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AUTOGENOUS BONE GRAFT IN RIDGE AUGMENTATION:AN OVERVIEW

Oral & Maxillofacial Surgery

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ABSTRACT

In many ways, autogenous bone grafts continue to remain the gold standard for repair of jaw atrophy and bone defects. Autogenous bone grafting is a well-documented procedure for reconstruction of the atrophic maxilla and mandible for rehabilitation with implant prostheses. Advancements in biologic engineering will produce alternatives to autogenous bone that may very well exceed existing clinical outcomes and replace traditional indications for its use.1 However, the increased costs of technology can be an obstacle to routine use of new products. Autogenous bone grafting offers a well-proven, predictable method for ridge augmentation and defect repair for dental implant placement.

KEYWORDS

Autogenous Bone Graft, Dental Implant, Inlay Bonegraft, Onlay Bone Graft

INTRODUCTION

The use of autogenous bone with dental implants was originally discussed by Branemark et al.2

Early studies focused on the use of iliac bone grafts in the treatment of the atrophic, edentulous maxilla and mandible.3 Although the iliac crest is most often used for major jaw reconstruction, it has the disadvantages of the need for hospitalization, general anesthesia, and alteration of ambulation. Additional donor sites have been evaluated, including the calvarium, proximal tibia, and maxillofacial regions. Autogenous bone can be used in several forms, including cancellous marrow, particulate bone chips, or cortical and corticocancellous blocks. The timing of graft placement and implant insertion has been well researched. The preferred approach in most cases today is delayed implant placement into the healed bone graft. Earlier studies of machined screw type of implants often found lower survival rates in grafted bone.3 The use of implants with enhanced surface features has improved outcomes in regenerated bone, with success rates comparable with those in native bone.

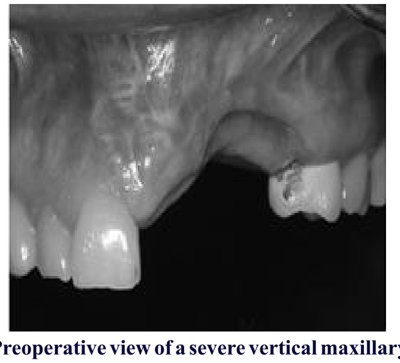

Figure 1:Preoperative view of a severe vertical maxillary defect.

Figure 2: Osseous distraction is used to manage the vertical component of the bone deficiency.

Figure 3: The maxilla is allowed to heal for 2 months following removal of the distraction device. A significant horizontal bone deficiency remains.

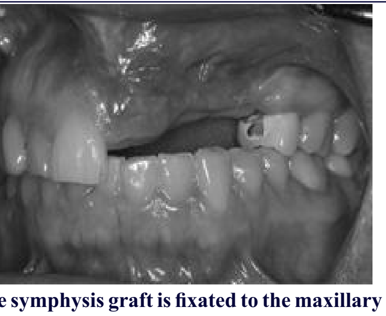

Figure 4:The symphysis graft is fixated to the maxillary ridge with screws for horizontal augmentation.

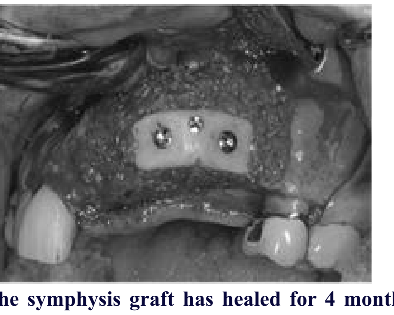

Figure 5: The symphysis graft has healed for 4 months before implant placement is performed.

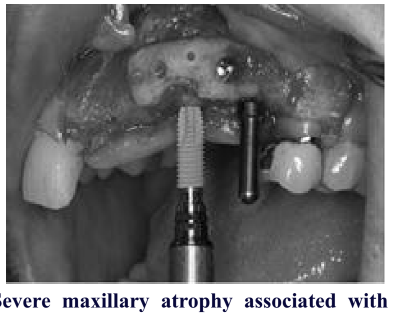

Figure 6:Severe maxillary atrophy associated with long-term denture use.

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Figure 7:Exposure of the atrophic maxillary residual ridge.

