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Hardtissue Augmentation:A Review

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ABSTARCT

It has become possible to provide the structural foundation of osseous tissue needed to support dental implants using a number of methods and materials. Alveolar abnormalities with insufficient bone height and width have become a major concern with the introduction of dental implants. Alveolar ridge deficiencies are caused by a number of conditions including developmental defects/clefts, tooth extractions, dehiscence or fenestration problems, advanced periodontal disease. The purpose of this review is to provide light on the relationship between the periodontium and the basic ideas behind bone regeneration.

Keywords: Bone,soft tissue,gbr,implant

Introduction

Implant dentures are the most popular aesthetic option for replacing missing teeth [1]. To ensure osseointegration of the implant during functional loading, there should be enough bone at the implant site to ensure a favourable long-term prognosis. The bone defect will be more severe if the tooth is taken due to periodontal disease, trauma, tumour, or other reasons [2]. Because the alveolar bone requires mechanical stimulation to maintain its form and density, the periodontium undergoes remodelling in the area following tooth extraction, resulting in a decrease in trabeculation and loss of height and width [3].

The width of keratinized tissue (KT) around natural teeth appears to be unrelated to periodontal health maintenance, with similar levels of plaque accumulation, gingival inflammation, and periodontal attachment maintenance regardless of KT width but providing adequate oral hygiene[4].

The employment of a barrier membrane to direct bone regeneration and prevent the surrounding fibrous connective tissue from prematurely expanding into the bone defect area, modifying the healing environment and so boosting bone tissue regeneration and repair[1] is referred to as GBR. The degree of osseointegration in sufficient and healthy bone is critical to the long-term effectiveness of dental implants[5].

Structure of hard tissue around the tooth and Implant.

The alveolar process, which is a component of the periodontium, encircles the fully erupted tooth. According to histology, the inner portion of the socket wall is made up of lamellar bone, also known as bundle bone. Its survival is solely dependent on the presence of teeth, much like the root cementum and periodontal ligament are[6].

Alveolar bone, sometimes referred to as the alveolar process, is the ridge of bone that forms the tooth sockets and holds the teeth in place [7].The cellular components of the alveolar bone act as a dynamic tissue that allows for rapid remodelling. Osteoblasts, osteocytes, and osteoclasts are included.

The soft and hard tissues surrounding dental implants play a significant role in the implant's success [8]. Peri- implant tissue is an extension of the oral mucosa. It's made up of connective tissue covered with layers of epithelial cell which attach to the implant's surface forming the "junctional epithelium" [9].

Sequence of Hard tissue Loss

Some notable hard tissue changes that have been observed following tooth extractions and implant placement include surface resorption on the buccal & lingual walls, resorption on marginal bundle bone and reduction in buccal bone height as healing progressed [10].

Alveolar buccal plates are often thinner than lingual plates and in these cases, increased resorption was also observed [25]. Systemic conditions that may lead to additional bone loss include: genetic predisposition; general and/or medical conditions (e.g., diabetes and smoking); medication and/or bisphosphone use [11].

Hard tissue Augmentation Techniques

The types of hard tissue augmentation were divided into two anatomic sites: the maxillary sinuses and alveolar ridges. Within the Alveolar ridge approach, different surgical techniques were identified and classified, including: [12] Osteoperiosteal Flap Techniques, Guided Bone Regeneration, Onlay/Veneer Grafting, Combinations Of Onlay, Veneer, Interpositional Inlay Grafting, Distraction Osteogenesis, Ridge Splitting, Socket Preservation, The Use Of Non-Permeable Occlusive Titanium Barriers, Autologous Platelet Rich Fibrin.

Osteoperiosteal Flap Techniques

Osteoperiosteal Flap is achieved by a vascularized alveolar osteotomy. The biological principles of osteoporulo-osteoporuloplastic flap techniques are derived from vascularization studies as well as experience with Lefort I techniques in the field of craniofacial surgery. OPF relies on maintaining the vascularization of bone fragments from the periostum. Micro-Anastomosed Free Bone Flaps (Fibular Grafts) are used in Craniofacial Surgery to correct severe Bone Deficiencies [13]. OPF in combination with Interpositional (Inlay) Grafts are increasingly used for the development of implant sites in Ridges with Height Deficiencies [14].

