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AUTOGENOUS BONE BLOCK GRAFTS

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ABSTRACT

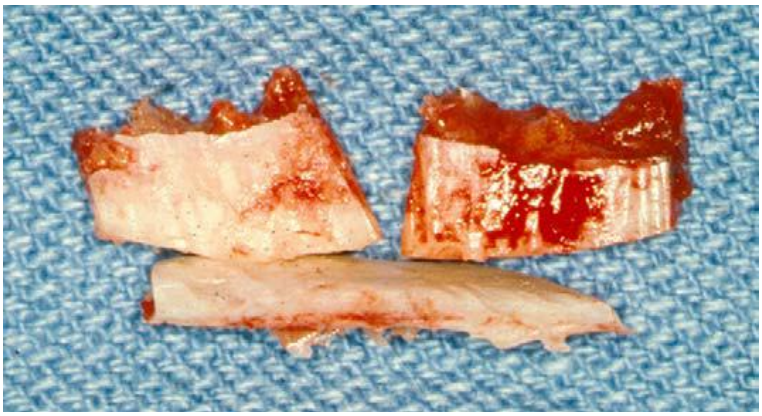
Reconstruction of alveolar ridge deficiencies requires bone augmentation before implantplacement. Osseous defects occur as a result of trauma, prolonged edentulism, congenitalanomalies, periodontal disease, and infection, and they often require hard and soft tissuereconstruction. Autogenous bone grafts have been used for many years for ridge augmentationand are still considered the gold standard for jaw reconstruction. The use of autogenous bonegrafts with osseointegrated implants originally was discussed by Branemark[1] 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 fromthe symphysis and ramus buccal shelf offer advantages over iliac crest grafts, including closeproximity of donor and recipient sites, convenient surgical access, decreased donor sitemorbidity, and decreased cost. This article reviews indications, limitations, presurgical evaluation, surgical protocol, andcomplications associated with mandibular block autografts harvested from the symphysis andramus buccal shelf for alveolar ridge augmentation.

INDICATIONS

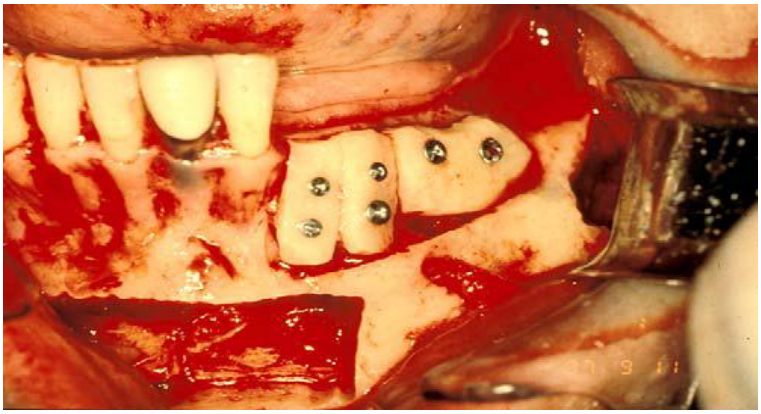
Block bone grafts harvested from the symphysis can be used for predictable boneaugmentation up to 6 mm in horizontal and vertical dimensions. The range of this corticalcancellous graft thickness is 3 to 11 mm, with most sites providing 5 to 8 mm. Thedensity of the grafts is D-1 or D-2, and up to a three-tooth edentulous site can be grafted.

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). This site is used for horizontal or verticalaugmentation of 3 to 4 mm. One ramus buccal shelf can provide adequate bone volume for upto a three-

and even four tooth segment. Bone density is D-1 with minimal, if any, marrowavailable. Some sites require extensive bone graft volume, which necessitates simultaneousbilateral ramus buccal shelf and symphysis graft harvest. For graft volume of more than 6 to7 mm thickness, a secondary block graft can be used after appropriate healing of the initial graft.



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



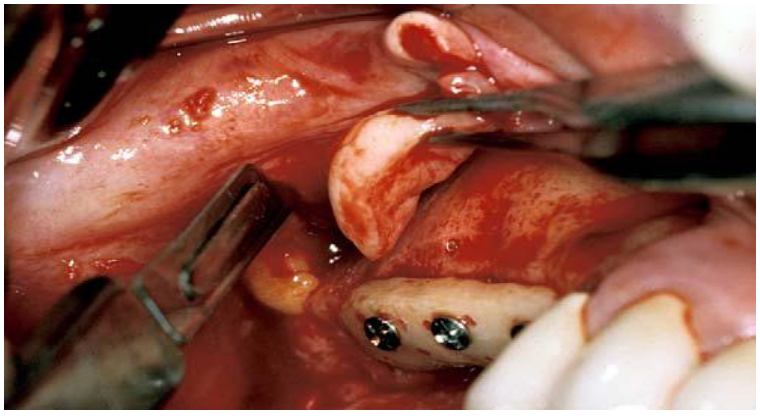
Fixation of symphysis and ramus block grafts. The two anterior vertical blocks are from the symphysis; the posterior block is from the ramus buccal shelf. Note donor sites.