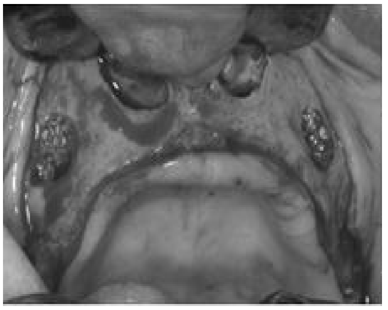

Figure 8:The use of corticocancellous block bone grafts from the ilium to reconstruct the anterior maxilla.

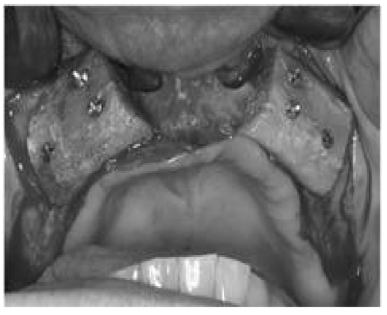

Figure 9:The bone grafts are well incorporated after 4 months of healing for implant placement.

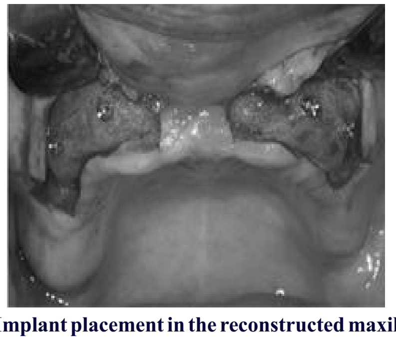

Figure 10:Implant placement in the reconstructed maxilla.

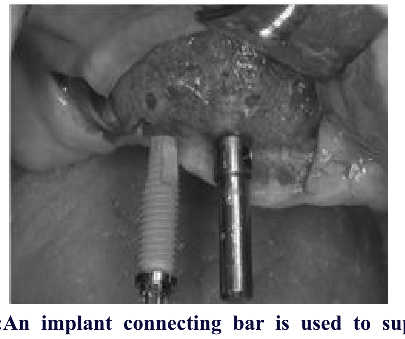

Figure 11:An implant connecting bar is used to support the overdenture prosthesis.

Figure 12:The final maxillary overdenture.

Figure 13:Cancellous bone from the tibia is packed into the titanium mesh.

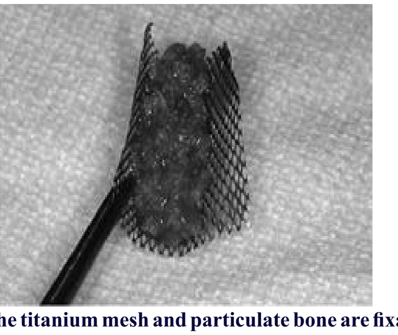

Figure 14:The titanium mesh and particulate bone are fixated over the atrophic mandible with screws.

Figure 15:Vertical bone gain for implant placement following a 6-month healing period.

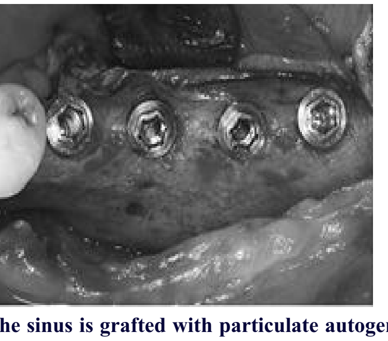

Figure 16:The sinus is grafted with particulate autogenous bone mixed with mineralized bone allograft. A cortical block graft is used to reconstruct the ridge sinus for implant placement and a lateral ridge deficiency

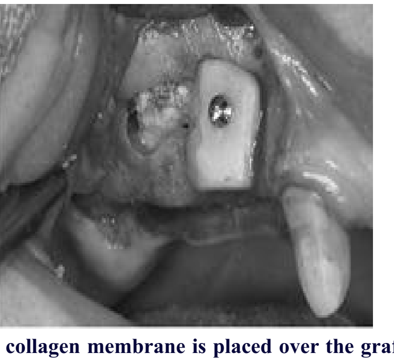

Figure 17:A collagen membrane is placed over the grafted sites.

Figure 18:The bone grafts are well incorporated after 4 months of healing.

Figure 19:Implant placement into the reconstructed posterior maxilla.

Indications For Various Techniques

Single Onlay Cortical Grafts.

