بسم الله الرحمن الرحيم

لاَ يُكَلِّفُ اللّهُ نَفْساً إِلاَّ وُسْعَهَا لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ رَبَّنَا لاَ تُؤَاخِذْنَا إِن نَّسِينَا أَوْ أَخْطَأْنَا رَبَّنَا وَلاَ تَحْمِلْ عَلَيْنَا إِصْراً كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِن قَبْلِنَا رَبَّنَا وَلاَ تُحَمِّلْنَا مَا لاَ طَاقَةَ لَنَا بِهِ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَا أَنتَ مَوْلاَنَا فَانصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ .

صدق الله العظيم

سورة البقرة الايه ٢٨٦

Role of Bio-Gen graft in Preservation of alveolar bone

A Thesis Submitted for Partial Fulfillment of Requirements of the Master's Degree in Oral and Maxillofacial surgery

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List of Abbreviations

Abbreviation	Term
GTR	Guided Tissue Regeneration
DFDBA	Deproteinized Freeze Dried Bone
BSMs	Bone Substitute Materials
HIV	Human Immunodeficiency Virus
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
b-TCP	Beta-tricalcium phosphate
HA	Hydroxyapatite
CP	Calcium Phosphate
a-TCP	Alpha- tricalcium phosphate
PGA	Polyglycolic acid
DCPA	Dicalcium phosphate-anhydrate
TTCP	Tetra-calcium phosphate
DMB	Demineralized bone matrix
BMPs	Bone morphogenic proteins
rhBMPs	Recombinant bone morphogenic proteins
CBCT	Cone Beam Computed Tomography
ROI	Region of interest
FOV	Field of view
CT	Computed Tomography
SD	Standard deviation
BCP	Biphasic calcium phosphte

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Introduction

The application of osseointegrated implants in the anterior maxilla has created pointed interest in obtaining an optimal esthetic result. A prominent root position is almost always accompanied by a thin, frail buccal plate that may be damaged during tooth removal, resulting in a deformed edentulous ridge whose bone morphology would require augmentation to place an implant in an optimal position for prosthetic restoration. The shift in paradigm from the fixed partial denture to the implant has placed new emphasis on management of the extraction wound. [(1)]

Alveolar ridge resorption following tooth removal is physiologically undesirable and possibly avoidable phenomenon. [(1-2)]

Significant knowledge exists of the healing process of extraction wounds, including contour changes caused by bone resorption and the cascade of histologic events in both animals and humans. [(2-3)]

The resorption of the alveolar process following tooth extraction in both jaws is significantly greater on the buccal aspect than the lingual or palatal, so that the reduction in width of the maxillary alveolar ridge is greater than the loss of height. [(3-4)]

The significant loss of tissue contour takes place during the first month after tooth extraction, averaging 3to5 mm at

6months. Hence, preservation of the alveolus at the time of extraction of prominent roots in the anterior maxilla is crucial to allow optimal implant placement. [3-5]

Review of literature

The alveolar process is a tooth dependent tissue that develops in conjunction with the eruption of the teeth. Further, the volume as well as the shape of the alveolar process is determined by the form of the teeth, their axis of eruption and eventual inclination. [6]

Subsequent to the removal of all teeth in the adult individual, the alveolar process will undergo atrophy. [7-9]

Alveolar bone resorption after tooth extraction is accelerated in the first 6 months after extraction and followed by a gradual remodeling that includes changes in size and shape. About 40% height and 60% width of alveolar bone is lost. [10-11]

The height and width reduction of the alveolar ridge complicates the implant placement thereafter, especially in the anterior maxilla, where bone volume is important for functional and aesthetic reasons. [12]

Early extraction socket healing is expected to decrease the alveolar ridge height by 2-4mm horizontally and 1mm vertically. This change is time dependent by the end of the first year post-extraction; nearly 6mm of buccal loss can be expected. [13-15]

Adequate volumes of alveolar bone are necessary to provide favorable aesthetic and successful long-term outcomes for dental implants. Therefore, in order to preserve the original dimensions following tooth extraction and promote bone regeneration of the residual alveolar socket, various bone grafts and substitutes used in combination with or without barriers for guided tissue regeneration (GTR)have been suggested.[14,16-19]

Among these grafting materials, bovine bone mineral xenografts have been able to promote bone regeneration and preserve the pre-extraction alveolar ridge dimensions when grafted in immediate extraction sockets, especially when combined with collagen. [11,20-21]

Clinical and/or radiographic studies have demonstrated that marked alterations of the height and width of the alveolar ridge will occur following single or multiple tooth extractions. The healing process following tooth removal apparently resulted in more pronounced resorption on the buccal than on the lingual/palatal aspects on the ridge. [13,22-25]

Pietrokovski& Massler [23] studied the amount of tissue that was lost after unilateral tooth extraction and used plaster models for the dimensional assessments. The authors concluded that the buccal bone plate both in the maxilla and the mandible were resorbed more than the corresponding palatal/lingual bone walls and that the center of the ridge, as a consequence, shifted palatally/lingually.