PRESURGICAL CONSIDERATIONS

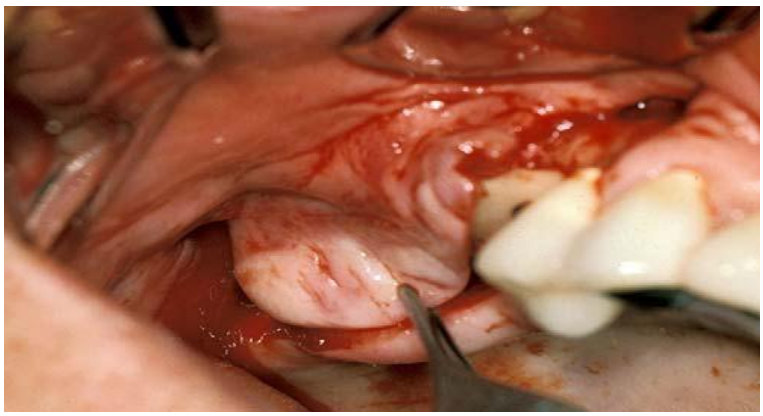
The recipient site must be evaluated for hard and soft tissue deficiencies, aesthetic concerns and overall health of the adjacent teeth. Some cases require soft tissue procedures to beperformed before or simultaneously with block grafting in conjunction with implantplacement or stage II surgery. These cases include use of connective tissue grafts, palatalepithelial grafts and human dermis. Conventional radiographs are obtained and includeperiapical, 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 theyprovide valuable information for implant placement. It also provides a basefor template fabrication.[2]

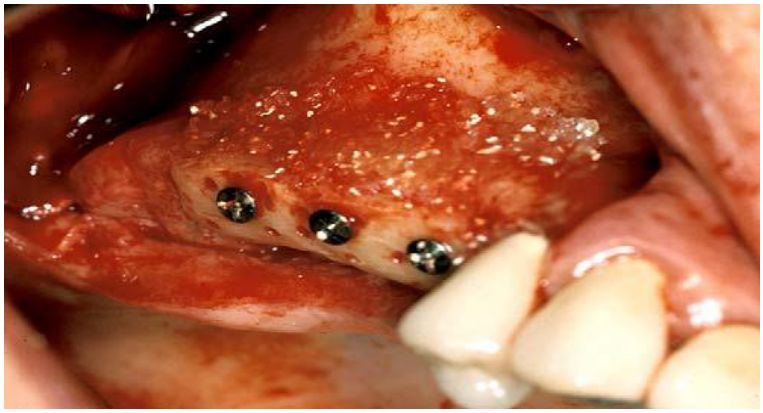
Anterior maxillary recipient site incision design. Note distal oblique release incisions.



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

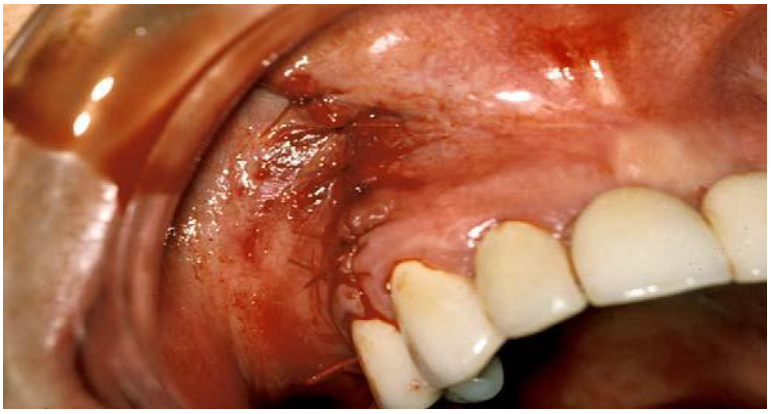


Note complete relaxation of the buccal flap secondary to periosteal release and oblique release incisions. This flapwill be repositioned anteriorly and inferiorly for tension-free closure.



Fixation of block graft with particulate graft overlay.

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



Tension-free wound closure.

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 withinthe arches. Maxillary anterior sites require a midcrestal incision that continues in the sulcusfor a full tooth on either side of the defect. Bilateral oblique release incisions are

madeapproximately one tooth removed, and a full-thickness mucoperiosteal flap is reflected. Symphysis and ramus buccal shelf block grafts harvested from same mandible. Note relative greater corticalthickness of the symphysis grafts.

Fixation of symphysis and ramus block grafts. The two anterior vertical blocks are from the symphysis; theposterior block is from the ramus buccal shelf.