Until relatively inert metals became available, the onlay bone graft was the simplest and most effective treatment for most ununited diaphyseal fractures. Usually the cortical graft was supplemented by cancellous bone for osteogenesis. The onlay graft is still applicable to a limited group of fresh, malunited, and ununited fractures and after osteotomies. Cortical grafts also are used when bridging joints to produce arthrodesis, not only for osteogenesis but also for fixation. Fixation as a rule is best furnished by internal or external metallic devices. Only in an extremely unusual situation would a cortical onlay graft be indicated for fixation, and then only in small bones and when little stress is expected. For osteogenesis the thick cortical graft has largely been replaced by thin cortical and cancellous bone from the ilium. The single-onlay cortical bone graft was used most commonly before the development of good quality internal fixation and was employed for both osteogenesis and fixation in the treatment of nonunions.

Dual Onlay Grafts

Dual onlay bone grafts are useful when treating difficult and unusual nonunions or for the bridging of massive defects. The treatment of a nonunion near a joint is difficult, since the fragment nearest the joint is usually small, osteoporotic, and largely cancellous, having only a thin cortex. It is often so small and soft that fixation with a single graft is impossible because screws tend to pull out of it and wire sutures cut through it. Dual grafts provide stability because they grip the small fragment like forceps.

The advantages of dual grafts for bridging defects are as follows: (1) Mechanical fixation is better than fixation by a single onlay bone graft. (2) The two grafts adds strength and stability. (3) The grafts form a trough into which cancellous bone may be packed. (4) During healing the dual grafts, unlike a single graft, prevent contracting fibrous tissue from compromising transplanted cancellous bone.

The disadvantages of dual grafts are the same as those of single cortical grafts: (1) they are not as strong as metallic fixation devices. (2) an extremity must usually serve as a donor site if autogenous grafts are used. (3) they are not as osteogenic as autogenous iliac grafts, and the surgery necessary to obtain them has more risk.

Inlay Grafts.

In the inlay technique a slot or rectangular defect is created in the cortex of the host bone, usually with a power saw. A graft the same size or slightly smaller is then fitted into the defect. In the treatment of diaphyseal nonunions, the onlay technique is simpler and more efficient and has almost replaced the inlay graft. The latter is still occasionally used in arthrodesis, particularly at the ankle. Albee popularized the inlay bone graft for the treatment of nonunions. Inlay grafts are created by a sliding technique, graft reversal technique, or as a strut graft. Although originally designed for the treatment of nonunion of the tibia, these techniques are also used for arthrodesis and epiphyseal arrest.

Medullary Grafts

Medullary bone grafts were tried early in the development of bone grafting techniques for nonunion of the diaphyseal fractures. Fixation was insecure, and healing was rarely satisfactory. This graft interferes with endosteal circulation and consequently can interfere with healing. Medullary grafts are not indicated for the diaphysis of major long bones. Grafts in this location interfere with restoration of endosteal blood supply; because they are in the central axis of the bone, they resorb rather than incorporate. The only possible use for a medullary graft is in the metacarpals and the metatarsals, where the small size of the bone enhances incorporation. Even in this location, however, internal fixation with onlay or intercalary cancellous bone grafting may be a superior method.

Osteoperiosteal grafts

In osteoperiosteal grafts, the periosteum is harvested with chips of cortical bone. These grafts have not been proven to be superior to onlay cancellous bone grafting, are more difficult than cancellous bone to harvest, and may involve greater morbidity; they are rarely used today. Pedicle grafts Pedicle grafts may be local or moved from a remote site using microvascular surgical techniques. In local muscle-pedicle bone grafts, an attempt is made to preserve the viability of the graft by maintaining muscle and ligament attachments carrying blood supply to the bone or, in the case of diaphyseal bone, by maintaining the nutrient artery. Two examples are the transfer of the anterior iliac crest on the muscle attachments of the sartorius and rectus femoris for use in the Davis type of hip fusion and the transfer of the posterior portion of the greater trochanter on a quadratus muscle pedicle for nonunions of the femoral neck. Multiple Cancellous Chip Grafts. Multiple chips of cancellous bone are widely used for grafting. Segments of cancellous bone are the best osteogenic material available. They are particularly useful for filling cavities or defects resulting from cysts, tumors, or other causes, for establishing bone blocks, and for wedging in osteotomies. Being soft and friable, this bone can be packed into any nook or crevice. The ilium is a good source of cancellous bone, and if some rigidity and strength are desired, the cortical elements may be retained.

