixation of block graft with particulate graft overlay.



Fig. 7. Collagen membrane impregnated with platelet-rich plasma. This fast resorbing membrane acts as a carrier for the platelet-rich plasma.



Fig. 8. Tension-free wound closure.



Fig. 9. Incision design for posterior mandibular recipient site. Anterior oblique release incision is made anterior to the mental neurovascular bundle. Distal aspect of the incision continues to the ascending ramus with oblique release incision into the buccinator muscle.

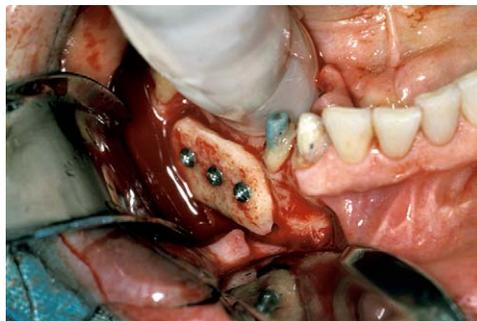


Fig. 10. Stripping of the mylohyoid muscle via finger dissection for lingual flap release. Note that lingual incision continues in the sulcus for three to four teeth to prevent flap tearing.

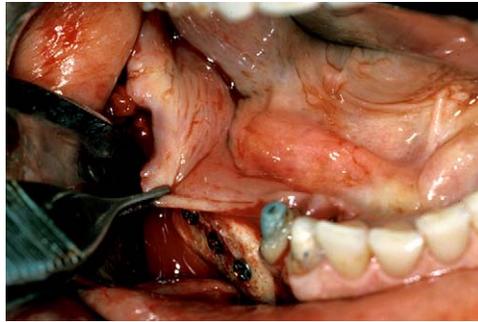


Fig. 11. Complete relaxation of the lingual flap allows for approximately 6 to 8 mm of lingual flap coverage over the block graft.



Fig. 12. Collagen membrane impregnated with platelet-rich plasma placed over the graft site.

to penetrate underlying marrow (Fig. 16). Next, platelet-rich plasma is applied to the recipient site and the block is morticed into position and fixated with two 1.6-mm diameter, low-profile head, self-tapping titanium screws (Fig. 17). Two screws are placed to prevent microrotation of the graft, which can result in compromised healing, including resorption and even graft nonunion. Site preparation for vertical augmentation requires only crestal bone burnishing to create bone bleeders followed by perforations into marrow (Fig. 18). A small vertical step is made approximately 2 mm adjacent to the tooth next to the site to allow for a butt joint to form with the end of the block graft. The block can be stored in normal saline or D₅W before contouring. The H71052 round fissure bur is used to smooth any sharp edges before fixation (Figs. 19–21). Horizontal augmentation in the maxilla using either donor site requires 4 months of healing time before implant placement. An additional month is required for horizontal augmentation in the mandible and for vertical augmentation in the maxilla and mandible (Box 3).

After graft fixation, autogenous marrow or particulate allograft can be morticed into any crevices between block graft and recipient bone. If a large amount of particulate graft is used, a collagen membrane is then placed and secured with titanium tacks. Otherwise, no membrane is necessary for predictable block grafting. Before particulate grafting, however, the overlying flap

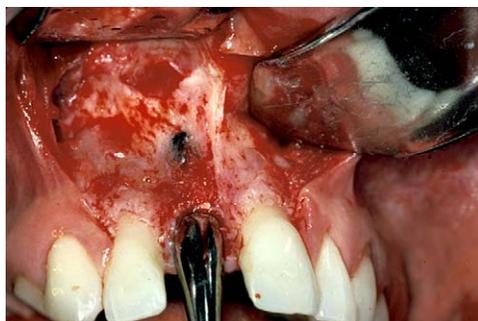


Fig. 13. Anterior maxillary recipient site exposed to reveal horizontal alveolar ridge defect.