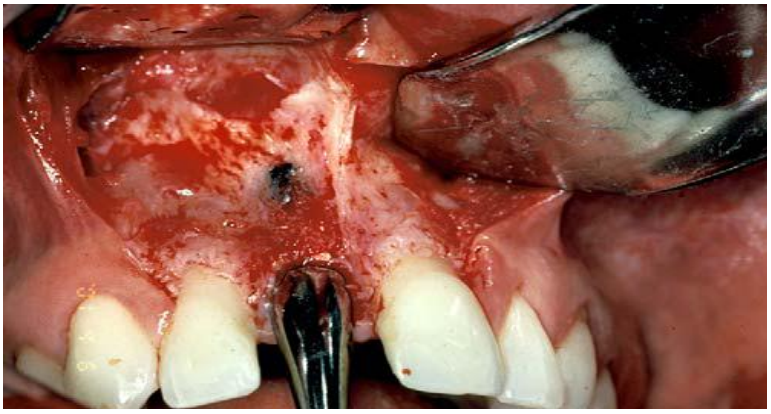
Symphysis block graft: indications

• Horizontal augmentation 4–7 mm (up to three-tooth defect).

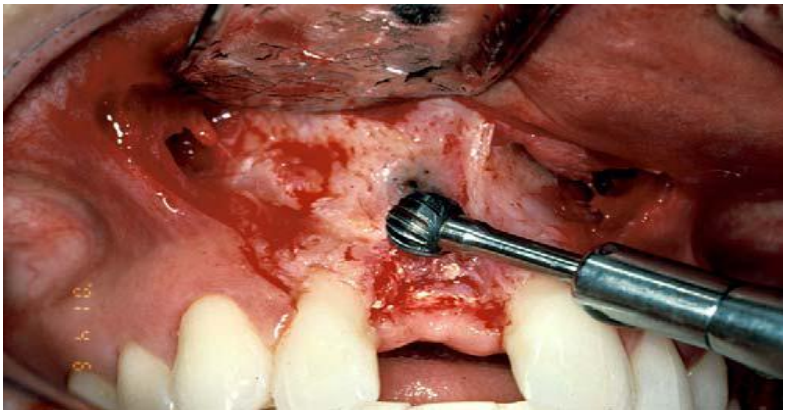
• Vertical augmentation 4–6 mm (up to three-tooth defect).

Papilla-sparing release incisions are not recommended because they overlie the interface ofrecipient and donor bone and can result in wound dehiscence. The mandibular anterior site ishandled in the same manner with care to avoid injury to the mental neurovascular bundle.Maxillary posterior sites also require a mid crestal incision that continues in the sulcus onetooth anterior to the defect with an oblique release incision. A posterior oblique release incisionis made at the base of the tuberosity and it extends apically to the zygomatic buttress, whichallows for complete mucoperiosteal flap reflection and relaxation in an anterior and crestal direction.

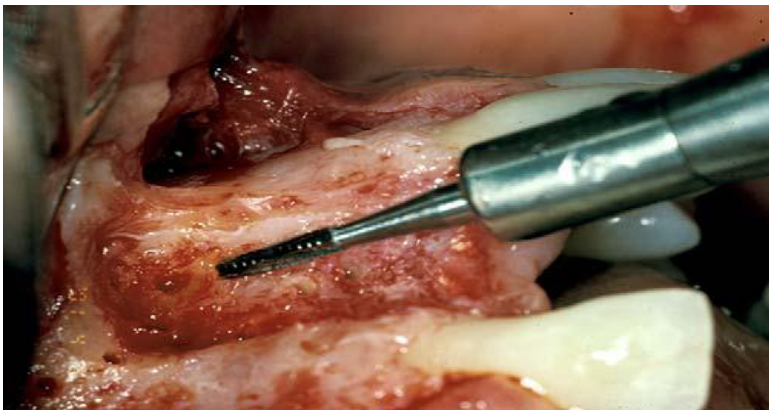
Mandibular posterior edentulous sites require a midcrestal and sulcular incision[6] continued tothe first bicuspid or canine tooth with an anterior oblique release incision to allow for completevisualization of the mental neurovascular bundle. The incision continues posteriorly up theascending ramus and can be released obliquely into the buccinator muscle. If the defectis between teeth, the incision continues in the sulcus of the posterior tooth and then distally. Inboth cases, the incision is made in the lingual sulcus for three to four teeth anteriorly, whichallows for lingual flap reflection via mylohyoid muscle stripping.



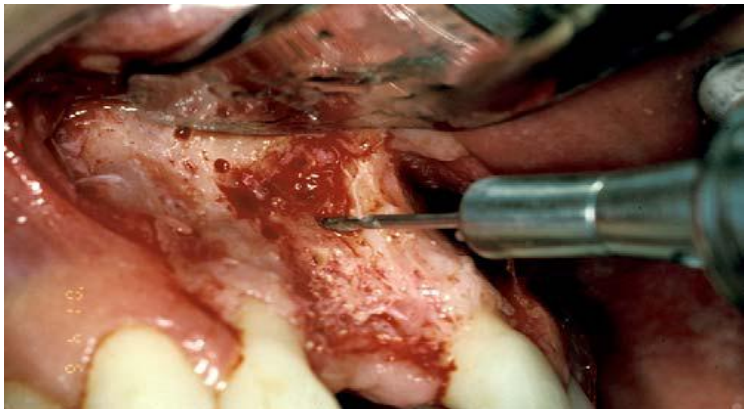
Anterior maxillary recipient site exposed to reveal horizontal alveolar ridge defect.