In most bone-grafting procedures that use cortical bone or metallic devices for fixation, supplementary cancellous bone chips or strips are used to hasten healing. Cancellous grafts are particularly applicable to arthrodesis of the spine, since osteogenesis is the prime concern. Hemicylindrical Grafts Hemicylindrical grafts are suitable for obliterating large defects of the tibia and femur. A massive hemicylindrical cortical graft from the affected bone is placed across the defect and is supplemented by cancellous iliac bone. A procedure of this magnitude has only limited use, but it is applicable for resection of bone tumors when amputation is to be avoided. The fibula provides the most practical graft for bridging long defects in the diaphyseal portion of bones of the upper extremity, unless the nonunion is near a joint. A fibular graft is stronger than a full-thickness tibial graft, and when soft tissue is a wound that could not be closed over dual grafts may be closed over a fibular graft. Sliding graft This technique is rarely used today, because internal fixation combined with onlay cancellous bone graft provides a better result. This technique may be combined with internal fixation if there is limited space to place a cancellous graft. The disadvantages of the sliding or reversed bone graft are that, after the cuts are made, the graft fits loosely in the bed, and it creates stress risers proximally and distally to the nonunion site. Peg and Dowel grafts

Dowel grafts were developed for the grafting of nonunions in anatomic areas, such as the scaphoid and femoral neck, where onlay bone grafting was impractical. In the carpal scaphoid, the dowel is fashioned from dense cancellous bone. The use of the dowel graft for the management of nonunion of the femoral neck. Free microvascularized fibula grafts are more commonly used today. A corticocancellous graft of appropriate length and approximately 25 mm wide is harvested from the ilium or the tibia. The curvature of the ilium often makes it difficult to obtain a straight graft of sufficient length.

Autogenous bone Graft Donor sites are as following:
1)Ilium.55,56
2)Tibia.49,50,51,52,53
3)Mandibular ramus.30,39,42,43,44,45,46,47,48
4)Mandibular symphysis.12,30,32,33,34,37,38,39,40,41
5)Maxillary tuberosity.24,25,26