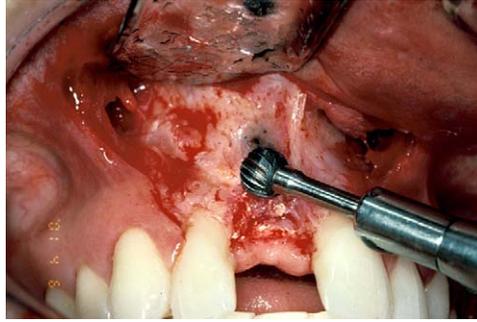


Fig. 14. Decortication begins with large round fissure bur.

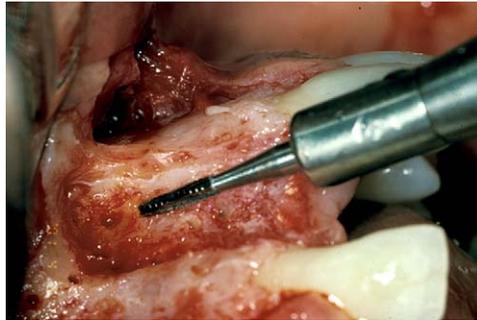


Fig. 15. Decortication continues with use of 702L straight fissure bur in a more aggressive mode at the apical half of the recipient site. Note rectangulation of the defect.

must be made passive to allow for tension-free closure. This procedure is accomplished in all areas by scoring periosteum and using blunt dissection into muscle for complete flap relaxation (Figs. 22–24). In the posterior mandible, it is highly recommended that lingual flap release be obtained by detaching the mylohyoid muscle with sharp and blunt dissection (see Fig. 10), which results in up to a 6- to 8-mm gain of flap relaxation (see Fig. 11). Along with buccal flap manipulation, lingual flap release creates posterior mandibular soft tissue closure in a predictable manner and virtually eliminates incision line opening. Before flap approximation for closure, the entire graft site is immersed in platelet-rich plasma (see Fig. 12). Closure is accomplished using 4-0 Vicryl for the crestal incision and 4-0 and 5-0 chromic for the release incision.

Donor site

Symphysis harvest

Two primary incision designs can be used for harvesting block bone from the symphysis. I prefer a sulcular incision as opposed to the more conventional vestibular approach. This

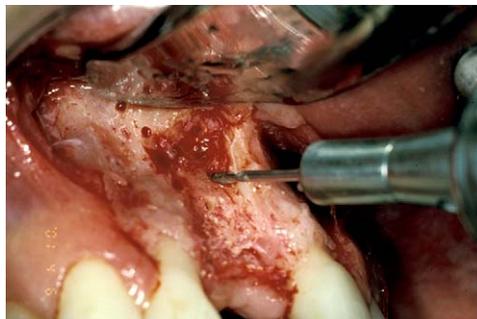


Fig. 16. Perforation of the recipient bed with 0.8-mm diameter bur.

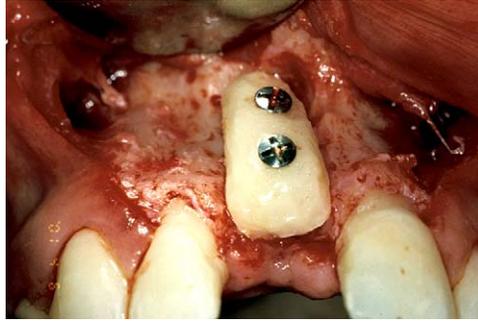


Fig. 17. Note two-point block graft fixation to prevent microrotation.



Fig. 18. Posterior maxillary recipient site preparation for vertical augmentation. Crestal burnishing and perforation is completed.

incision can be used safely if the periodontium is healthy and no crowns are present in the anterior dentition that could present aesthetic problems with associated gingival recession. A highly scalloped thin gingival biotype also is contraindicated. The incision begins in the sulcus from second bicuspid to second bicuspid. An oblique releasing incision is made at the distal buccal line angle of these teeth and continues into the depth of the buccal vestibule. A full-thickness mucoperiosteal flap is reflected to the inferior border, which results in a degloving of the anterior mandible and allows for good visualization of the entire symphysis, including both mental neurovascular bundles (Figs. 25 and 26). Additional bone blocks, including cores and scrapings, can be obtained easily. It also provides for easy retraction at the inferior border and results in a relatively dry field. Contrast this with the vestibular approach, which results in more limited access, incomplete visualization of the mental neurovascular bundles, and more difficulty in superior and inferior retraction of the flap margins. Typically, bleeding is secondary to the mentalis muscle incision and results in the need for hemostasis. No wound dehiscence has been noted with the sulcular approach. The vestibular incision can result in wound dehiscence and scar band formation up to 11%. Finally, postoperative pain is less and no associated ptosis has been noted with the intrasulcular approach (Box 4).