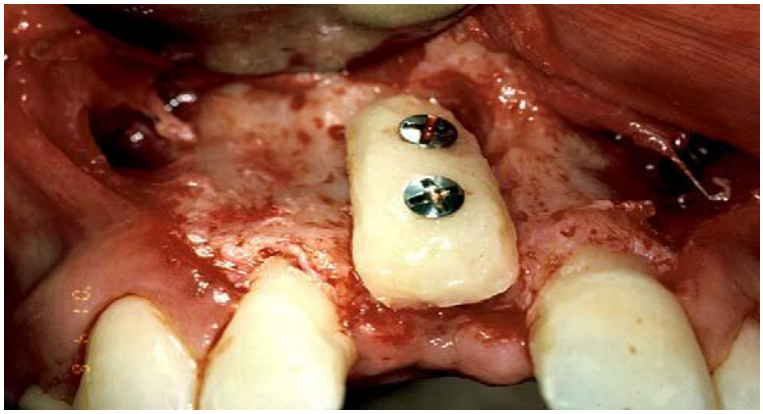
Decortication begins with large round fissure bur.



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.



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



Note two-point block graft fixation to prevent microrotation.

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

Recipient site preparation is critical for predictable incorporation of block grafts and includesdecortication and perforation into underlying marrow. This preparation provides access fortrabecular bone blood vessels to the graft and accelerates revascularization. Surgical traumacreated also allows for the regional acceleratory phenomenon[4] to occur, which results in tissuehealing two to ten times faster than normal physiologic healing. There

is also massive plateletrelease along with associated growth factors and osteogenic cells. Finally, graft union to theunderlying host bone is accomplished more readily, which allows for intimate contact tofacilitate graft incorporation.

For horizontal defects, decortication[3] creates an outline for close graft approximation. Boneburnishing with a large round fissure bur from crest of ridge toapproximately 4 to 5 mm apically is done initially. Decortication continues apically witha 702L straight fissure bur in a more aggressive fashion to create extra walls to the defect in theform of a rectangular inlay preparation. The site is perforated with a 0.8-mm burto penetrate underlying marrow. Next, platelet-rich plasma is applied to the recipientsite and the block is morticed into position and fixated with two 1.6-mm diameter, low-profilehead, self-tapping titanium screws. Two screws are placed to prevent microrotationof the graft, which can result in compromised healing, including resorption and even graftnonunion. Site preparation for vertical augmentation requires only crestal bone burnishing tocreate bone bleeders followed by perforations into marrow. A small vertical step ismade approximately 2 mm adjacent to the tooth next to the site to allow for a butt joint to formwith the end of the block graft. The block can be stored in normal saline or D5W beforecontouring. The H71052 round fissure bur is used to smooth any sharp edges before fixation. Horizontal augmentation in the maxilla using either donor site requires 4 monthsof healing time before implant placement. An additional month is required for horizontalaugmentation in the mandible and for vertical augmentation in the maxilla and mandible.

After graft fixation, autogenous marrow or particulate allograft can be morticed into anycrevices 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 isnecessary for predictable block grafting. Before particulate grafting, however, the overlying flap must be made passive to allow for tension-free closure. This procedure is accomplished in allareas by scoring periosteum and using blunt dissection into muscle for complete flap relaxation.

In the posterior mandible[7], it is highly recommended that lingual flap release beobtained by detaching the mylohyoid muscle with sharp and blunt dissection, which results in up to a 6– to 8-mm gain of flap relaxation. Along with buccal flapmanipulation, lingual flap release creates posterior mandibular soft tissue closure in a predictablemanner and virtually eliminates incision line opening. Before flap approximation for closure, theentire graft site is

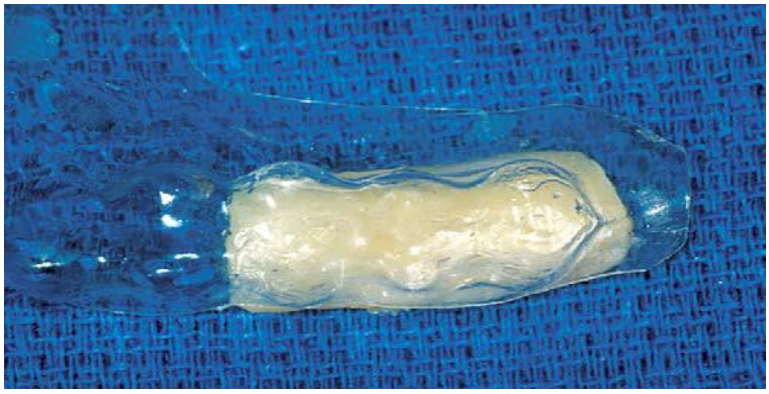
immersed in platelet-rich plasma. Closure is accomplished using4-0 Vicryl for the crestal incision and 4-0 and 5-0 chromic for the release incision.