AUTOGENOUS GRAFT RECIPIENT SITES

Incisions to expose the recipient site are typically made along the ridge crest through attached gingiva. Crestal incisions maintain vascular supply to the flaps because vessels facial to the ridge do not cross over to the palatal or lingual regions.128 Divergent releasing incisions remote to the defect facilitate closure and also maintain blood supply to the flap. The mucoperiosteal reflection is made over a broad area, well beyond the defect margins. All soft tissue remnants are removed from the defect site. The osseous recipient bed is prepared to improve the fi t and contact of the bone block to the ridge. Perforation of the cortex with a small round bur releases growth factors, expedites revascularization of the graft, and improves the graft-tohost union60. The bone graft should have intimate contact with the underlying host bone. The clinician should preferably decorticate the host bone to mortise the cortical bone block to the ridge rather than significantly adjusting the graft.60 Corticocancellous block grafts require less adjustment because the softer cancellous bone will often mold to the ridge. Following harvest, the bone graft may be stored in sterile saline. Block bone grafts should be oriented with the cancellous side against the host bone.Block bone grafts do not tolerate micromovement and will fail to incorporate unless rigidly fixated. The graft is mortised into position and fixated to the ridge with screws. Fixation screws typically range from 1.0 to 2.0 mm in diameter. A screw length that maximizes retention within the host bone should be selected. A lag screw technique is used for fixation of cortical onlay bone grafts (See in Figures). The screw engages and threads the host bone, but fits passively through the cortical bone graft to compress and rigidly fixate the block. Although one screw may be considered for small block grafts, repairing single tooth sites, two or more screws should be used for larger grafts. The fixation screws may also have a positive effect on graft retention because they tent the periosteum during remodeling. The periphery of the block graft and small discrepancies between the graft and host bone may be filled with a variety of graft materials. If available, autogenous cancellous bone is preferred. An alternative is to harvest cortical shavings from local intraoral sites using a bone-scraping device. Particulate mineralized bone allograft or resorbable hydroxyapatite xenograft may also be considered for this purpose. The particulate bone may be mixed with platelet-rich plasma to improve the handling and placement. The routine necessity for barrier membranes over block bone grafts has been a debated topic. Cortical bone grafts exhibit minimal resorption and do not typically require membrane protection.12,13,62,63 Grafts with a larger cancellous component and particulate grafts are more susceptible to volume loss. When using corticocancellous block grafts, compaction of the cancellous bone with an instrument can help minimize overall resorption during healing. The use of a barrier membrane may improve the incorporation of the peripheral particulate graft around the block (See in Figures). They should always be used with particulate grafts for ridge augmentation. Collagen membranes are preferred because they are associated with fewer complications than polytetrafluoroethylene (PTFE) membranes, such as exposure and infection.64 Another approach for particulate cancellous bone is to use titanium mesh to support and protect the graft during healing65 (See in Figures).Vicryl and PTFE sutures are preferred over materials such as chromic gut or silk. Multiple interrupted or mattress sutures are used to close the flaps over the grafted site. It is imperative that the graft is immobilized during healing. A fixed provisional prosthesis, such as a temporary bridge or bonded prosthesis, is preferred for tooth replacement over the grafted site. The use of a soft tissue borne removable prosthesis is discouraged for the first few weeks until the incision has healed. Removable prostheses should then be adjusted to minimize any contact with the grafted site. The facial flange is completely removed, and the ridge area is relieved. The prosthesis may be relined with tissue conditioner, and denture adhesive is often necessary for added retention. The patient is instructed to use the removable prosthesis for cosmetic appearance and minimize function. Unfavorable concentration of forces from the opposing dentition should be avoided, and a broad distribution of occlusal contacts is preferred.65 Patients wearing removable prostheses over larger bone grafts should maintain a softer diet for at least 2 months after surgery. After this time period, the onlay graft has formed a union to the host bone and relies less on the fixation screws for immobility. Transitional implants have been used successfully to support fixed interim prostheses for patients less tolerant of complete or partial dentures. Postoperatively the patient should continue antibiotic therapy for at least 1 week. Nonsteroidal antiinflammatory drugs may be considered for pain control. Chlorhexidine rinsing is used for oral hygiene until the sutures are removed. Smoking has been associated with a high rate of wound dehiscence and graft failure.67 A smoking cessation protocol is followed, including the use of prescription medications, such as bupropion, and the nicotine patch. Patients are instructed to quit 1 week before surgery and told not to smoke at least until the incision is completely closed.

IMPLANT PLACEMENT IN ONLAY BONE GRAFTS

Reconstruction of the atrophic jaws for implant placement is usually staged with implant placement after graft healing. Previous studies on simultaneous bone graft and implant placement reveal lower success rates, unpredictable bone remodeling, and diminished bone-to-implant contact.3,28,6,7 Onlay bone grafts should be allowed to incorporate before dental implant placement. Enough time should elapse for graft incorporation, but implants should be inserted early enough to stimulate and maintain the regenerated bone.8 Autogenous block grafts should heal for approximately 4 months before implant placement.12,9 Particulate cancellous bone grafts with barrier membranes or titanium mesh used for ridge augmentation often require longer healing periods of at least 6 months. The placement of implants into healed bone grafts is similar to their use in sites that have not been grafted. However, the implant site is often at the junction between the block and host bone. The surgeon should be careful not to displace the block from the ridge during the implant osteotomy and placement. Fixation screws are usually removed before implant insertion. Elevation of large flaps simply for screw removal is discouraged because this disrupts the vascular supply to the healed graft. Small mucosal incisions over the screw heads allow for easy retrieval. If a fixation screw is not in the path of implant insertion, it may be left intact, especially if it will provide added stability to the graft. Upon healing, the quality of block mandibular bone grafts is often dense, regardless of the original quality of the recipient bone. An appropriate drilling sequence for dense bone and even tapping may be necessary for implant insertion in cortical bone grafts. The healing period of implants placed into incorporated bone grafts is similar to native bone. Microtextured implant surfaces have diminished healing implant periods to as little as 6 weeks.10 Immediate implant loading in grafted bone may even be considered if primary implant stability is adequate. Additional graft resorption following implant placement and delayed loading has not been noted radiographically.11

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