ORIGINAL RESEARCH PAPER

Volume - 9 | Issue - 9 | September - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

BONE GRAFTING MATERIALS IN IMPLANT DENTISTRY: AN OVERVIEW

Prosthodontics

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ABSTRACT

The implant restoration is an essential everyday treatment to replace missing teeth, advance function and enhance esthetics for patients in the general dental practice. An understanding of implant hardware design and placement for optimum clinical results is common knowledge for the dental practitioner. The understanding of bone grafting needs and procedures that are the foundations for implant treatment. Bone graft substitute materials play an important role in reconstructive surgery, and understanding the biologic effects of these materials is necessary for optimum use. Bone graft materials can be divided broadly into autograft, allograft, xenograft, synthetic materials, and combinations. Bone augmentation procedures are routinely applied in cases of alveolar ridge deficiency, in order to achieve sufficient vertical and/or horizontal bone volume, which ensures successful outcomes of dental implant therapy. This article will review different types of bone graft materials ,the basic principles for bone grafts in implant dentistry: the rationale, indications, locations, requirements, types, materials, and surgical procedures for both hard and soft tissue grafting in the placement of endosseous dental implants.

KEYWORDS

Guided Bone Regeneration, Block Graft, Distraction Osteogenesis

INTRODUCTION

The implant restoration is an essential everyday treatment to replace missing teeth, advance function and enhance esthetics for patients in the general dental practice. An understanding of implant hardware design and placement for optimum clinical results is common knowledge for the dental practitioner[1]. Treatment planning for bone graft placement requires the selection of an appropriate surgical technique and graft material. Poor planning or execution may lead to resorption of the graft material or its failure to integrate. In addition, the lost tissue may be replaced by fibrous tissue rather than functional bone[2]. Following the extraction of a tooth, 40 to 60 percent of the original height and width of the surrounding alveolar bone is expected to be lost; the greatest loss is in the first two years. With this loss of hard and soft tissue, conditions are less favourable for the proper axial alignment of the implant for function and esthetics. To minimize alveolar atrophy post extraction, healing procedures termed "socket preservation" or "ridge preservation" have been developed. These procedures involve filling the socket with bone or bone substitute material, with or without a membrane[3].

This article will address the basic principles for bone grafts in implant dentistry and various surgical procedures for hard and soft tissue grafting before and after placement of dental implants[4].

- **Indications for Bone Grafts** :

Bone graft materials are placed in different locations for various indications[1]:
- In alveolar sockets post extraction
- To refill a local bony defect due to trauma or infection
- To refill a peri-implant defect due to peri-implantitis
- For vertical augmentation of the mandible and maxilla
- For horizontal augmentation of the mandible and maxilla

- **Requirements for the Ideal Bone Graft:**

Definition proposed by "***Muschler and Lane***": a bone graft material is any implanted material that, alone or in combination with other materials, promotes a bone healing response by providing osteogenic, osteoconductive, or osteoinductive activity to a local site.

An ***osteogenic*** material can be defined as one which contains living cells that are capable of differentiation into bone. An ***osteoconductive*** material promotes bone apposition to its surface, functioning in part as a receptive scaffold to facilitate enhanced bone formation. An ***osteoinductive*** material provides a biologic stimulus that induces local or transplanted cells to enter a pathway of differentiation leading to mature osteoblasts[6].

Bone healing and new bone formation after grafting occur through osterogenesis, osteoinduction and osteoconduction:[5]

- **Osteogenic** graft materials supply actual viable osteoblasts themselves
- **Osteoinductive** materials stimulate primitive mesenchymal cells brought in via the blood supply from adjacent bone or periosteum to differentiate into osteoblasts
- **Osteoconductive** materials merely act as a lattice or framework for cell growth, allowing osteoblasts from the wound margin to infiltrate the defect and to migrate across the graft. This brings a population of osteoblasts into the graft site.

For the bone graft to be successful[2]:
1. Osteoblasts must be present at the site
2. Blood supply must be sufficient for nourishment
3. The graft must be stabilized during healing
4. The soft tissue must not be under tension

- **Grafts are classified as**[3]
- **Autograft (autogenous graft):** Tissue transferred from one location to another within the same individual
- **Allograft**: A graft between genetically dissimilar members of the same species i.e. human tissue
- **Xenograft**: A graft taken from a donor of another species i.e. bovine, porcine etc
- **Alloplast**: Inorganic, synthetic or inert foreign material implanted into tissue.

The ***autograft*** is the patient's own bone. It is chiefly harvested intraorally or from the iliac crest. It is the ideal bone substitute since in contains living cells and human growth factors. It has greater osteogenic potential than any other bone substitute as well as inherent biocompatibility.