Ramus buccal shelf block graft: indications

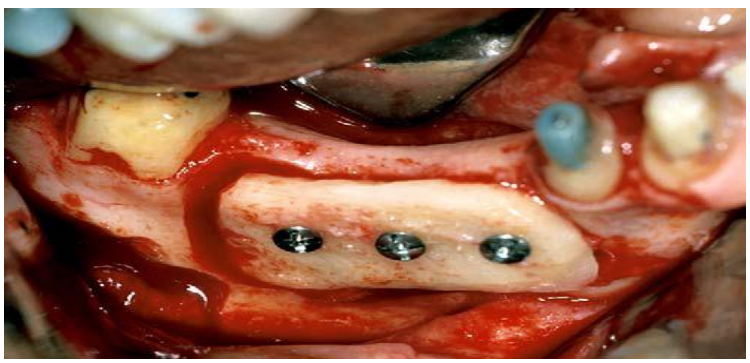
• Horizontal augmentation 3–4 mm (up to four-tooth defect)

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

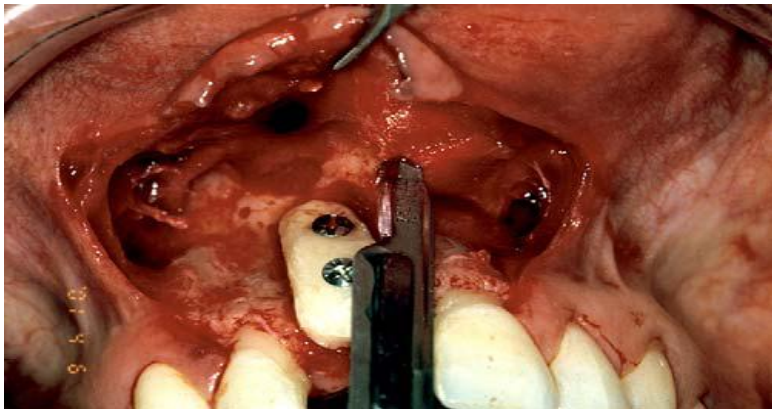
Ramus buccal shelf block graft harvest. Block is contoured with H71050 round fissure bur.



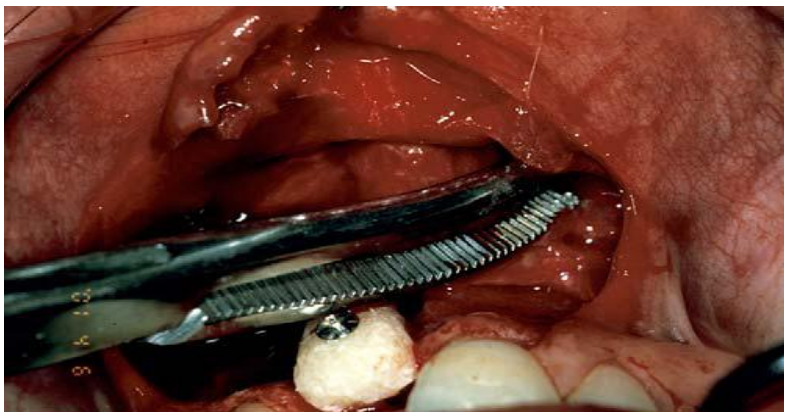
Surgical template for stage I surgery is also used for graft contouring.



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



Flap release via periosteal incisions.



Curved hemostat is used to spread muscle layers.

DONOR SITE

Symphysis harvest

Two primary incision designs can be used for harvesting block bone from the symphysis. Asulcular incision is preferred as opposed to the more conventional vestibular approach. This incision can be used safely if the periodontium is healthy and no crowns are present in theanterior dentition that could present aesthetic problems with associated gingival recession. Ahighly scalloped thin gingival biotype also is contraindicated. The incision begins in the sulcusfrom second bicuspid to second bicuspid.

An oblique releasing incision is made at the distalbuccal line angle of these teeth and continues into the depth of the buccal vestibule. A fullthicknessmucoperiosteal flap is reflected to the inferior border, which results in a degloving ofthe anterior mandible and allows for good visualization of the entire symphysis, including bothmental neurovascular bundles. Additional bone blocks, including cores andscrapings, can be obtained easily. It also provides for easy retraction at the inferior border andresults in a relatively dry field. Contrast

this with the vestibular approach, which results in morelimited access, incomplete visualization of the mental neurovascular bundles and moredifficulty in superior and inferior retraction of the flap margins. Typically, bleeding is secondaryto the mentalis muscle incision and results in the need for hemostasis. No wound dehiscence hasbeen noted with the sulcular approach. The vestibular incision can result in wound dehiscenceand scar band formation up to 11%. Finally, postoperative pain is less and no associated ptosishas been noted with the intrasulcular approach.