Fig. 19. Ramus buccal shelf block graft harvest. Block is contoured with H71050 round fissure bur.

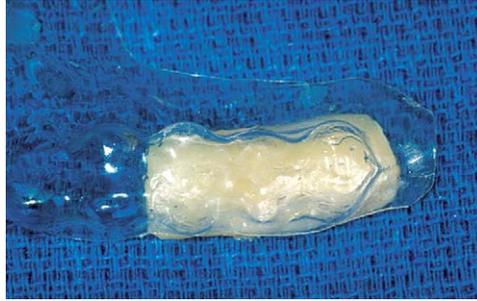


Fig. 20. Surgical template for stage I surgery is also used for graft contouring.



Fig. 21. Block graft fixation completed. Note intimate fit into the recipient site with almost vertical positioning of the block.

The graft size should be approximately 2 mm larger than the recipient site in horizontal and vertical dimensions to allow for contouring. A 702L tapered fissure bur in a straight handpiece is used to penetrate the symphysis cortex via a series of holes that outline the graft. It is important not to encroach within 5 mm of the apices of the incisor and canine teeth and the mental neurovascular foramina. The inferior osteotomy is made no closer than 4 mm from the inferior border. All holes are connected to a depth of at least the full extent of the bur flutes (7 mm), and the graft is harvested using bone spreaders and straight and curved osteotomes. The graft is placed in normal saline before contouring and fixation. The donor site is then packed with gauze soaked in saline, platelet-poor plasma, or platelet-rich plasma. Closure of the site is performed with 4-0 Vicryl horizontal mattress sutures after recipient site closure and includes a particulate graft (Figs. 27–29). Although this graft does not play a role in terms of soft tissue profile, its placement is recommended to allow for a secondary block harvest that can be obtained no sooner than 10 months from initial harvest.

Box 3. Time required for graft incorporation before stage I surgery

Symphysis

- Maxilla: horizontal, 4 months
- Maxilla: vertical, 5 months
- Mandible: horizontal and vertical, 5 months

Ramus buccal shelf

- Maxilla: horizontal, 4 months
- Maxilla: vertical, 5 months
- Mandible: horizontal and vertical, 5 months

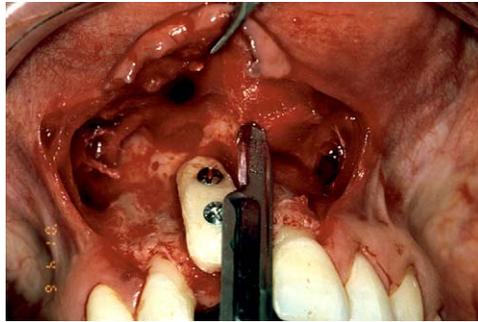


Fig. 22. Flap release via periosteal incisions.



Fig. 23. Curved hemostat is used to spread muscle layers.

Ramus buccal shelf block graft harvest

A full-thickness mucoperiosteal incision is made distal to the most posterior tooth in the mandible and continues to the retromolar pad and ascending ramus. An oblique release incision can be made into the buccinator muscle at the posterior extent of this incision should more flap release be needed. The incision continues in the buccal sulcus opposite the first bicuspid, where an oblique release incision is made to the depth of the vestibule. A full-thickness mucoperiosteal flap is then reflected to the inferior border to allow for visualization of the external oblique ridge, buccal shelf, lateral ramus and body, and mental neurovascular bundle. The flap is further elevated superiorly from the ascending ramus and includes stripping of the temporalis muscle attachment.

