



Bone Grafts in Oral Surgery

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ABSTRACT- Bone grafts can be used as scaffolds to facilitate new bone formation and promote wound healing . They can even be used as filler materials . These bone grafts act as mineral store houses which help in inducing new bone formation . Most of them are bio-resorbable which do not have any antigen – antibody reaction .

KEYWORDS – Allograft , Autograft , Hydroxyapatite , Bone repair , Implant , Polymer

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Ridge defects may develop after any surgical intervention , trauma , infection or any congenital malformations . The aim of grafting is maintenance of contour and shape , elimination of dead space and reducing the post operative infection . The goals are mainly targeted at enhancing the osseous and soft tissue healing. There is rapid resorption of alveolar bone which results as a result of tooth loss .This tooth loss is subsequent to lack of intra osseous stimulation by periodontal ligament (PDL)

Bone grafting is a surgical procedure that involves replacement using patients' own bone , an artificial , synthetic or a natural substitute .The ability of the bone tissue to regenerate completely into the space provided has made bone grafting possible . After the grafting is complete , the natural bone grows , replacing the graft material completely , leading to a fully integrated region of new bone .

Classification of bone grafts based on the material groups : ^[1]

(a) Allograft- based bone graft involves allograft bone , used alone or in combination with other materials (eg., Grafton , Orthoblast)

(b) Factor –based bone graft are natural and recombinant growth factors , used alone or in combination with other materials such as transforming growth factor – beta (TGF – β) , fibroblast growth factors (FGF) , platelet derived growth factor (PDGF) and bone morphogenic protein (BMP) .

(c) Cell- based bone grafts use cells to generate new tissue alone or added onto a support matrix , eg , mesenchymal stem cells .

(d) Ceramic –based bone graft substitutes include calcium phosphate , calcium sulphate and bioglass used alone or in combination eg., OsteoGraf.

(e) Polymer –based bone graft uses degradable and non degradable polymers alone or in combination with other materials eg open porosity polylactic acid polymer .

The biological mechanisms that provide a rationale for bone grafting can be described as osteoconduction , osteoinduction and osteogenesis .^[2]

I. OSTEOCONDUCTION

Osteoconduction occurs when bone graft material serves as a scaffold for osteogenesis , which is initiated by the native bone .Osteoblasts migrate from the margin of the defect that is being grafted , utilize the graft material as framework and generate new bone .^[1] A bone graft material should be osteoconductive in the very least .

II. OSTEOINDUCTION

Osteoinduction involves the stimulation of osteoprogenitor cells to differentiate into osteoblasts and then begins formation of new bone . The most widely studied type of osteoinductive cell mediators are BMPs . A bone graft material that is osteo conductive and osteo inductive will not only serve as a scaffold for the existing osteoblasts but will also bring about the stimulation of new osteoblasts leading to faster integration of the graft .

OSTEOPROMOTION –

Osteopromotion involves enhancement of osteoinduction without possession of osteoconductive properties . Eg., Demineralized freeze-dried bone allograft (DFDBA)

OSTEOGENESIS

It occurs when the vital osteoblasts originating from bone –graft material contributes to the growth of new bone along with bone formation .

III. TYPES OF BONE GRAFTS

AUTOGRAFT – Autogenous bone grafting involves harvesting the bone graft from the same individual who receives the graft .The grafts can be harvested from non essential bones – such as iliac crest , mandibular symphysis , buccal shelf area , maxillary tuberosity and the anterior mandibular ramus region (coronoid process) . Whenever block grafting is performed , autogenous bone is most commonly preferred because there is less chances of graft rejection as the graft is obtained from the patient’s own body .^[3] One of the primary disadvantages of autogenous grafting is an additional site of surgery which increases the potential of post operative pain and complications .^[3]

Depending upon the transplant site and size of the graft , an additional blood supply may be required . For these grafts , extraction of the part of the periosteum and accompanying blood vessels along with the donor bone is required . This kind of graft is known as a free flap.

ALLOGRAFTS –

Allografts are the grafts that are harvested from the humans. The difference is that allograft is harvested from an individual other than the one receiving the graft .Allograft bone is harvested from individuals that have donated their bone so that it can be used for living people who are in need of it . There are essentially three types of bone allograft available :

- 1.Fresh or fresh – frozen bone.
- 2.FDBA
- 3.DFDBA

The utilization of allografts requires sterilization and deactivation of proteins normally found in healthy bone. The desired factors and proteins are removed from the mineralized bone by using an agent such as hydrochloric acid which serves as a demineralizer . The mineral content of the bone is degraded and the osteoinductive agents remain in a demineralized bone matrix (DBM) .

