Bone grafts Creating Foundation for Implantology and Periodontology

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In present era, where there is significant progress in the understanding of biology of bone, wound healing and reconstruction of lost bone, its application in implants and reconstructive periodontal treatment has increased many folds. Treatment of periodontal disease revolves around scaling, root planing and maintenance by patient, but significant bone fill and regeneration of lost periodontal tissue has been achieved using guided tissue regeneration along with bone substitutes.

Implant dentistry revolves around bone, bone and only bone. Recently bone substitutes have established their foothold in the field of implant dentistry. Advanced techniques of ridge augmentation and sinus lifting procedures is now being routinely carried out. Also, guided bone regeneration technique is utilized for osseous defects and periimplantitis. As these advanced techniques were complex and required special training and skills, now preservation of extraction socket with bone grafts is becoming more popular.

There are many available bone grafts in market, but as usual the confusion is which one is the best? The question may be tricky but clinician's judgment, skill, experience and specific indications shows the path for optimum utilization of bone graft material. This article will give overview of available bone grafts and bone substitutes which will give better and predictable results.

Selection of specific grafting material is based on a number of factors each of which must be evaluated. The following factors should be considered-

1. Osteoinductive potential
2. Predictability
3. Accessibility
4. Availability
5. Rapid vascularization.
6. Safety
   - A. Biologic compatibility
   - B. Immunologic acceptability
   - C. Minimal operative hazard
   - D. Post operative sequelae
7. Workability

It is difficult to find a material with all these characteristics, and to date there is no ideal material or technique available. Many graft materials have been developed and tried in many forms. The following classification will categorize bone grafts-

I. Bone grafts:

1. Autogenous bone graft:

a. Intra oral sites
   i. Edentulous ridges
   ii. Healing wounds (extraction socket)
   iii. Maxillary tuberosity
   iv. Exostoses
   v. Mandibular symphysis
   vi. Mandibular ramus
   vii. Osteotomy sites of implants
   viii. Resective osseous surgery

b. Extra oral site:
   i. Iliac
   ii. Tibia

2. Allografts: (from tissue banks)
   a. Frozen cancellous iliac bone and marrow
   b. Freeze-dried bone allograft (FDBA)
   c. Demineralized freeze-dried bone allograft. (DFDBA)

3. Xenografts
   a. Anorganic bovine bone (Bio-oss)
   b. Combination of Anorganic bovine bone with cell binding polypeptide (Pepgen P-15)

II. Synthetic bone substitutes (Alloplasts)

a. Plastic material:
   i. HTR polymer composite of polymethylmethacylate andpolyhydroxyethylmethacrylate
   ii. Polyglycolic and polylactic acid - Fisiograft

b. Calcium phosphate biomaterials
   i. Hydroxyapatite (Sybograf, G-bone)
   ii. Tricalcium phosphate (RTR by Septodent)

c. Bioactive glass (Perioglass)

D. Coral-Derived materials
   i. Natural coral
   ii. Coral derived porous hydroxyapatite

Unlike other tissues, bone has the unique capacity to regenerate itself completely. The major limiting factor is maintenance of space for bone formation. Bone graft materials have been used to facilitate bone formation, within a given space by occupying that space and allowing the subsequent bone growth to take place. The biologic mechanisms that support the use of bone graft materials are osteogenesis, osteoinduction and osteoconduction.

Ellegard et al (1973) and Nielsen et al (1980) reported that grafting materials in periodontal bony defects may be,

a. Osteoproliferative (osteogenetic):
New bone is formed by bone forming cells contained in the grafted material.

b. Osteoinductive:
Bone formation is induced in the surrounding tissue immediately adjacent to the grafted material.

c. Osteoconductive:
Graft material does not contribute to new bone formation but acts as a scaffold for bone formation originating from adjacent host bone.

