Review Article

Bone graft materials in dental implantology- An overview

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Abstract

Accidents, surgical removal of benign lesions or malignant neoplasms, congenital anomalies, periodontal inflammation, tooth abscess or extraction, and finally jaw atrophy owing to advanced age or general disease are all common causes of bone losses in the jaws.
For a number of reasons, including as maintaining the natural anatomic shape, removing empty space, aesthetic restoration, and the placement of dental implants, these bone abnormalities require rehabilitation. Various days, a number of methods, including as bone grafting, guided bone regeneration, distraction osteogenesis, usage of growth factors, and stem cells, have been developed to treat these bone abnormalities.Natural or artificial materials are used to create bone grafts, which have been demonstrated to have the ability to promote bone healing when implanted into the area of the defect. There are already a variety of materials available for bone restoration with different traits and qualities.Despite years of work, the "perfect" bone graft has not yet been found; further research is required before we can analyse its characteristics, advantages, and disadvantages as well as our current and projected uses for bone regeneration.

Keywords – Grafts , Osteointegration,Growth Fcators

INTRODUCTION-

Both alveolar resorption and subsequent bone formation in the socket is a physiological phenomenon after extraction which is followed by osteoblastic differentiation and osteo-progenitor cells Replacing the edentulous area with dental implants has become a leading treatment modality in the dental practice as it has improved aesthetics, osseous preservation, and hygiene accessibility. However, the available bone quantity and quality of the bone on the recipient sites have a great impact on the success rate of dental implants. Defects due to trauma, surgery, congenital abnormalities, infections, and also periodontal diseases all of the above may need augmentation for a successfulresult.[1,3]

The grafting of bone plays an important role in augmentation in regenerative dentistry. With Introduction of bone graft materials and use of different bone grafting techniques, it is able to increase the height, bone volume, and width of bone in the areas where regeneration of the tissues is required for supporting questionable teeth and angulations, which gives more acceptable and predictable also allows the implants to place in ideal positions and results.[2,6] For the graft to be successful there should be a sufficient no. of osteoblasts if not the graft will fail.

Requirement of bone graft materials

The two most important requirements for the placement of dental implants are sufficient bone volume and biologic quality. The demand for certain dimensional property for long term success is due to the macro design of the dental implant.[8]

Osteogenesis, osteoinduction and osteoconduction - These three factors occur after bone healing and new bone formation.

Osteogenic- osteoblast are themselves supplied by the graft material.

Osteoinductive- These materials are from the adjuction bone of the periosteum supply and stimulate primitive mesenchymal cells, via the the blood to differentiate into osteoblast.

Osteoconductive- These allow osteoblast to infiltration into the defect and cause i t t o migrate across the graft. It act as a framework for the cell growth.

Following are the factors for the bone graft to be successful-

At the site osteoblast should be present. For the nourishment blood supply should be sufficient..During healing the graft should be estabilised.

There should be no tension on the soft tissue. OSTEOBLAST- New bones are only created by osteoblasts. BLOOD SUPPLY- Grafting is not a repair but is a regenerative process. Regaining of the loss tissue is known as repair. When all the form and function of the tissue is regained it is known as regeneration, which is only possible due to proper blood supply to the surrounding tissues and grafts.[6] Clot formation and cell viability blood is needed. The main role is the initial matrix where cells migrates and serves as anchorage for the osteoblast is of the clot.

GRAFT STABILISATION-

Mechanical stresses which cause disruption of the fibrin clot can be due to application of stress on the graft during healing instead of filling the bone this movement can cause the fibrous tissue to fill the defect. It is not a true regeneration but a form of repair. Guided bone regeneration, collagen membrane, titanium mesh and bone screws are the fixation devices that can be used.[6,9]