Sandwich techniques are similar in surgical approach as well as in healing patterns and final results [15].

Guided Bone Regeneration (Gbr)-

GBR is a surgical technique that utilises barrier membranes, whether particulate or not, as well as bone grafts and/or bone substitutes. The osseous regeneration process of GBR relies on the translocation of pluripotent (pluripotent) and osteogenic cells to the site of the bone defect, as well as the exclusion of cells that inhibit bone formation (e.g., epithelial cells, fibroblasts etc.) [16]. Bone regeneration can be achieved in three ways: - osteogenesis; Osteoinduction; Osteoconduction [17] .

Bone autograft

An autograft is tissue transferred from one location to another within the same individual.

Common areas of autogenous bone that can be harvested include the extraoral site (e.g. iliac crest, tibial plateau) and the intraoral site (mandibular symphyses, maxillary tubules, healing sites 8-to-12-weeks

after extraction, ramus tori, or exostoses). Autogenous bone can also be harvested as a block autograft, or as a particulate graft.

Bone allografts

Allografts consist of tissue transferred from one individual to another genetically dissimilar individual of the same species. Freeze-drying and the Tutoplast® processes are two of the most common sample processing techniques that can further minimise the transmission of disease. There are two types of freeze dried bone, demineralized freeze-dried bone allograft (DFDBA) or mineralized freeze-dried bone allograft (FDBA).

The primary advantages are: Allograft bone eliminates the need for a second donor site; Reduces surgical time; Reduces blood loss; Reduces host morbidity; and Provides an unlimited supply of donor material. Schwartz *et al* found that The DFDBA from various tissue banks varied in shape and size, as well as significantly varying osteoinduction potential, which appeared to be related to age, with younger donors having more robust potential[18].

Bone xenografts Xenografts are tissue grafts obtained from a species other than the host species. The representative materials for the xenografts are naturally occurring hydroxyapatite and anorganic bone matrix/ ABM. These are inert filler materials that act as scaffolds for the formation of new bone. [19]

Alloplasts

Alloplasts are an inert synthetic graft material. Alloplast materials consist mainly of calcium carbonate, calcium sulfate, bioactive glass polymers and ceramics materials like synthetic hydroxyapatite and tricalcium phosphate. Alloplast materials have a purely osteocompatible mechanism of action and provide scaffolding for improved bone tissue remodelling and growth.

Barrier Membranes

The process of guided bone regeneration is employed to facilitate the development of new alveoluses for implant placement, as well as in the vicinity of pre operative defects.

Studies by Dahlin et al. showed that when a barrier membrane is directly in contact with the bone surface and an opening is created, only bone or marrow cells can migrate to this bone defect without competing soft tissue cell growth from the surrounding mucosa. [20].

Non-resorbable membranes - Expanded polyethylene, titanium mesh, titanium reinforced PTFE . Resorbable membranes - Polymeric membranes, collagen membrane

Onlay bone grafts

External bone grafts can be used to fix horizontal or vertical gaps in alveolar ridges, or to fix combined defects.[21] Compression screws can be used to attach bone blocks to remaining alveolar crests that need to be perforated big enough to let more blood flow to the graft-host interface. Bone grafts can be taken from either the inside or outside of the donor site.

Symphysis, the body and the mandible ramus are the internal sources of block grafts. The mandible ramus is the preferred site because the local effects of graft harvesting are less and preferred in augmenting minor defects. Implant placement is immediate or delayed [22].

COMBINATIONS OF ONLAY, VENEER, INTERPOSITIONAL INLAY GRAFTING (COG)

Reconstructive alveolar ridge augmentation methods can be divided into two categories based on their degree of coverage: soft tissue graft and hard tissue graft [23]. Roll flap technique involve a de-epithelialized connective tissue pedicle flap. Combination onlay-interpositional graft is a technique that is primarily used for buccolingual augmentation by inserting the de-epithelialized portion of graft into the labial pouch of the deformed ridge [24].

Distraction osteogenesis (DO)

Distraction osteogenesis (DO) is aprocedure for growing new bone by gradually lengthening individual bone fragments inside the osteotomized gap.

Three phases make to the DO technique:[25] Following the (i) latency phase of 7 days, (ii) distraction phase, and (iii) consolidation phase, osteogenesis (bone) and histiogenesis (functional soft tissue matrix) occur simultaneously.

