Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 82.06

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Bone Grafting in Implant Dentistry

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***ABSTRACT*:**
Bone grafting has become an integral part of Implant dentistry. Grafts are used in patients with inadequate bone volume or height which often requires the use of biomaterials during the surgical procedures to ensure implant success. Bony defects both horizontal and vertical defects that can be treated using graft materials, especially in the field of implant dentistry. Commonly used graft material includes autografts, allografts, xenografts, and alloplast. These materials mostly function as osteogenic, osteoconductive, osteoinductive scaffolds. Defects with four walls of host bone can be repaired with alloplasts alone or allografts. The loss of three or more bony walls mandates the addition of autogenous bone to the graft or the use of a membrane. The larger the defect, the more autogenous bone is required. Along with grafts to enhance healing membranes can be used, one of the recent advances of new generation platelet concentrate called PRF, which promotes bone regeneration, soft tissue healing, and better osseointegration can be achieved. All these biomaterials play a pivotal role in Regenerative dentistry, this article explains the various indications of bone substitutes and their specific applications in implant dentistry.

Key words: Biomaterial, Bone defects, Grafts, Implants, Platelet Rich Fibrin.

Received: 10 April, 2020 Accepted: 26 April, 2020

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This article may be cited as: Viswanathan J, Mohan J, Ramesh R., Kalaignan P, Rajkumar G. Bone Grafting in Implant Dentistry. J Adv Med Dent Scie Res 2020;8(5):31-36.

INTRODUCTION:
Tooth loss could be due to dental caries, periodontitis, or trauma. The loss of teeth in the anterior region is one of the main concerns of the patient. Dental implants are the advanced treatment to replace the missing teeth and this treatment plan shows predictable outcomes. Bone augmentation helps in providing sufficient quality and quantity of the bone in the atrophic ridges for the placement of dental implants. Grafts and guided bone regeneration techniques are used to improve primary stability during implant placement in atrophic ridges. (1) In this article, various types of graft materials including PRF, alloplast, GBR in implant dentistry are highlighted.
The patients presenting with inadequate bone volume represents clinical complexity and often requires additional biomaterials and surgical procedures in order to ensure successful implant treatment. They work on the principle of epithelial cell exclusion to allow periodontal ligament and alveolar bone cells to repopulate the defect before the normally faster epithelial cells. (1)
However, in an attempt to overcome complications, clinicians commonly use a combination of membranes with hard tissue grafts. That will promote bone regeneration, osseointegration process, soft tissue healing. The Rationale for Bone Grafts;

- The resorption of the edentulous ridge post-extraction
- Presence of bony defects due to trauma or infection
- The need to place implants in strategic sites for functional and aesthetic success.
- In Aesthetic areas, soft tissue requires a bony base since “soft tissue follows hard tissue” (17)

CLASSIFICATION OF BONE GRAFT MATERIALS

Human bone graft tissues	*Non human source material*	*Synthetic materials (Alloplasts)*
•a) Autografts (cancellous and cortical) •-Extra-oral •-Intra-oral •(b) Allografts (cancellous and cortical) •-Fresh and frozen bone •-Freeze dried bone allograft (FDBA) •-Demineralized freeze dried bone allograft (DFDBA)	•Xenografts •-Bovine Hydroxyapatite •-Porcine bone •-Equine bone •-Coralline calcium carbonate	•a) Bioactive glasses •(b) Calcium phosphates •-Hydroxyapatite •-Tricalcium phosphate •-Other calcium phosphates (Brushite, •monetite, calcium polyphosphates/CPP) •(c) Calcium Sulphate

PLATELET RICH FIBRIN

Platelet-rich fibrin (PRF) belongs to a new second generation of platelet concentrates. PRF was first used by Choukroun in 2001. It is considered to be a wonderful tissue engineering product and it has gained much popularity due to its promising results in wound healing.[11] Platelet cells interact, release growth factors. Growth factors are the biologically active substances that are involved in tissue-repair mechanisms such as chemotaxis, cell proliferation, angiogenesis, extracellular matrix deposition, and remodelling. PRF has a very significant slow sustained release of key growth factors for at least 1 week and up to 28 days, which stimulates its environment for a significant. Because of its natural fibrin framework properties, growth factors can keep their activity for a relatively longer period and promote tissue regeneration [7]

Classification of Platelet-rich Fibrin Products, Based on leukocyte content:

1. Pure PRF or leukocyte-poor PRF
2. Leukocyte-rich PRF (also called advanced PRF or Choukroun's PRF). [10]

ALLOPLAST

Alloplast is a synthetic graft material. It consists of 60% Hydroxyapatite crystals and 40% Tricalcium phosphate. Various grafting materials have been used to fill the gap to ensure the constitution of the osseous interface with the implant.