NO TENSION ON SOFT TISSUE-

As the bone is known to be the slowest growing tissue. Separation of surrounding of the soft tissue from the area to be gafted is the principle on which guided bone regeneration is based. Tissue which hhave the ability t o g r o w f a s t e r like epithelium, fibrous tissue, gingival connective tissue are kept isolated from the defect which allows controlled regeneration.[8] This is the main advantage of the guided bone regeneration. Collagen membrane collapse is prevented due to the administration of the graft material into the defect s i t e which also act in the case of new regenerative bone as a placeholder.[12]

BONE GRAFT S AND SUBSTITUTE MATERIALS IN DENTISTRY

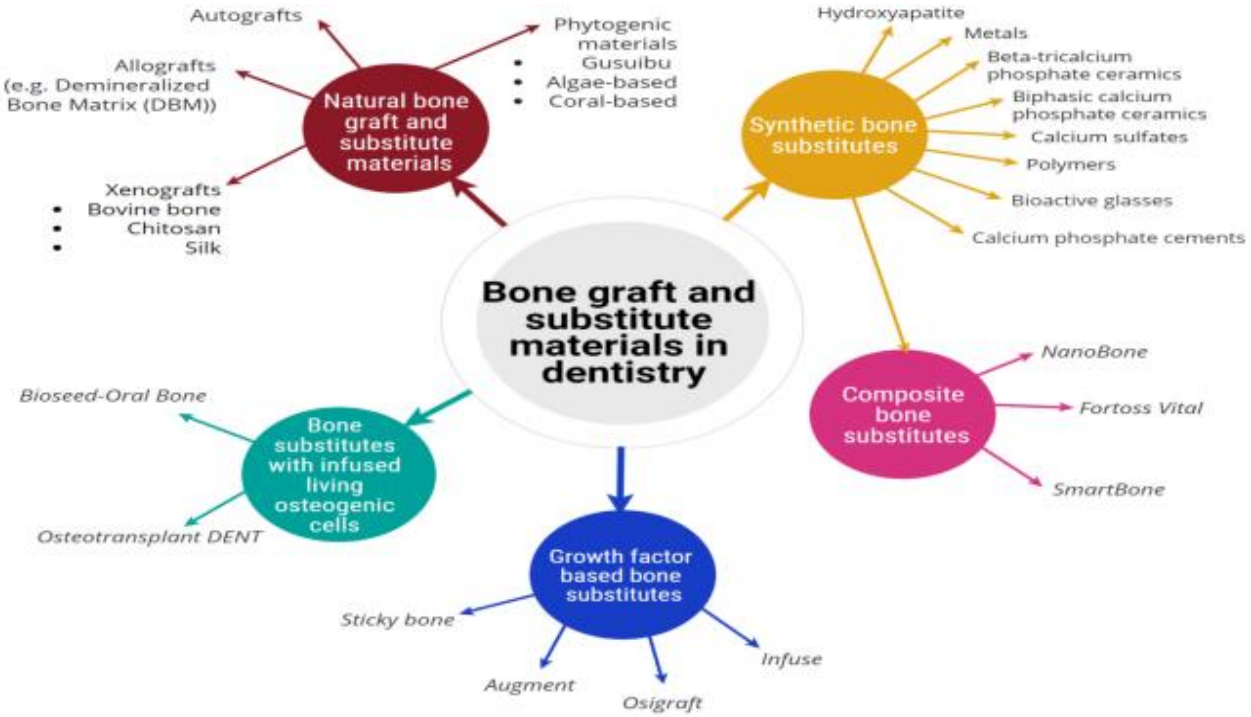

Fig-1

AUTOGENOUS BONE GRAFTS-

Transplantation of bone obtained from one individual receiving the bone graft. Grafts can easily be harvested from non-essential bones, such as from mandibular symphysis, iliac crest, and mandibular ramus area[1].

Autogenous graft is considered as the gold standard for regeneration of bone and must be preferred because of its less rejection rate as the graft is harvested from patients body itself. Autogenous bone graft gaveswell -provenpredictableresultsforaugmentationofridges and restoring bone defect for implant placement.

It possesses properties like-

osteoinduction, osteoconduction, osteogenesis.