The graft size should be approximately 2 mm larger than the recipient site in horizontal andvertical dimensions to allow for contouring. A 702L tapered fissure bur in a straight handpiece isused to penetrate the symphysis cortex via a series of holes that outline the graft. It is importantnot to encroach within 5 mm of the apices of the incisor and canine teeth and the mentalneurovascular foramina. The inferior osteotomy is made no closer than 4 mm from the inferiorborder. All holes are connected to a depth of at least the full extent of the bur flutes (7 mm), andthe graft is harvested using bone spreaders and straight and curved osteotomes. The graft isplaced in normal saline before contouring and fixation.

The donor site is then packed with gauzesoaked in saline, platelet-poor plasma, or platelet-rich plasma. Closure of the site is performedwith 4-0 Vicryl horizontal mattress sutures after recipient site closure and includes a particulate graft. Although this graft does not play a role in terms of soft tissue profile, itsplacement is recommended to allow for a secondary block harvest that can be obtained nosooner than 10 months from initial harvest.

Surgical template for stage I surgery is also used for graft contouring. Block graft fixation completed. Note intimate fit into the recipient site with almost vertical positioning of theblock.

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[9]

• Maxilla: horizontal, 4 months

• Maxilla: vertical, 5 months

• Mandible: horizontal and vertical, 5 months.

RAMUS BUCCAL SHELF BLOCK GRAFT HARVEST

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

Three complete osteotomies and one bone groove must be prepared before graft harvest. A superior osteotomy is created approximately 4 to 5 mm medial to the externaloblique ridge with a 702L fissure bur in a straight handpiece. It begins opposite the distal half ofthe mandibular first molar or opposite the second molar and continues posteriorly in theascending ramus. The length of this osteotomy depends on the graft size. The anterior extent of this bone cut can approach the distal aspect of the first molar depending on the anterior locationof the buccal shelf. A modified channel retractor is used for ideal access to the lateral ramus bodyarea to allow for the two vertical bone cuts. The vertical osteotomies begin ateach end of the superior bone cut and continue inferiorly approximately 10 to 12 mm. Allosteotomies just penetrate through buccal cortex into marrow. Finally, a #8 round bur is used tocreate a groove that connects the inferior aspect of each vertical osteotomy.

The graft is thenharvested using bone spreaders that are malletted along the superior osteotomy. The graftfractures along the inferior groove and should be harvested carefully so as to avoid injury to theinferior alveolar neurovascular bundle, which is visible 10% to 12% of the time. A sharp ledge iscreated at the superior extent of the ascending ramus and can be smoothed with a large roundfissure bur before closure. Gauze moistened with saline, platelet-poor plasma, or platelet-richplasma is then packed into the wound site. Closure of the donor site can be conducted after graftfixation. No bone grafting of this site is needed because form

follows function (functional matrixtheory), which allows for complete remodeling of the buccal shelf within 9 to 10 months. Asecond ramus buccal shelf block graft then can be harvested if needed.

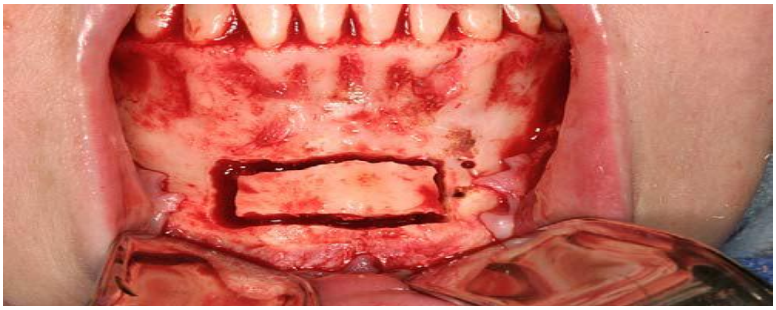
Symphysis harvest[10,11]

Sulcular incision: advantages over vestibular incision

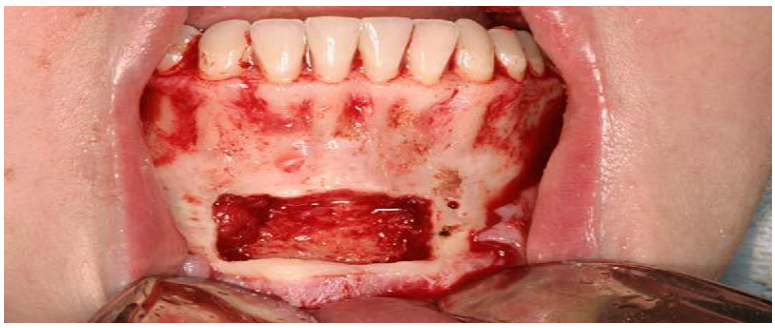
- Excellent exposure
- Easy retraction
- Minimal bleeding
- Minimal nerve morbidity
- Soft tissue healing without scar band
- No ptosis
- Decreased postoperative pain