Beta tricalcium phosphate (b-TCP) is a biocompatible alloplast that has been shown to influence osteoconduction, simultaneously with osteoblastic activity. Histological study in humans found that pure-phase b-TCP had a resorption rate that enabled new bone formation without interfering with the bone matrix. b-TCP has been shown to completely resorb. [8]

GUIDED BONE REGENERATION (GBR)

GBR is performed simultaneously with other graft materials and is indicated only in narrow ridge defects with deficient bone height and width. Guided bone regeneration is the most frequently used procedure for the reconstruction of hard tissue. The treatment concept advocates that regeneration of osseous defects which mechanically excludes non-osteogenic cell structures, thereby allowing osteogenic cell populations originating from the parent bone to inhabit the osseous wound. [11]

Features of Guided bone regenerative membrane are absorbable in nature, and so it can be left in place. The membrane is made with a unique manufacturing process which creates a longer resorption profile suited to GBR procedures (6 months). The material consists of a fibrillar matrix structure to provide strength for tacking or suturing the membrane if desired. This composition provides excellent handling characteristics when hydrated—thus improving adaptability to various defects. [9]

GROWTH FACTORS

Platelet-based preparations from the patient's own blood provide an inexpensive alternative to commercially available bioactive materials. Activated platelets secrete a wide range of proteins and growth factors including, [4]

1. Bone Morphogenetic Protein (BMP),
2. Platelet-Derived Growth factor (PDGF),
3. Insulin-like Growth Factor (IGF),
4. Vascular Endothelial Growth Factor (VEGF),
5. Transforming Growth Factor-β1 (TGF-β1) and
6. Transforming Growth Factor-β2 (TGF-β2), [4]
7. Fibroblast growth factor
8. Epidermal growth factor. [10]

All the above-mentioned factors play a key role in bone healing. They attract undifferentiated mesenchymal cells to the injured site and facilitate angiogenesis, chemotaxis, and cell proliferation. Growth factors also control the synthesis and degradation of extracellular matrix proteins, enhance osteogenesis and potentially accelerate peri-implant wound healing and osseointegration. [4]

Mode of action:

On the external cell membranes of the graft, growth factors Binds to the transmembrane receptors

↓

Activation of an endogenous internal signal protein,

↓

Initiate the expression of a normal gene sequence of a cell such as a matrix formation, Cellular proliferation, osteoid production, and collagen synthesis. [5]

RISK FACTORS FOR FAILURE OF BONE GRAFT

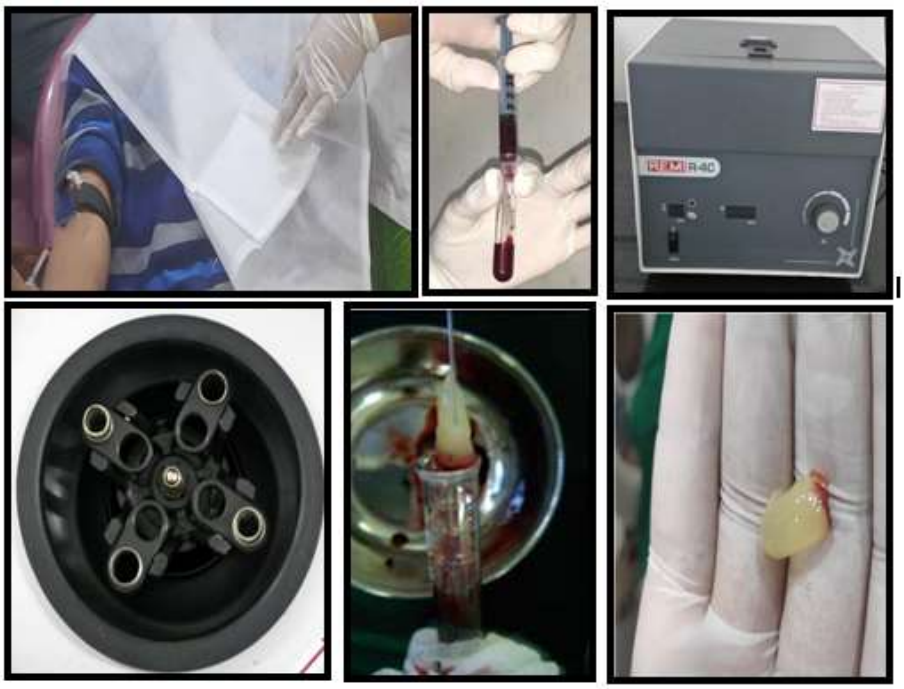
Periodontal disease	Smoking	Osteoporosis	Surgical errors
	Systemic conditions such as uncontrolled diabetes	Immune system deficiencies	