Three complete osteotomies and one bone groove must be prepared before graft harvest (Figs. 30 and 31). A superior osteotomy is created approximately 4 to 5 mm medial to the external oblique ridge with a 702L fissure bur in a straight handpiece. It begins opposite the distal half of the mandibular first molar or opposite the second molar and continues posteriorly in the ascending ramus. The length of this osteotomy depends on the graft size. The anterior extent of



Fig. 24. Complete relaxation of the labial flap is accomplished. Note approximation of wound margins at rest.

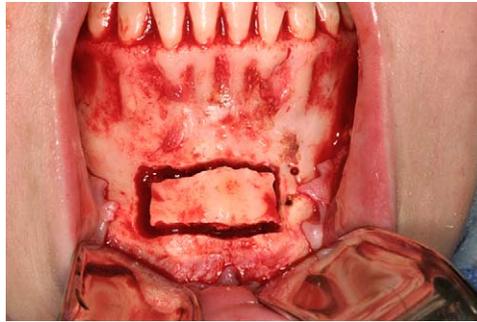


Fig. 25. Outline of symphysis block graft. Sulcular incision design is used with distal oblique release incisions at the second bicuspid bilaterally.



Fig. 26. Symphysis donor site. Bone bleeders are taken care of with electrocautery and collagen plugs.

this bone cut can approach the distal aspect of the first molar depending on the anterior location of the buccal shelf. A modified channel retractor is used for ideal access to the lateral ramus body area to allow for the two vertical bone cuts (Figs. 30 and 31). The vertical osteotomies begin at each end of the superior bone cut and continue inferiorly approximately 10 to 12 mm. All osteotomies just penetrate through buccal cortex into marrow. Finally, a #8 round bur is used to create a groove that connects the inferior aspect of each vertical osteotomy. The graft is then harvested using bone spreaders that are malletted along the superior osteotomy. The graft fractures along the inferior groove and should be harvested carefully so as to avoid injury to the inferior alveolar neurovascular bundle, which is visible 10% to 12% of the time. A sharp ledge is created at the superior extent of the ascending ramus and can be smoothed with a large round fissure bur before closure. Gauze moistened with saline, platelet-poor plasma, or platelet-rich

Box 4. Symphysis harvest

Sulcular incision: advantages over vestibular incision

- Excellent exposure
- Easy retraction
- Minimal bleeding
- Minimal nerve morbidity
- Soft tissue healing without scar band
- No ptosis
- Decreased postoperative pain

Contraindications

- Unhealthy periodontium
- Thin, highly scalloped gingival biotype
- Crowns associated with anterior mandibular teeth

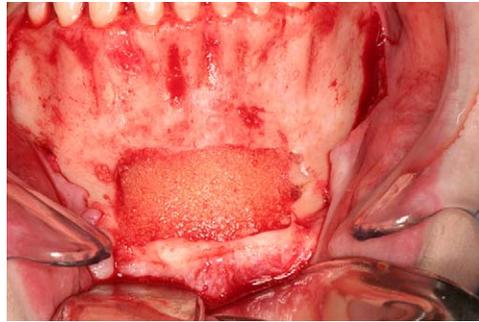


Fig. 27. Particulate demineralized bone putty used for donor site grafting.

plasma is then packed into the wound site. Closure of the donor site can be conducted after graft fixation. No bone grafting of this site is needed because form follows function (functional matrix theory), which allows for complete remodeling of the buccal shelf within 9 to 10 months. A second ramus buccal shelf block graft then can be harvested if needed.

Implant placement

After graft incorporation (**Box 3**), implants can be placed either submerged (**Figs. 32–34**) or nonsubmerged (**Figs. 35–40**), depending on relative density of the overall recipient site. Staging of the mandibular block graft allows increased bone volume and quality to be created before implant placement to ensure better initial implant stability. Ideal implant alignment is also facilitated, with increased bone maturation at the bone-implant interface, which is possible



Fig. 28. Collagen membrane impregnated with platelet-rich plasma used over the grafted donor site.



Fig. 29. Primary closure of the symphysis donor site using 4-0 Vicryl horizontal mattress sutures.