There are two types of alveolar distraction: vertical distraction, where bone is gained vertically, and horizontal distraction, where bone is gained horizontally. Any acquired or congenital alveolar abnormalities are criteria for alveolar distraction osteogenesis [26]. It should not be used if either jaw has substantially resorbed residual bony heights [27].

Socket preservation techniques

Socket preservation is a procedure which is done to reduce external ridge resorption following tooth extraction and enhances bone formation within the socket. It is typically carried out right once after tooth extraction, although in some cases, such as when acute infections are present, it may be postponed for 6–8 weeks.

The indications for the preservation of extraction sockets include:

- Reduce Alveolar Ridges After Tooth Extraction for Implant Prosthesis Treatment
- Anterior Teeth with Buctal Bone Thickness ≤2 mm
- Areas near anatomic structures (Maxillary Sinus and Mandibular Canal)

Contraindications to retaining an extraction socket include medical conditions that preclude implant placement, extraction socket not recommended when molar root is pointing to the maxilla sinus; nasal floor projection can result in risk of nasal floor perforation.

Bone ring augmentation

Melsungen-based bone augmentation specialist Dr. Giesenhagen has developed a technique that enables the surgical removal and implantation of large, three-dimensional skeletal defects in one operation. The bone is harvested from either the chin or palatal area, or the retromolar pads[28]. Indications for this procedure include a single tooth gap, edentulous space, severe atrophic ridge, and sinus floor elevation.

Particulate grafts

The use of Particulate Onlay Grafts for the Reconstruction of Mandibular Alveolar Defects has been widely utilized.

The most reliable and predictable type of organic bone graft for the regeneration of osseous tissue is the autogenous bone graft, which is harvested from intraoral and extraoral areas [29]. Iliac crest extraoral sites provide adequate volume of graft material with superior osteogenic, osteoconductive, and

osteocomposive properties, but they have a high mortality associated with the other surgical site. Particle autografts are the gold standard for the majority of craniofacial, bone grafting procedures, including treatment of dental implant-related defects.
Advantage- rapid vascularization. However, they must be membrane-protected to prevent resorption.

The Use of Non-Permeable Occlusive Titanium Barriers (Otb)
A titanium pre-shaped barrier (OTB) is a thin, non-porous, and non-porous barrier that can provide better biological protection for the graft in the event of accidental exposure. This barrier must be attached to the remaining bone by screws or pins to provide perfect primary stability for the particulate graft in the wound. Titanium's biocompatibility and osteoconductive and mechanical properties help to stabilize the bone graft and provide space maintenance, which are essential for successful bone regeneration [30].

OTB was proposed as an alternative for PTFE because it appears to provide better protection for the graft when exposed to the oral environment due to its non-porousness to oral fluids. The non-porous nature of the OTB also makes it easier to remove the barrier as there is no connective tissue that penetrates through its occlusive surface.The smooth surface texture of the external surface has previously been shown to be important in the prevention of early bacterial colonisation and biofilm development on dental implants, as well as in the clinical enhancement of blood clot adhesion and bone growth due to the mild micro roughness of the internal surface. Even in the event of accidental exposure, an OTB can cause hard tissue augmentation as long as it is securely attached to the remaining bone.

Alveolar Ridge Expansion [Bone Splitting Technique]
In the 1970's, Dr. Hilts Tatum introduced ridge splitting, or bone spreading. Over the years, ridge splitting has been used as an esthetic treatment for implant dentistry and as an implant site preparation technique in cases of alveolar ridge deficiency to meet the fundamental ideal need for hard tissue enhancement for functional and aesthetically pleasing implant results [31].
Alveolar ridge augmentation in areas with inadequate alveolar ridge support is achieved through block graft (autogeneic or allogeneic), guided bone regeneration (guided bone regeneration), distraction osteogenensis, and by splitting or expansion of the alveolar ridge with predictable results alone or in combination [32]. Ridge splitting technique can be used to manage narrow edentulous rigues (>3,5 mm), for implant placement, with predictable results in maxillae rather than mandibles [33]. Only cortical bone is contraindicated in this technique.
The Piezolectric Ridges expansion technique, as described in Vercellotti, uses modulated-frequency Piezolectric Energy scalpels to expand edentulous Ridges regardless of bone quality, even for the most mineralised bone, for single stage surgery [34].
This technique significantly minimizes the risk of bone fracture, which is one of the most common complications of ridge expansion. Bone expansion gives a more natural facial shape to the area. Bone splitting doesn't affect the facial plate and palatal plate in the same way. The palatal plate is thicker, making it harder to manipulate, so the expansion process mainly takes place in the direction where the palatal plate is thinner. Bone grafts can be inserted into the space of the bone and implant, and into the crestal area with membrane to reduce the risk of losing crestal bone, which also helps with bone remodeling [35].