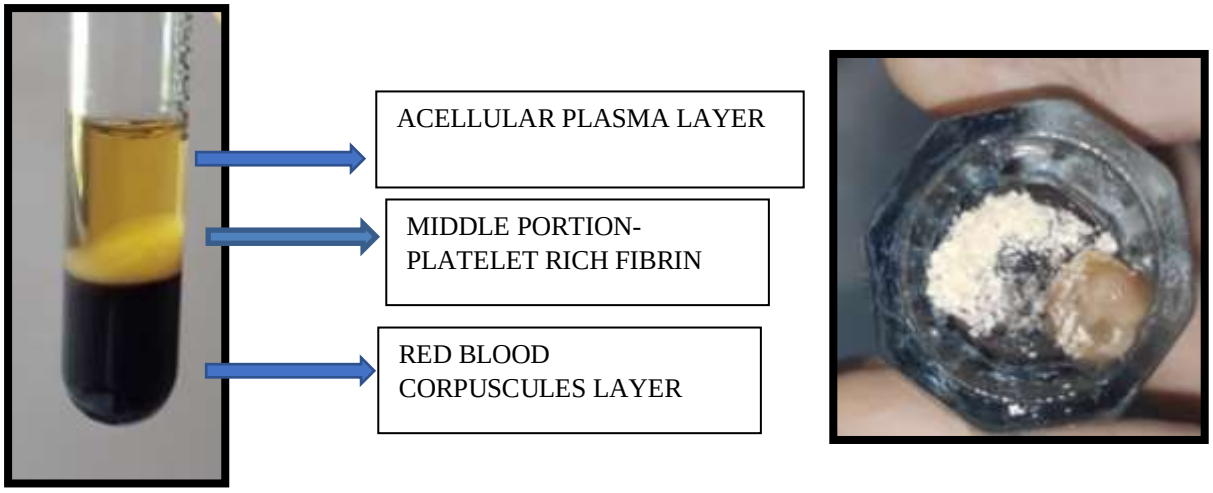
PRF PREPARATION

PRF preparation requires an adequate table centrifuge and collection kit including an 18-gauge needle,

- 5ml of whole blood is drawn by venepuncture of the antecubital vein and collected into blood collection tubes without anticoagulant,
- The tubes are initially centrifuged for 10 min at the rate of 3000 rpm in a centrifuge.
- The PRF easily separated from the red corpuscles base using sterile tweezers and then transferred to a sterile dappen dish. [15]

SEQUENCE OF FIGURES SHOWN FOR THE PREPARATION OF PLATELET RICH FIBRIN (PRF)





The Regeneration of bone is accomplished through three different mechanisms,

1. Osteogenesis is the formation and development of bone, with the absence of undifferentiated mesenchymal stem cells.
2. Osteoinduction is the transformation of undifferentiated mesenchymal stem cells into osteoblasts or chondroblasts through growth factors that exist only in living bone.
3. Osteoconduction is the process that provides a scaffold, or physical matrix, which is bio-inert in nature, suitable for the deposition of new bone from the surrounding bone also it encourages differentiated mesenchymal cells to grow along the surface of grafts.

WOUND HEALING

Basically, there are different kinds of wound healing:

In primary intention healing,

1. There is no loss of tissue and all tissues are replaced in the same anatomic position and with the same structure they had before the injury,
2. This kind of healing is quicker, involves minimal scarring and a lower risk of infection than secondary healing.

Secondary healing,

1. Occurs in areas which are not covered by normally epithelialized tissue
2. That can be due to intentional (extraction sockets, apically repositioned flaps) or accidental (wounds with full-thickness loss of substance) exposure, or due to an insufficient amount of lining tissue to be used for coverage. [6]

The tertiary intention is defined as delayed healing which occurs in both types of healing after an infected wound is left open for days until the infection disappears and is completely covered by surgical closure of the overlying tissue.