Fig. 30. Ramus buccal shelf block graft osteotomies. Note superior, anterior, and posterior vertical osteotomies and inferior groove.



Fig. 31. Ramus buccal shelf harvest site. Note modified channel retractor for excellent soft tissue retraction.



Fig. 32. Four-month re-entry. Note papilla-sparing incision design and excellent graft incorporation.

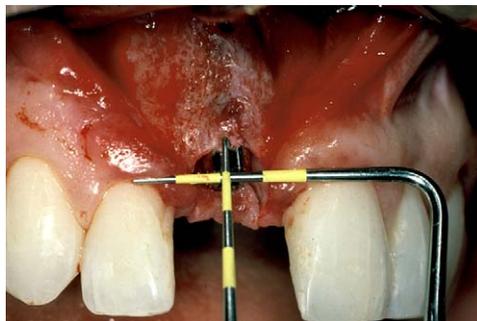


Fig. 33. Stage I surgery complete with 3-mm height, parallel wall healing abutment. Implant rim is 3 mm apical to the free gingival margin of the adjacent central incisor.



Fig. 34. Completed crown fabrication.



Fig. 35. Five-month re-entry with excellent graft incorporation. Note partial fill of block perforations.

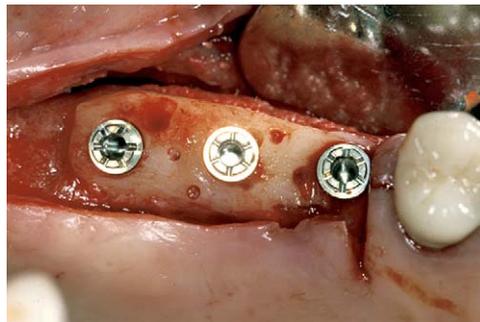


Fig. 36. Stage I implant surgery.

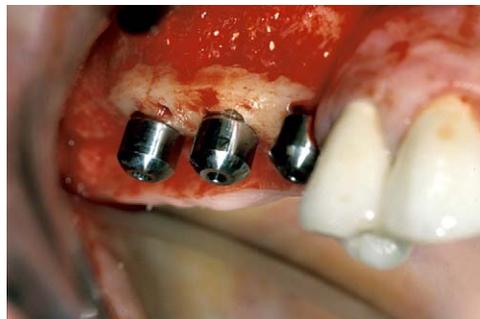


Fig. 37. Healing abutments in place for nonsubmerged protocol into D2 quality bone.

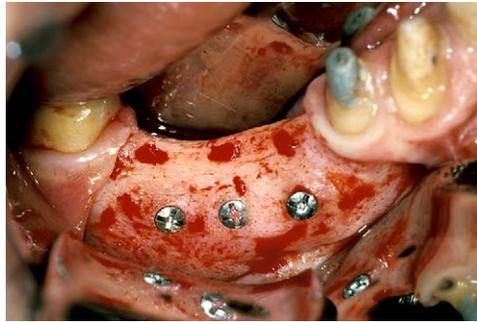


Fig. 38. Five-month re-entry. Note excellent graft incorporation with minimal resorption.

because the grafts exhibit minimal resorption (0–20%). Increased bone density also is obtained using symphyseal bone (type II or I) and ramus buccal shelf bone (type I). Because the greatest stresses of a loaded implant are located around the neck and ridge crest, the crestal bone with increased density can withstand implant loading in a more favorable biomechanical manner. This is a distinct advantage over other regenerative techniques, including guided bone regeneration. Finally, block autografts allow for maximum diameter implants to be used, which results in optimal force distribution to bone.

Complications

Despite the many advantages block grafts offer for alveolar ridge augmentation, complications can occur when mandibular block autografts are used for horizontal and vertical augmentation. Morbidity with this grafting protocol is associated with donor and recipient sites. This information includes the author's experience with 434 block grafts harvested between August 1991 and December 2002: 208 symphysis grafts and 226 ramus buccal shelf grafts.