They are from the identical biologic origin which makes it zero rejection rate,and obtaining >95% success rate . Autogenous block bone grafts have the ability to heal faster than any other methods such a guided bone regeneration using other bone substitutes. Autografts graft generally requires less healing period before implants is inserted.

Common disadvantages associated with autografts are- 1)Creation of second trauma in the patient which sometimes even affects the systemic health of the patient.

ALLOGRAFTS-

Non-vital osseous tissues which are originated from members of the same species who belong to a different genus.[3] Following thorough screening of the donor and thorough sociological, medical, and serological investigation, these grafts are chosen, prepared, and then maintained in bone banks2.[2]

Main types of bone allografts-

FRESH FROZEN BONE (FFB)-f rozed at 800 C to avoid degration caused by the enzymes.

The FFB is acellular , with highest osteoinductive & osteocondutive properties which is due to the presences of BMPSs. But due to disease transmission and the likelihood of a strong immune reaction, the graft is no longer used[2].

FREEZE-DRIED BONE ALLOGRAFTS (FDBA)-

FDBA has only Osteoconductive properties.

Decreased antigenicity because it undergoes dehydration and freezing without demineralization.

Comparision between autografts and allografts-

ADVANTAGES-

Osteogenic
Faster healing.
More durable
No fear of disease transmission
Readilyavailable
No hostrejection

DISADVANTAGES-

Increased operative time
Morbidity of donor site
Pain and chances of infection

ADVANTAGES-

Osteoconductive
Osteoinductive
No morbidity of donor site
Less post-operative pain
Easily available

DISADVANTAGES-

Fear of transmission of diseases
Chances of immune response and rejection
Somewhat expensive
EEthical and religious concern.

DIMINERALISED FREEZE-DRIED
BONE ALLOGRAFT(DFDBA)-

Both osteoconductive and inductive characteristics are exhibited by DFDBA. Dehydration causes the inorganic portion of the bone to disappear, leaving behind only organic portion, which contains BMPs.[2] Advantages of allografts- Availability in adequate quantites, shapes and sizes. Outcomes are predictable and the removal of donor site surgery.

Disadvantages of allografts- From donor to recipient: the transfer of disease. Immunogenicity.

XENOGRAFTS-

Xenografts are bone grafts acquired from species other than humans, such as cattle. With little potential for resorption, it possesses osteoconductive characteristics. In many cases, xenografts are coupled with bone grafts from different sources or with growth hormones, typically bovine[6].

Studies have demonstrated that when xenograft is placed on either hard or soft tissue these is lack of osteogenic response[6,8]. Disadvantage of xenografts includes transmission of virus and other infective agents.

ALLOPLASTIC

Development of diverse synthetic grafts has been facilitated by advancements in the field of biomaterial science, which aim to reduce infection, morbidity, and cost.

Alloplastics are those grafts that are created frominorganic sources without the use of human or animalparts. Alloplastic grafts are made from hydroxy-apatite, which is occurring minerals, made out of bio-active glass with their composition closely identical to natural bone.

Due to its osteoconduction, hardness, and acceptability of the hydroxyapatite by the bone it is mostly used[6]. Hydroxyapatite however have no osteoconductive or osteogenic properties and immediate structural support is also minimal.

A hetergenous group of materials, including calcium carbonate, calcium phosphate, bioactive glasses, calcium sulphate and polymers[2,4].

GROWTH FACTORS-

Various growth factorsincludes- 1.Platelets derived growth factor 2.Transforming growth factor 3.Insulin like growth factor 4.Vascular endothelial growth factor 5.Fibroblast growth factor6.Bone morphogenic proteins. Growth factors is refer to those protein which are capable of stimulating proliferation of the cell, their differential and prevention of apoptosis[4,5,6]. Functions of growth factor is to control internal process of the cell cycle, via abadonment of cellular quienscence (phase Go) and phase G1 entry of the cell. Growth factor helps in cell survival , migration of cell, differentiation, mitosis and maturation[4,6].