Finally, a fourth type of wound healing can be considered when the overlying tissue is partially lost (abrasion) or intentionally removed (epithelialized free gingival graft donor site), so a de-epithelialized connective tissue layer is exposed and heals by re-epithelialization from the normal contiguous epithelium. [6]

DISCUSSION

Bone replacement graft materials have played an important role in regenerative dentistry for many years. New technology continues to improve the predictability and success rates of grafting procedures. There are four basic divisions of bone grafts: Autogenous, Allograft, Alloplastic, and Xenograft.
Autogenous bone is derived from the individual for whom the graft is intended and considered as the gold standard. It consists of two components.

- The first is an anatomical structure for scaffolding cellular invasion and for graft and host site support.
- The second is a component of type I collagen that provides pathways for vascularity and resilience.

PRF is more effective than the other surgical additives because its method of manufacture is simpler, effective, and with low cost of preparation. [2] In dentistry, especially in implantology, the use of this biomaterial has as main objective the increase of the surrounding bone tissue for implant placement, since the lack of adequate thickness, as well as the proximity of the maxillary sinuses in the maxilla, and the inferior alveolar nerve in the mandible are the most frequent problems that professionals in this area face. [2] The plasma used in this process is the patient's own, that is, reapplication at the graft site does not present a risk of infections and rejections. [2] Platelet-rich fibrin came to aggregate tissue regeneration, making healing more effective and qualified, both bone and tissue. PRF membranes can be used in all patients (and may even be recommended in patients who use anticoagulants or smokers), they promote the healing of soft tissues,

reducing the risk of necrosis of the flaps after surgery. Potential applications are numerous, but a knowledge of biomaterial, efficiency, and limitations are required for its use in daily practice.[2]

Abdel Salam et al in 2000 concluded that the use of guided tissue regeneration (GTR) and guided bone regeneration (GBR) techniques are preferred to use autogenous bone grafts in situations of extensive bone loss, and allogenous bone grafts when small fenestration, labial dehiscence, or extraction sockets.[12]

Tatullo et al. who conducted histological and clinical evaluations of 60 patients who underwent sinus lifting surgery before implant surgery. The experimental group received bovine bone graft material (Bio-Oss) combined with PRF, whereas the control group received only bovine bone graft material. Results revealed that the good osteoconductive capacity of PRF led to the production of new bone, even at106 days. No implant loss was observed at 36 months. [13]

According to Carl Misch, no bone grafting attempts are indicated in the presence of infection or exudate as acid pH will rapidly resorb any material, and graft will be infective.[14]

Fay Goldstep stated that Bone quality at the recipient site determines the type of graft material to be used. Cortical bone is inferior to cancellous bone at the recipient bed. Cells within cancellous bone are responsible for at least 60 percent of the patient's bone healing capacity. [16]

Kraigler et al. 2012 stated that Tissue engineering may be used to regenerate bone by combining cells from the body with growth factors and scaffold biomaterials. This combination of cells, signalling molecules, and the scaffold is often referred to as the tissue engineering triad. Growth factors are naturally occurring signalling proteins that can recruit cells and stimulate cell proliferation and differentiation. [3]

With the use of various graft materials especially, PRF can improve the success rate. The characteristics and main advantages of PRF are:

1. The acceleration of the healing process of bones and gums in dental surgeries and in dental implants;
2. High potential for tissue regeneration;
3. PRF is capable of transforming adult stem cells into specific cells for the formation of bone and gingival tissues;
4. Ability to regenerate the tissue vascularization network and the need to remove bone from another part of the body for bone grafting.

Hence the Platelet Rich Fibrin, alloplast of 60% hydroxyapatite and 40% tricalcium phosphate and GBR membrane can be used during implant placement for bone regeneration, stabilization, soft tissue healing, regeneration of interdental papilla.

CONCLUSION

One of the major challenges in implant dentistry is the treatment of large bone defects or deficiencies. Although four categories of grafts are present, autografted is the only one considered to be of gold standard due to its osteoinductive, osteoconductive, and osteogenic nature. Various bone regenerative materials in the form of gels, particle, and scaffolds have also been designed with the help of nanotechnology and engineering and have opened up a new horizon for bone regeneration. The use of PRF in daily clinical practice shows promising results, however, research that accompanies the patient over the years is necessary for the understanding of which substances or substances are effectively beneficial to patients [3]

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