The ***allograft*** can be derived from cadavers or living donors (tissue harvested from hip replacement surgery). It has natural bone composition and structure. This tissue is osteoinductive as well as osteoconductive but lacks osteogenic properties because of the absence of viable cells. Frozen allografts induce stronger immune responses than freeze dried allografts, hence they are no longer used. Allografts are available in different shapes from demineralized bone matrix granules to complete bone segments.

Labial Granules can be used in socket preservation for future implant placement, ridge reconstruction for prosthetic therapy, filling osseous defects and maxillary sinus floor elevation. Allograft bone segment blocks are a predictable and effective alternative to traditional autogenous block grafting and ridge augmentation. When very large areas need to be grafted, a shell of autogenous bone is often used as a biologic container; this creates the necessary space for the incorporation of the particulated bone graft material. The bone cells in the autogenous bone die within a few days and then the boneplate functions as a stable, avital, slowly resorbable membrane. Allogenic bone blocks can also be used for this shell technique as a substitute for autogenous bone. This avoids the time consuming harvesting and splitting of the autogenous bone blocks. The space between the local bone and surrounding shell can be filled with a variety of different particulated bone grafting materials (autogenous, allogenic, xenogenic or alloplastic).

The ***xenograft*** is derived from other organisms, mainly bovine. It provides long-term volume stability. Porous natural hydroxyapatite can be obtained from animal bones. Bovine bone has a long well-documented tradition. It is deproteinized by heating to eliminate the risk of allergic reactions and disease transmission. The removal of all proteins transforms it into biologically derived hydroxyapatite ceramic. It is characterized by well-preserved 3D natural bone structure similar to human bone. The trabecular architecture with interconnecting pores allows for optimal in-growth of new vascularity.Guided osseous integration rather than rapid resorption leads to excellent volume stability of the graft with the formation of new bone on the highly structured bovine bone surface. The bovine bone xenograft is osteoconductive and is available in a range of volumes and particle sizes. Another option is the use of bovine collagen. Untreated collagen (which acts as a scaffold) and heat-denatured collagen (which stimulates growth) are mixed, freeze-dried and crosslinked by heat. The material is then processed into a sponge block and formed into a bullet shape for easy placement into the extraction socket.

The ***alloplast*** is synthetically produced so there is no risk of disease transmission. The most common alloplastic materials are calcium phosphate based ceramics such as hydroxyapatite (HA) and tricalcium phosphate (TCP). Calcium phosphates are BIOACTIVE and RESORBABLE. They support attachment and proliferation of bone cells and undergo natural remodeling. There is an initial integration of the material into the surrounding bone matrix and then a gradual degradation. HA is incompletely resorbed while TCP is completely resorbed. HA is the inorganic base bone substance that makes up two thirds of bone. HA ceramics are chemically nearly identical to natural HA. TCP is a calcium phosphate ceramic that is used as a synthetic scaffold substance in dentistry and orthopedics. Both TCP and HA have blood biocompatibility and osteoconductivity without immunogenic or toxic effects. However, they possess no osteogenic or osteoinductive properties and demonstrate minimal immediate structural support. HA and TCP differ in the biologic response created at the host site. TCP is removed from the implant site as bone grows into the scaffold; HA is more permanent. HA's slow solubility provides long term volume stability. It is also an excellent carrier of osteoinductive growth factors and osteogenic cell populations, adding to its value as a bioactive delivery vehicle. An ideal bone regeneration material should be resorbed in pace with new bone formation.

The basic principle of using HA and TCP in combination is a balance between the stable HA which can be found years after implantation, and the fast resorbing TCP. The ratio between the two affects the resorptive properties of the graft material. A ratio between 65:35 and 55:45 of HA to TCP has been proven particularly suitable in many studies. The HA portion remains integrated in the newly formed bone, while the TCP part of the product is resorbed; it is replaced by new bone which imbeds itself within the remaining HA component creating a stable scaffold.4 Products with TCP alone are completely resorbed and replaced by bone within five to 15 months.4 Bioactive glass is another alloplastic bone substitute material. It is used extensively in orthopedics and dentistry. It is more reactive than inert materials like HA or TCP. Intrinsic properties of bioactive glass give it the ability to promote natural bone regeneration by releasing mineral ions. After reacting with blood it binds with bone and progressively releases silica ions. This stimulates osteoblast differentiation and proliferation. Over time, it is fully absorbed and replaced by bone. When mixed with autogenous bone graft material, it doubles natural bone regeneration.Different types of bone substitute materials can be combined and even hybridized to accommodate the needs of the clinical situation. Adjustment of material composition and physical characteristics allows for a wide range of resorption rates as well as physical forms such as powders, granules, pastes, blocks and even custom manufactured grafts[3].