Undisturbed extraction sockets heal uneventfully with bone tissue 1-2 months following extraction. [26-27]

This healing process usually occurs with substantial reduction of the original height and width of the alveolar bone, which in some cases may aesthetically compromise an implant, supported prosthesis. [28]

Several studies have proposed various ridge preservation techniques following tooth extractions, including placement of different graft materials and/or use of occlusive membranes to cover the extraction socket entrance. [29-32]

Indeed studies in humans using demineralized freeze-dried bone allograft (DFDBA) [33,30] , deproteinized natural bovine bone mineral (Bio-Oss) [20,31,34-35] or bioactive glass [16] have shown the presence of particles of the grafted material in the alveolar sockets 6-9 months following their insertion.

Furthermore, few studies have used quantitative methods to measure the efficacy of ridge preservation techniques following tooth extraction. [36-37]

Lekovic [36] reported that healing of extraction sites seems to occur with different degrees of bone resorption, which can be partly prevented by the use of resorbable membranes made of glycolide and lactide polymers.

Polylactide and polyglycolic acids are considered to be suitable matrices for bone and soft connective tissue. [38]

Fisiogrft* is a synthetic resorbable sponge formed by 50-50 lactide-glycolide polymer, and it has the fastest degradation rate of the D-L lactide/glycolide materials, with the polymer degrading in about 50-60 days. [39]

***Fisiograft (Ghimas, Bologna,Italy)**

The breakthrough in the present-day development of bone substitute materials (BSMs)was initially achieved by Barth as early as who carried out animal experiments in order to study different bone replacement materials for the first time.[40]

Historically, autogenous bone grafts, allografts, and a variety of biomaterials have been used for the repair of osseous defects and the augmentation of compromised bone. The ideal bone-graft substitute is biocompatible, bioresorbable, osteoconductive, osteoinductive, structurally similar to bone, easy to use, and cost-effective. [41]

Problems related to the availability of graft material, donor-site morbidity, immunogenicity and biomechanical integrity have limited its success. An increasing number of bone graft materials with completely different origins are commercially available for many applications throughout the human body. They are variable in their composition, their mechanism of action and, therefore, their indications. BSMs are generally considered to be a highly important alternative to bone grafting in dental surgery, implantology and periodontology. [42]

Donor site morbidity is diminished while simultaneously guaranteeing a nearly unlimited level of material disposition. In this way, a large variety of osseous defects can be repaired using BSMs. Due to current developments innovative BSMs with new chemical, structural and subsequent biological properties will embrace a lot of requirements in order to imitate the characteristics of the bone defect. [42]

In the context of large osseous augmentations, autogenous bone is still used as the preferred gold standard material. However, in certain clinical settings and appropriate indications a combination of BSMs with living tissue/cells or BSMs alone may be suitable. [42]
The current functions of BSM include: space maintenance for bone regeneration, pre-setting of the desired anatomical form, supporting functions for the periosteum and associated membranes, acceleration of bone remodeling, osteoconductive structural guidance for the regeneration of osseous tissue, carrier substance for antibiotics, growth factors [41-45] and scaffolds for tissue engineering approaches.[46-47]
The morbidity associated with autogenous bone graft harvest and concerns regarding transmission of live viruses from allografts have been the impetus for research into a variety of bone grafting materials. Current requirements for an ideal BSMs include: biocompatibility, stability under stress, osteoinduction, osteopromotion/osteoconduction, resorbability/degradability, plasticity, sterility, stable and long-term integration of implants.[47]

Biocompatibility ensures the absence of toxicity, teratogenicity or carcinogenicity. The lack of antigenicity guarantees the avoidance of pro-inflammatory and immunologic reactions.
All such requirements serve as a basis for effective long-term tolerance and such criteria are mainly fulfilled by available synthetic materials. [48]

In addition BSMs should support osteogenesis conductively, stabilize the coagulum, fill up osseous defects and contribute to mechanical resistance. In this way BSMs serve as an artificial extracellular matrix in order to support and later stabilize the new creation of bone. Thus so called osteoconductive effect means that

the attachment of new osteoblasts and osteoprogenitor cells is supported by the graft, providing an interconnected structure for migration of new cells and formation of new vessels. [49]
Moreover, a stimulating effect on the osteogenetic cells called osteogenicity or osteopromotive represents the ability of a graft to induce non differentiated stem and/or osteoprogenitor cells to differentiate into osteoblasts causing new bone formation at locations where it is unexpected. These processes are influenced by cytokines such as bone morphogenetic protein (BMP) that induce differentiation of mesenchymal stem-cells, to result in new bone formation that parallels direct osseous Interconnecting porosity of a BSM is one of the most important requirements for continuous vascular ingrowth.[50-51]

Many pores extend to the surface and can be vascularized with an adequate diameter (>approx. 100 µm). [52-53]
Smaller pore diameters are more advantageous in the adhesion and incorporation of mineralized tissues, cell-to-implant contacts and in the absorption of extracellular liquids. [54-55]
An incomplete co-mingling of the material with adjacent vessels can result in particles that are encased by connective tissue. [54]
Condensation of the materials can cause a reduction or a loss of their Porosities. [56]

In particular, form stability is of essential importance with regard to larger bony defects. Resorption of the material and replacement by normal bone is either biologically based on the influence of cells or by chemical-physical dissolving processes [57], and should occur simultaneously in the ideal case. If not, the formation of connective tissue may occur resulting in biomechanical inferior structures.[49]
The BSMs should be easy to use, should withstand sterilization and