Commonly used growth factors –

PLATELET-DERIVED (PDGF)- PDGF one if the most vital wound healing hormones. Plays several essential roles in the formation of bone and its regeneration which includes-

Healing cells present in the wound site is increased. Convert the endothelial mitosis into the functioning capillaries. Debriment of the wound site.Act as a second phase growth phase.Growth factor power house for continuation ofbone regeneration. for cells of mesenchymal origin, including osteoblasts it act as a potent mitogen , causes cell differentiation , and chemotacticfactor. PDGFs subtypes- they have different physiologic roles and changes there expression patterns. it consist of homo or hetero dimers of PDGF-Alpha and PDGF -Beta gene products.Sources of PDGF are platelets, activated macrophages and bone matrix[5,8]

INSULIN- LIKE GROWTH FACTOR-IGF-I & IGF-II.are the two types of IGFs

There role are similar but it regulates independently . IGFS are functionally & biochemically identical to insulin. IGFs are primarily produced in liver. By promoting cell proliferation and differentiation as well as the synthesis of bone matrix, IGFs encourage the development of bone.

FIBROBLASTS GROWTH FACTOR-

FGF has general growth promoting effects on fibroblastic cells. FGF stimulates wound healing, migration of cells ,stimulates angiogenesis for vascular invasion of bone. Both these forms stimulates the replication of bone cells, but may inhibits the bone cells synthesis of matrix. Under several conditions , they have

no stimulatory effect on stimulatory effect on mature osteoblasts[13]

TRANSFORMING GROWTH FACTOR-

In both bone and platelets, TGF is a key multifunctional factor. TGF and bone morphogenic proteins share a structural similarity, however they operate fundamentally differently.[5,8]

TGF-β is mitogen which is weak for osteoblasts. TGF-β is chemotactic for bone cells and it shall be increasing or decreasing its proliferation depending on certain conditions.

TGF-β has shown to stimulate synthesis of type I collagen.

TGF- may stimulate the formation of new bones and cartilage, according to number of studies, but it must be applied in close proximity to a bony location.

PLATELET- RICH PLASMA-

PRP has gained tremendous clinical traction in a variety of surgical treatments, including oral regenerative ones. It is a concentrated autologous supply of growth factors, which also includes VEGF,

IGF, and PDGF as well as TGF-1 and TGF-2..[9,12]

a procedure that involves taking a little sample of the patient's own blood, sequestering the platelets, and then concentrating them.A 20 to 30 minute outpatient clinical setting isnecessary overall.[7] PRP transforms the graft substance to create a growth-rich membrane. On radiographs, it has been shown that adding PRP to the grafting process has sped up the process of bone development and produced better trabecular bone density than sites that have simply received autogenous bone graft material astreatment.

BMP is a potent bone inducing factor. They are actually a different group of protein from growth factors.

BMPS are composed of components which intiate growth such as metabologens and cytokines which has the ability to activate the bone and formation ofcartilage[4].

BMPS are vital component to building as well as healing tissues throughout the body.It act as a catalyst for triggering basic cells in the bloodstream resulting in it to form as a bone cells and the only proteins that have the necessary action to activate the formation of newbone.[6,9]

CONCLUSION-

Large bone defects and deficiencies are one of the most challenging task in implant dentistry. The subject of bone grafts for implant procedures is complex and many a times confusing for the dental surgeon[12]. This article has attempted to simplify andclarify the basics. Equipped with this information, the general dentist can be a better judge of the materials used[4,9,12]. This information can prepare the clinician for counselling patients on the surgical procedures to be performed and further exploration of simple bone grafting procedures that can be done in the general practice. Overall different groups of graft is available, still the autografts is considered to be the leading one. Due to it osteoinduction, osteoconduction, osteogenity[6].

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How to cite this article: Dutta A, Sharma M, Kumar S, Gopi A, Bumb P, Tomar N. Bone graft ma**terials in dental implantology** An overview. TMUJDent2022;9(4):28-30.

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