- **Surgical Techniques For Hard Tissue Grafting :**

Adequate bone volume pre-requisites the implant therapy and proper esthetic result. Inadequate alveolar bone height and width often requires bone augmentation procedures either performed prior to, at the time of, or after the implant surgery.

There are several techniques that had been described for ridge augmentation:

- **Guided bone regeneration:**

The concept of guided bone regeneration implies the use of cell-occlusive membranes for space provision over a vertical or horizontal defect, promoting the in-growth of osteogenic cells while preventing migration of undesired cells from the overlying soft tissue.[6] Space maintenance by various particulate graft materials and the use of resorbable, non-resorbable as well as titanium-reinforced membranes has been described.

mean increase in horizontal and vertical dimensions of 2.6 mm and 3.6 mm, respectively[7]

- **Block Graft:**

Onlay bone grafts are used for external augmentation of horizontal (veneer graft) or vertical alveolar ridge defi ciencies, as well as combined defects (saddle graft). Compression screws are placed to fix bone blocks to the residual alveolar crest that should be extensively perforated to increase blood supply to the host-graft interface[8] Barrier membranes are not routinely used with cortical block grafts[9]

A mean increase in horizontal and vertical dimension of 4.4 mm and 3.7 mm has been reported[10]

- **Particulate Graft:**

Particulate onlay grafts have been used extensively for reconstruction of mandibular alveolar defects. Both autogenous and non-autogenous options can be used. The graft is usually harvested using a bone shaver. Allergenic and xenogenic particulate grafts have been growing in popularity. These grafts are readily available and abundant. They can be used in combination with autogenous bone or alone.[11]

- **Alveolar ridge expansion:**

It is also known as bone splitting technique. Following crestal osteotomy, the buccal cortex is gently expanded against the lingual plate using osteotomes of increasing diameters to allow implants to be placed in between. The residual gap created may be filled with graft material. Bone splitting of knife-edge ridges is only possible if the buccal and lingual cortices are separated by spongy bone[10]

Indication:

When the bucco-lingual bone width is 3 mm or greater but less than 6 mm, to allow implant placement. The existing 3 mm bone should have at least 1 mm of trabecular bone between the cortical plates[12].

- **Distraction osteogenesis :**

In this technique, a defect is created when two bone segments are slowly separated under tension. One week after osteotomy and distractor placement (latency period), distraction of segments is advanced at a rate of 0.5-1 mm per day until the desired separation is reached. A consolidation period of 5 days per mm of the space created should be maintained before device removal and implant placement. It allows for a vertical bone gain of 3-20 mm without the use of graft material and additional mucosal grafting is not required as the soft tissue follows bone distraction.[13]

- **Surgical techniques for soft tissue grafting :**

Several surgical techniques may be applied to obtain an adequate emergence profile of the restoration with suffi cient keratinized gingiva:[14,15]

- **The "roll flap procedure:**

The roll technique, described by Abrams in 1980, involves the preparation of a de-epithelialized connective tissue pedicle graft, which is subsequently placed in a subepithelial pouch. The length of the pedicle should be compatible with the height of the defect on the buccal aspect and similar to the crest in mesiodistal direction. This pedicle is rolled under the buccal mucosa to increase the buccolingual dimension of the edentulous ridge for later fabrication of a fi xed prosthesis. The flap is released by two vertical incisions extended beyond the mucogingival junction[16].

- **The "pouch procedure :**

A subepithelial pouch is prepared in the area of the ridge deformity,

PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

into which a free graft of connective tissue is placed and molded to create the desired contour of the ridge. The entrance incision and the plane of dissection may be made in different ways:

Coronal–apically: The horizontal incision is made on the palatal or lingual side of the defect and the plane of dissection carried in an apical direction

Apical–coronally: The horizontal incision is made high in the vestibule near the mucobuccal fold and the plane of dissection is carried coronally to the crest of the ridge

Laterally: One or two vertical entrance incisions are started from either side of the defect. The plane of dissection is made laterally across the span of the deformity.

- **Onlay grafts:**

An onlay graft is a full-thickness detached mucosal graft that is shaped to fill in a ridge defect. A large full-thickness tissue graft is obtained from the palate and trimmed, shaped and adapted to fit the defect[17].

- **Interpositional grafts:**

Interpositional grafts are not completely submerged and covered in the manner that a sub-epithelial connective tissue graft is placed. Therefore, there is no need to remove the epithelium from the surface of the donor tissue. If augmentation is required not only in the buccolingual but also in the apico-coronal direction, a portion of the graft must be positioned above the surface of the tissue surrounding the recipient site. A certain amount of the grafted connective tissue will thus be exposed in the oral cavity

- **Combination grafts:**

the ridge has to be augmented in both vertical and horizontal dimensions. The combined onlay–interpositional graft procedure may successfully be used in such a situation[18].