SYNTHETIC VARIANTS –

Flexible hydrogel – hydroxyapatite (HA) composite which has a mineral to organic matrix ratio , approximating that of human bone .

Artificial bone can be manufactured from ceramics such as calcium phosphates . bioglass and calcium sulphate are biologically active depending on solubility in physiological environment .^[5] These materials are either combined with growth factors , ions such as strontium or mixed with bone marrow aspirate to increase biological activity .The presence of elements such as strontium can result in greater bone density and increased osteoblast proliferation .

XENOGRAFT –

Xenografts are bone grafts which are derived from species other than human , such as bovine sources which are used as calcified matrix .

ALLOPLASTIC GRAFTS –

Alloplastic grafts may be derived from hydroxyapatite , a naturally occurring mineral or from bioactive glass. Hydroxyapatite is a synthetic bone graft which finds greater application nowadays because of its

osteoconduction, hardness and acceptability by bone. Some of the other synthetic bone grafts are made of calcium carbonate, their usage has decreased because of the resorbable nature makes the bone brittle. Lastly used is the tricalcium phosphate in combination with hydroxyapatite and thus giving effect of both, osteoconduction and resorbability.

GROWTH FACTORS –

Growth factors enhanced grafts are produced using recombinant DNA technology. They may be derived from human growth factors or morphogens (BMPs in conjunction with a carrier medium such as collagen). The factors and proteins that exist in bone are responsible for regulating cellular activity. Growth factors bind to receptors on cell surfaces and stimulate intracellular environment to act. This activity translates a protein kinase that induces a series of events resulting in transcription of messenger ribonucleic acid (mRNA) and ultimately lead into the formation of protein to be used intracellularly or extracellularly. The combination and simultaneous activity of various factors leads to a regulated production and resorption of bone. These factors that are present in extracellular matrix of bone, include TGF- β , insulin growth factors I and II, Platelet derived growth factor (PDGF), Fibroblast growth factor (FGF) and BMPs.^[6,7]

The addition of TGF- β and BMP-2, BMP-4 and BMP-7 to the culture media can also influence the stem cells towards osteogenic lineage. Mesenchymal cells have been also seeded onto bioactive ceramics which are conditioned to induce differentiation in osteoblasts.

CERAMIC BASED BONE GRAFT SUBSTITUTES –

Majority of the bone grafts that are available involve ceramics, either alone or in combination with another material (eg., calcium sulphate, bioactive glass). The use of ceramics, like calcium phosphates is calcium hydroxyapatite which is osteoconductive and osteointegrative and in some cases, osteoinductive as well. They require high temperatures for scaffold and have brittle properties.

- Calcium sulphate is also known as plaster of Paris. It is biocompatible, bioactive and resorbable after 30-60 days.
 - OsteoSet is a tablet used for defect packing. It is degraded in approximately 60 days.
 - Allomatrix is OsteoSet combined with DBM, forms a putty like mixture or an injectable paste. OsteoSet is a calcium sulphate tablet used for bone defect sites, whereas allomatrix is a combination of calcium sulphate and DBM that forms an injectable paste or a putty.
- Bioactive glass is a biologically active silicate-based glass,^[8] having a brittle nature. It has been used in combination with polymethylmethacrylate to form bioactive bone cement and with metal implants as a coating to form a calcium-deficient carbonated calcium phosphate layer which facilitates the chemical bonding of implants with the surrounding bone. Such calcium phosphate based products include Bio-Oss and OsteoGraft products use hydroxyapatite, either as a particulate or as blocks and particulates. The advantage of this material is that the structure of coral, which is similar to that of trabecular bone.

USES –

The most common use of bone grafting is in the placement of dental implants, in order to restore an edentulous area of missing tooth. In general, bone grafts may be used either as block form or particulate form for better adaptability to the defect site. The grafted, vascularized fibulas have also been used to restore the skeletal integrity of the long bones of the limbs in which congenital bone defects are present and to replace the lost segments after tumor or malignant invasion. In addition to the use of grafts in dental implants, this procedure is used to fuse joints to prevent movement, repair the broken bones that have bone loss and repair the broken bone that has not yet healed.^[9]

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