Symphysis donor site morbidity includes intraoperative complications, such as bleeding, mental nerve injury, soft tissue injury of cheeks, lips, and tongue, block graft fracture, infection, and potential bicortical harvest. Bleeding episodes are intrabony and can be taken care of with cautery, local anesthesia, and collagen plugs. Injury to the mental neurovascular bundle is avoidable with proper surgical technique, especially the use of the sulcular approach for bone harvest. Block fracture and bicortical block harvest also can be prevented by following good surgical technique. Pain, swelling, and bruising occur as normal postoperative sequelae and are not excessive in nature. Use of platelet-rich plasma has decreased overall soft tissue morbidity. Infection rate is minimal (<1%). Neurosensory deficits include altered sensation of the lower lip, chin (<1% permanent), and dysesthesia of the anterior mandibular dentition (transient, 53%; permanent, <1%). No evidence of dehiscence or chin ptosis was seen using the sulcular approach.

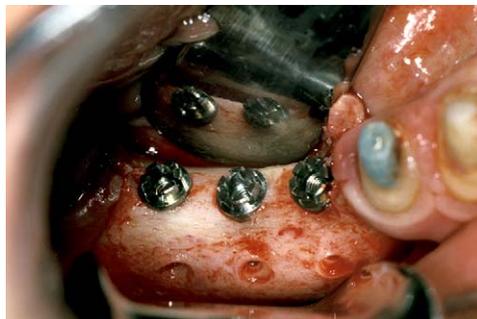


Fig. 39. Stage I surgery completed using threaded root form implants.



Fig. 40. Healing abutments placed as per nonsubmerged implant protocol.

The ramus buccal shelf harvest also can result in intraoperative complications, including bleeding, nerve injury, soft tissue injury, block fracture, infection, and mandible fracture. Intrabony and soft tissue bleeding can be handled with cautery. Injury to the inferior alveolar and lingual neurovascular bundle can be avoided with proper soft tissue manipulation and meticulous osteotomy preparation. Block fracture is also an avoidable problem with proper surgical technique. Postoperative morbidity includes trismus (approximately 60%), which is transient and can take up to 3 to 4 weeks to resolve. Pain, swelling, and bruising are typically mild to moderate and are minimized with use of platelet-rich plasma. Infection rate is less than 1%. Altered sensation of the lower lip or chin occurs approximately 8% of the time with less than 1% of cases ($n=1$) being permanent. Altered sensation of the lingual nerve also has been reported but has been transient only. No instances of permanent altered sensation of mandibular dentition have been found.

Complications associated with the recipient site include trismus, bleeding, pain, swelling, infection, neurosensory deficits, bone resorption, dehiscence, and graft failure. Trismus is expected if the recipient site is the posterior mandible, which affects the muscles of mastication. Incidence is 60% and is transient. Bone bleeding is expected secondary to site preparation (decortication and perforation), but excessive bleeding can occur secondary to intrabony and soft tissue vessel transection. Pain, swelling, and bruising are mild to moderate and are minimized with platelet-rich plasma. The infection rate is less than 1% and is usually secondary to graft exposure. Neurosensory deficits can occur secondary to site preparation and block fixation because normal anatomy is violated. Graft dehiscence is the primary complication seen with mandibular block autografts and is primarily caused by soft tissue closure without tension (Fig. 41), thin mucosal tissue (Fig. 42), or excessive prosthesis contact with the graft site. This complication can be prevented in virtually all cases by ensuring primary closure without tension and ensuring adequate mucosal thickness before bone grafting, which often requires soft tissue grafting to be done before block grafting. Block graft resorption is minimal (0–20%) but can be excessive if graft dehiscence occurs. Primary closure without tension along with adequate mucosal thickness prevents virtually all bone graft dehiscence. Unfortunately, wound site dehiscence results in



Fig. 41. Note dehiscence of lingual mucosal tissues with screw exposure.



Fig. 42. Significant block graft dehiscence at 3-week postoperative examination.

partial and more often complete graft loss. In summary, overall morbidity of mandibular block autografts for alveolar ridge augmentation is minimal. Most complications are preventable, and those that occur can be handled predictably with minimal adverse effects to patients.

Further readings

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