Contraindications

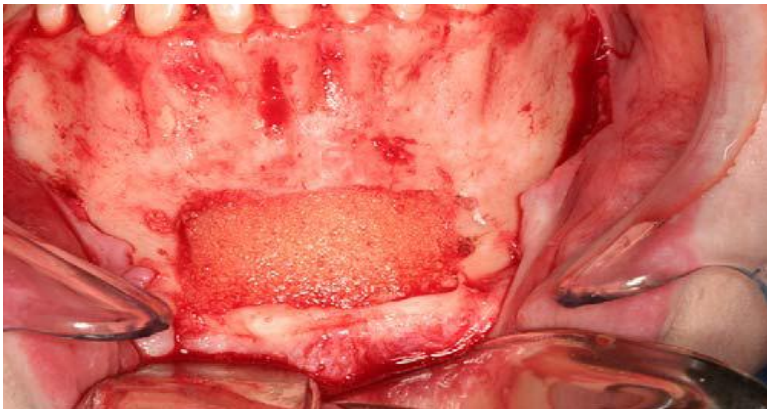
- Unhealthy periodontium
- Thin, highly scalloped gingival biotype
- Crowns associated with anterior mandibular teeth.



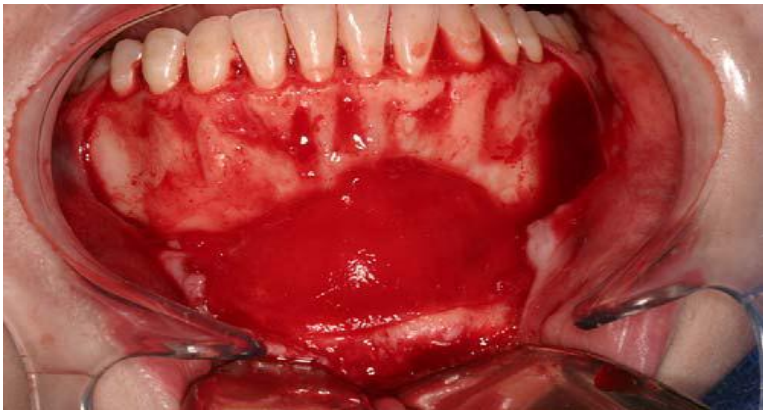
Outline of symphysis block graft. Sulcular incision design is used with distal oblique release incisions at the second bicuspid bilaterally.



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

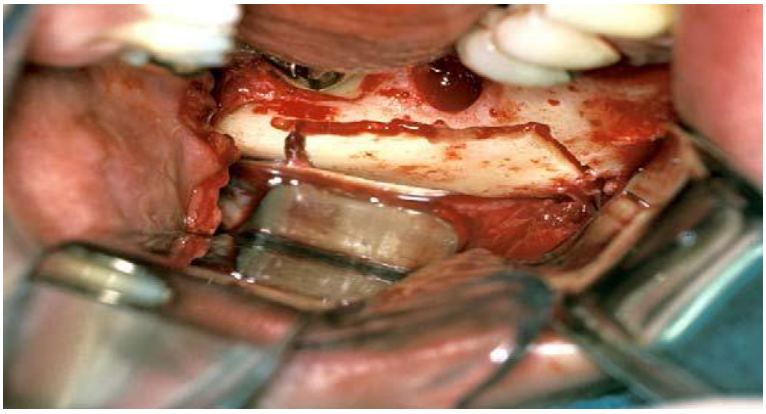


Particulate demineralized bone putty used for donor site grafting.

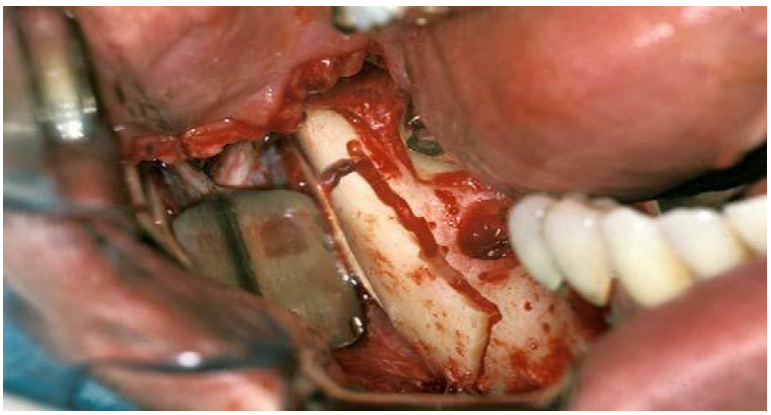


Collagen membrane impregnated with platelet-rich plasma used over the grafted donor site.

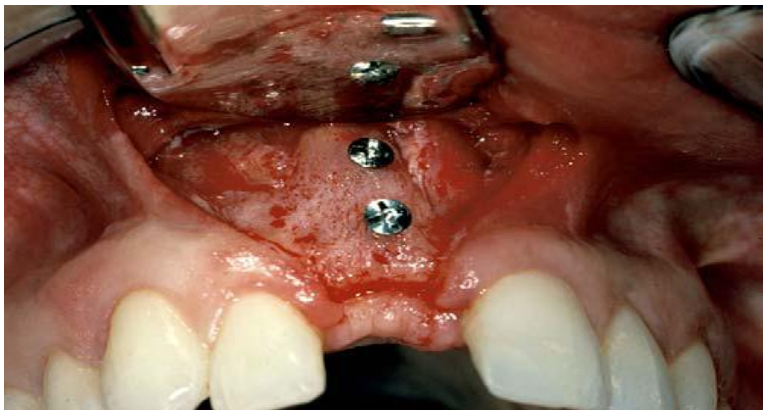
Primary closure of the symphysis donor site using 4-0 Vicryl horizontal mattress sutures.