- **Barrier Membrane:**

A wide range of membrane materials have been used in experimental and clinical studies to achieve GBR including polytetrafluoroethylene (PTFE), expanded PTFE (ePTFE), collagen, freeze-dried fascia lata, freeze-dried dura mater allografts, polyglactin 910, polylactic acid, polyglycolic acid, polyorthoester, polyurethane, polyhydroxybutyrate, calcium sulfate, micro titanium mesh, and titanium foils.[19]

- **CONCLUSION:**

The subject of bone grafts for implant procedures is complex and confusing for the surgeon, let alone the restorative dentist and patient. This article has attempted to simplify and clarify the basics.

- **REFERENCES**

1. Klein, M. O., & Al-Nawas, B. (2010). For which clinical indications in dental implantology is the use of bone substitute materials scientifically substantiated?. European journal of oral implantology, 4, 11-29.
2. Smiler, D., & Soltan, M. (2006). The bone-grafting decision tree: a systematic methodology for achieving new bone. Implant dentistry, 15(2), 122-128.
3. Goldstep F.,(2015). Bone Grafts For Implant Dentistry: The Basics.
4. Prasad, D. K., Mehra, D., & Prasad, D. A. (2014). Osseointegrated supported prosthesis-Surgical techniques for hard and soft tissue grafting. Journal of Dental Implants, 4(1), 72.
5. Wang, H. L., & Neiva, R. F. (2008). Socket augmentation: rationale and technique. Fundamentals of Esthetic Implant Dentistry, 209.
6. Buser, D., Brägger, U., Lang, N. P., & Nyman, S. (1990). Regeneration and enlargement of jaw bone using guided tissue regeneration. Clinical oral implants research, 1(1), 22-32.
7. Chiapasco, M., Casentini, P., & Zaniboni, M. (2009). Bone augmentation procedures in implant dentistry. International Journal of Oral & Maxillofacial Implants, 24.
8. Stellingsma, C., Vissink, A., Meijer, H. J. A., Kuiper, C., & Raghoebar, G. M. (2004). Implantology and the severely resorbed edentulous mandible. Critical reviews in oral biology & medicine, 15(4), 240-248.
9. Pikos, M. A. (2005). Mandibular block autografts for alveolar ridge augmentation. Atlas of the oral and maxillofacial surgery clinics of North America, 13(2), 91-107.
10. Jensen, S. S., & Terheyden, H. (2009). Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. In Database of Abstracts of Reviews of Effects (DARE): Quality-Assessed Reviews [Internet]. Centre for Reviews and Dissemination (UK).
11. Torres, J., Tamimi, F., Alkhraisat, M. H., Manchón, Á., Linares, R., Prados‐Frutos, J. C., ... & López Cabarcos, E. (2010). Platelet‐rich plasma may prevent titanium‐mesh exposure in alveolar ridge augmentation with anorganic bovine bone. Journal of clinical periodontology, 37(10), 943-951.
12. Elian, N., Jalbout, Z., Ehrlich, B., Classi, A., Cho, S. C., Al-Kahtani, F., ... & Tarnow, D. P. (2008). A two-stage full-arch ridge expansion technique: review of the literature and clinical guidelines. Implant dentistry, 17(1), 16-23.
13. Bernstein, S., Cooke, J., Fotek, P., & Wang, H. L. (2006). Vertical bone augmentation: where are we now?. Implant dentistry, 15(3), 219-228.
14. Cranin, A. N. (2002). Implant surgery: the management of soft tissues. Journal of Oral Implantology, 28(5), 230-237.
15. Heller, A. L., Heller, R. L., Cook, G., D'Orazio, R., & Rutkowski, J. (2000). Soft tissue management techniques for implant dentistry: A clinical guide. Journal of Oral Implantology, 26(2), 91-103.
16. De Melo, L. G., Neto, J. S., Teixeira, W., Ciporkin, F., & Figueiredo, C. M. (2006). Application of a modified roll technique to ridge augmentation before implant surgery: A case report. Periodontol 2000, 3, 49-56.
17. Seibert, J. S. (1983). Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts, Part I. Technique and wound healing. Compend Contin Educ Dent, 4(5), 437-453.
18. Seibert, J. S., & Louis, J. V. (1996). Soft tissue ridge augmentation utilizing a combination onlay-interpositional graft procedure: a case report. International Journal of Periodontics & Restorative Dentistry, 16(4).
19. Hämmerle, C. H., & Jung, R. E. (2003). Bone augmentation by means of barrier membranes. Periodontology 2000, 33(1), 36-53.