Biologic Properties of Various bone Graft Materials

Source	Osteoconductive	Osteoinductive	Osteogenic
Alloplast	Yes	No	No
Xenograft	Yes	No	No
Allograft	Yes	Yes/ No	No
Autograft	Yes	Yes	Yes

Autogenous bone graft:

It is considered to be the "gold standard" in bone grafts as they contain

viable cells, and are the only ones capable of osteogenesis. Unless an autogenous graft is in close apposition to a vascular supply, it will not survive the transplantation process. Therefore most autografts function as osteoinductive &/or osteoconductive agents. However, the limited availability and the complications associated with the donor sites, clinicians knowledge and skills are its main disadvantages.

So research on suitable substitutes which offer similar potential for osteogenesis but which do not require the additional surgery at the donor site were investigated. Hence next viable and easily available options were Allografts (Obtained from genetically dissimilar individual of same species) and Xenografts (Tissue transferred from one species to another species). But it must be remembered that they are foreign to the host and will have potential to provoke an immune response. Hence attempts have been made to suppress the antigenic potential by radiation, freezing, and chemical treatment.

Allografts:

FDBA: This material is osteoconductive. Although FDBA contains inductive proteins, the polypeptides are sequestered by calcium. This material is resorbed and replaced by host bone slowly.

DFDBA: (Lam bone, Dembone, DBM)

It has been shown to induce new bone formation by osteoinduction. Demineralization with HCL exposes the bone inductive proteins located in the bone matrix. These proteins are collectively referred to as Bone morphogenic Proteins (BMP). Laboratory studies have found DFDBA has higher osteoinductive potential than FDBA.

This suggests that DFDBA may have clinical application and may be a superior allograft for dental applications.

Xenograft:

Anorganic bovine bone (Bio-oss): Bovine bone that has been chemically treated with ethylenediamine to remove its organic components, leaving a trabecular & porous architecture similar to human bone. It is osteoconductive. Several studies have reported successful bone regeneration in periodontal defects, around implants and in sinus lift procedures.

Synthetic bone substitutes (Alloplasts):

They are synthetic, inert, biocompatible materials.

HTR polymer is a biocompatible microporous composite of polymethylmethacrylate, polyhydroxyethylmethacrylate.

Hydroxyapatite: It is the primary mineral component of bone. Synthetic hydroxyapatite has been marketed in variety forms.

A) Porous non-resorbable
B) Dense non-resorbable
C) Resorbable form.

When prepared at high temperature (sintered) hydroxyapatite is non-resorbable, non-porous, dense and has a larger crystal size. These grafts are osteoconductive and act primarily as inert biocompatible fillers. Porous hydroxyapatite is obtained by the hydrothermal conversion of calcium carbonate exoskeleton of the natural coral into the calcium phosphate hydroxyapatite.

Another form of synthetic hydroxyapatite is a resorbable, particulate material processed at a low temperature. This resorbable form is a non-sintered precipitate with particles ranging from 300-400m. Its reported advantage is slow resorption rate allowing it to act as a mineral reservoir at the same time acting as a scaffold for bone replacement.

Tricalcium phosphate: It is a porous form of calcium phosphate, commonly used form being -tricalcium phosphate. It serves as biological filler which is partially resorbable and allows bone replacement.

Bioactive glass: Bioactive glasses are composed of salts of calcium, sodium, phosphates, Silicon dioxide, etc; they bond to bone through the development of a surface layer of carbonated hydroxyapatite. When exposed to tissue fluid, bioactive glasses are covered by a double-layer composed of silica gel and a calcium phosphorous (apatite) rich layer. The calcium phosphate layer promotes adsorption and concentration of proteins utilized by osteoblasts to form a mineralized extracellular matrix.

Synthetic bone graft materials clinically and radiographically have shown their capability of inducing bone fill. However it should be noted that when they are histologically evaluated they show encapsulation by connective tissue fibers (collagen) with little or no evidence of periodontal regeneration (new attachment).

Conclusion

Bone grafts have been used to treat the osseous defects associated with periodontal disease successfully since 4 decades and in implantology for more than a decade. The results of studies using GTR/GBR along with bone graft therapy suggest their clinical efficacy and stability over relatively long-term intervals. The present research data indicates best bone graft material singly is autogenous, followed by DFDBA, Xenograft and Bioactive glass. However combinations of autogenous and allografts/xenografts to increase the volume of bone to be grafted have also shown tremendous potential for clinical use.

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