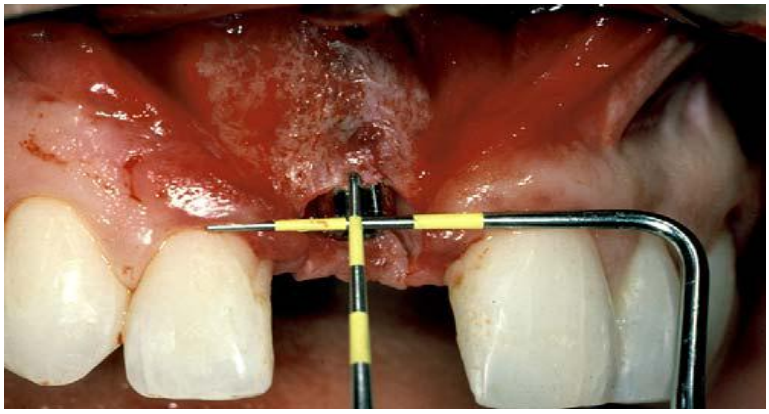
Ramus buccal shelf block graft osteotomies. Note superior, anterior, and posterior vertical osteotomies and inferior groove.



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



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



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.

IMPLANT PLACEMENT

After graft incorporation, implants can be placed either submerged or nonsubmerged, depending on relative density of the overall recipient site. Stagingof the mandibular block graft allows increased bone volume and quality to be created beforeimplant placement to ensure better initial implant stability. Ideal implant alignment is alsofacilitated, with increased bone maturation at the bone-implant interface, which is possiblebecause 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 greateststresses of a loaded implant are located around the neck and ridge crest, the crestal bone withincreased 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, whichresults in optimal force distribution to bone.

Complications

Despite the many advantages block grafts offer for alveolar ridge augmentation, complicationscan occur when mandibular block autografts are used for horizontal and verticalaugmentation. Morbidity with this grafting protocol is associated with donor and recipient sites.

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 withcautery, local anesthesia, and collagen plugs. Injury to the mental neurovascular bundle isavoidable with proper surgical technique, especially the use of the sulcular approach for boneharvest. Block fracture and bicortical block harvest also can be prevented by following goodsurgical technique. Pain, swelling, and bruising occur as normal postoperative sequelae and arenot 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 lowerlip, 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 sulcularapproach.

The ramus buccal shelf harvest also can result in intraoperative complications, includingbleeding, 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 alveolarand lingual neurovascular bundle can be avoided with proper soft tissue manipulation andmeticulous osteotomy preparation. Block fracture is also an avoidable problem with propersurgical technique. Postoperative morbidity includes trismus (approximately 60%), which istransient and can take up to 3 to 4 weeks to resolve. Pain, swelling, and bruising are typicallymild to moderate and are minimized with use of platelet-rich plasma. Infection rate is less than1%. Altered sensation of the lower lip or chin occurs approximately 8% of the time with lessthan 1% of cases (n=1) being permanent. Altered sensation of the lingual nerve also has beenreported but has been transient only. No instances of permanent altered sensation ofmandibular 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 isexpected 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 softtissue vessel transection. Pain, swelling and bruising are mild to moderate and are minimized withplatelet-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 normalanatomy is violated.

Graft dehiscence is the primary complication seen with mandibular blockautografts and is primarily caused by soft tissue closure without tension, thin mucosal tissue, or excessive prosthesis contact with the graft site. This complication can beprevented in virtually all cases by ensuring primary closure without tension and ensuringadequate mucosal thickness before bone grafting, which often requires soft tissue grafting to bedone before block grafting. Block graft resorption is minimal (0–20%) but can be excessive if graftdehiscence occurs.

Primary closure without tension along with adequate mucosal thicknessprevents virtually all bone graft dehiscence. Unfortunately, wound site dehiscence results in partial and more often complete graft loss. In summary, overall morbidity of mandibular blockautografts for alveolar ridge augmentation is minimal. Most complications are preventable, andthose that occur can be handled predictably with minimal adverse effects to patients.

Note dehiscence of lingual mucosal tissues with screw exposure.

Significant block graft dehiscence at 3-week postoperative examination.

CONCLUSION

The use of the monocortical block from the mandibular ramus and symphysis can provide excellent quality and quantity of bone to restore alveolar defects spanning up to four teeth. The mandibular ramus augmentation harvest site allows the use of autologous bone – the gold standard in bone grafting – to predictably and within a short healing time, provide ideal sites for endosseous implant placement.

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