Maxillary sinus augmentation (sinus floor elevation)

Maxillary sinus augmentation is a surgical procedure that is performed before dental implants are placed in the posterior maxillae of patients who have lost a lot of bone due to sinus pneumonia, bone atrophy or trauma [36].

The type of Maxillary sinus Elevation and Augmentation a surgeon chooses to perform depends on the surgeon's preference as well as the patient's anatomy. The patient's anatomical factors include residual bone height and the amount of lift desired.There are two primary ways to elevate the maxilla sinus floor: Direct approach and indirect approach.

Other Appoachs- Direct –Lateral Window Technique ; Indirect – Osteotome Sinus Floor Elevation; Bone Added Sinus Floor Elevation ; Minimally Invasive Transalveolar Sinus Approach, Antral Membrane Balloon Elevation [37].

Autologous platelet rich fibrin-

Autologous Platelet Rich Fibrin is a type of second generation immune & platelet concentrate commonly used in hard & soft tissue healing. It has previously been used in bone augmentation, angiogenesis, wound healing & periodontal treatment (38).

Unlike Platelet Rich Plasma which requires addition and ablation, PRF is bioactive. Unlike PRP, PRF does not require addition and ablation.(161).Tetramolecular Structure of the Autologous Biomaterial Fibrin Matrix of Platelets, Leukocytes, Cytokines and Circulating Stem Cells [39].

PRP, first described in 1998 by Marx et al., requires the above-mentioned biochemically modifi cation (modifi cation) to be prepared. PRF offers various benefits, including: Promotes wound healing, Promotes bone growth, Promotes graft stabilization, Promotes wound sealing, Promotes hemostasis [40].

Types of Plasma rich fibrins-

Pure Platelet-Rich Plasma
Leukocyte-and Platelet-Rich Plasma
Pure Platelet-Rich Fibrin
Leukocyte- and Platelet-Rich Fibrin

PAW (Platelets, Activation, White cells)[40] was proposed to collate and compare data in the literature and insists on the absolute number of platelets, mode of platelet activation and presence of white blood cells.Again, this is a restricted system and only applies to the PRP families and is actually very close to the proposal of Mishra et al[39].

Conclusion

There are a variety of surgical techniques available for the placement of implants in alveolar ridges that are prone to splitting or spreading. In cases where the ridge width is greater than 3.5 mm, ridge split cases are most commonly recommended. In most cases, the site of the ridge split will heal similar to that of a fracture repair, with a clot filling the gap over a period of time and eventually being replaced by woven bone and, in some cases, by load bearing laminal bone in the interim phase.

Therefore, in order to achieve the desired outcomes of dental implant dentistry, augmentation of missing alveolar ridges is an important part of the dental implant therapy, with the ultimate goal of providing functional restoration compatible with the surrounding natural dentition.[31]
RhPDGF-BB had a positive effect on soft tissue healing and ensured a better preservation of regenerated bone, especially when used in combination with the deproteinised bovine bone material [4].

PRF in conjunction with Bovine Bone Space Maintainer is a promising approach for buccal Bone augmentation and soft tissue restoration. The PRF approach in conjunction with the bovine bone replacement may be a promising approach in oral implantology [40].
Maxillary sinus pneumatization (secondary to posterior maxilla tooth loss) prevents implant placement at this site. Elevation and augmentation of the maxilla sinus provide a predictable outcome of the regenerative process of the loss of osseous tissue in posterior maxilla, offering the patient many benefits for long term implant site success [36]. Large skeletal discrepancies necessitate such large bone movements that surrounding soft tissues may not adjust to the new position, leading to relapse or loss of function and aesthetics.

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