



Alloplastic Grafts - Beta-tricalcium phosphate

Presentation of clinical cases

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This case report presents a brief review of bone loss due to periodontal infection and tooth extraction, and evaluates the biological characteristics, description and indications of an alloplastic graft material, beta-tricalcium phosphate, as an alternative treatment in two clinical cases.

Introduction

The effects of periodontal infection and its consequences, attachment and bone losses, result in the formation of periodontal bone defects (1,2). Tooth extraction involves two processes, the healing of the alveolus (3) and any change that may appear during post-extraction healing (4). The clinical consequences of tooth extraction are the resorption of the alveolar ridge (5) and the pneumatization of the maxillary sinus (6). If the effects of periodontal disease and tooth extraction are combined, the consequences will be even more severe and will complicate tooth restoration (7). The use of bone grafting materials prevents and/or repairs the insufficient bone conditions due to the previously mentioned situations (8). We will first evaluate the biological characteristics (9) of the

alloplastic graft material, beta-tricalcium phosphate, before presenting Clinical Cases using a commercial presentation of beta-tricalcium phosphate. The objective of this presentation is to demonstrate the clinical applications of beta-tricalcium phosphate alloplastic graft in periodontal bone defects and extraction sites.

Modifications in the Alveolar Process

The most common modifications involving the bone tissue of the oral cavity are: Horizontal bone loss due to periodontal infection, bone defects caused by periodontal disease, tooth extraction resulting in vertical and horizontal

resorption, pneumatization of the maxillary sinus and a combination of these. The clinical consequence of these conditions are inappropriate bone dimensions for prosthetics on natural abutment teeth and the placement of its substitutes, dental implants (10).

Periodontal bone defects

As a result of inflammatory and immune reactions to the presence of bacterial plaque and the way in which it progresses apically over the cement surface in one of the periodontal attachment components, the alveolar bone, specific patterns of destruction can be observed. These patterns depend mainly on the type of subgingival bacterial plaque and the anatomical characteristics of the alveolar process (11). Basically there are two bone loss patterns, horizontal or vertical forms. The vertical form of bone loss has been described as intrabony loss and the resulting defects have been historically classified according to the number of bone walls lost: one, two or three-wall intrabony defects. Other bone loss patterns have been described as osseous craters and circumferential defects. The special anatomy of molars and premolars involves furcations as a special condition in periodontal defect (12).

Tooth extraction

The consequences of tooth extraction represent specific conditions and a special challenge in conventional restorative dentistry and oral rehabilitation, especially with the use of dental implants (13). Whether in case of single or multiple implants - as abutments for fixed bridges and/or removable prosthesis - or in complete oral rehabilitation, the bone loss that follows tooth extraction in alveolar area or in edentulous arch represents a clinical challenge (14). The consequences of this biological process are both functional -which complicates the prosthesis design - and aesthetic, especially in the anterior zone. After tooth extraction, the

alveolus has a very high and predictable chance of healing in a natural and healthy way without any intervention. The biological principle of the alveolus repair is based on the formation of a blood clot that covers it completely. Post-extraction healing process has been accurately described. The stages of this natural process may be summarised in the following manner: At 30 minutes: clot; at 24 hours: formation of blood clot and haemolysis; at 2-3 days: formation of granulation tissue. At 4 days: increase in fibroblast density and epithelial proliferation over the edge of the wound and presence of osteoclasts indicating the alveolus remodelling. At 1 week: defined vascular network and maturing connective tissue; osteoid formation in the bottom of the alveolus. At 3 weeks: dense connective tissue; full epithelial cover. At 2 months: full bone formation is complete but without reaching the original height (15,16).

Graft Material Characteristics

Autogenous bone is the only graft material that meets the requirement of being osteogenic activating new bone formation via viable osteogenic cells (Periosteum osteoblasts, endosteum, bone marrow cells, perivascular cells and undifferentiated and/or stem cells) which are transplanted with the material and is considered as the "Gold Standard" as it also has osteoinductive and osteoconductive properties (17,18). The term "Osteoinduction" implies the biological effect of inducing differentiation of pluripotent undifferentiated cells and/or potentially inducible cells to express the osteoblast phenotype leading to new bone growth both within bone tissue and in ectopic sites. i.e. sites in which there is no natural bone formation. Even though there are several molecules able of inducing "de novo" bone tissue formation, the Bone Morphogenetic Protein (BMP) is the main protein involved (19). The term "Osteoconduction" refers to the characteristic of the graft material to act as a scaffold or mesh on which existing bone cells can proliferate and form new bone. In the absence of this supporting structure

provided by the material, the defect or bone surface would be filled or covered by fibrous soft tissue. The porosity, pore size, shape, particle size and physical/chemical characteristics influence the biological effects of cell adhesion, migration, differentiation and vascularisation at the receptor site (20,21).

Classification of graft materials by origin

Autogenous materials or Autografts are tissues from the same individual transplanted from one site to another. Viable cortical or spongy/medullar bone is commonly used in periodontology and maxillofacial surgery. Allogenic materials or Allografts are tissue from one individual of the same species; usually via a freeze-drying process; bone and skin are the most common ones. Xenografts are tissue from different species; mainly mineral bone component or collagen. Alloplastic graft materials are synthetic materials, i.e. they are manufactured by industrial processes and the most representative in medical dental use are Hydroxyapatite, β -Tricalcium Phosphate and Bioactive glasses or polymers (22).

Beta-tricalcium phosphate

Beta-tricalcium phosphate (β -TCP) is a synthetic ceramic bone graft material which has been used in orthopaedic and dentistry - periodontology and maxillo-facial surgery - for more than 30 years (23). β -TCP can be treated during the manufacturing process so that it has a structure similar to the bone mineral component, either in a block or in particles similar to spongy or trabecular bone (24). This structure has randomly interconnected pores. Porosity may range from 20% to 90%. The variation in pore size ranges from 5 μ m to 500 μ m depending on the particle size. The particle size in dental use is generally inferior to 1000 μ m. The mechanism of action of β -TCP as a graft material is via

osteoconduction with the subsequent resorption and replacement by host bone. (25) Osteoconduction is facilitated by the interconnection between pores. In the biological process the material is resorbed and replaced by bone from the receptor individual. When the graft is placed in the receptor site, serum proteins are adsorbed on the surface of the particles, which later favours cell migration to initiate neo-vascularisation in the porous structure. Over time, the particles inferior to 1 micron start to dissolve and are then resorbed in a process mediated by phagocytic cells, thus allowing bone deposit over the material. The level of porosity and the particle size will define the resorption rate and the bone replacement process which occurs in 9 to 12 months in average (26).

Case Report no.1

48-years-old male patient in general good health conditions with two localized areas presenting some discomfort since a couple of months mainly in tooth 15 where the patient refers recurrent swelling but without need to take analgesics. A full periodontal examination reveals a localized distal periodontal probing of 10 mm. with bleeding and suppuration and a mild redness (*Fig. 1*).



Fig. 1: Bleeding and suppuration in 10 mm pocket in tooth 15

On X-ray examination a wide distal intrabony-two walls defect is present(Fig. 2). The previous root canal treatment seems without complications in the periapical area. The localized periodontal attachment loss and the overall periodontal health could support the etiology of pulpar complication i.e. a lateral canal since the patient report at least 8 years of root canal treatment after a painfull episode in the tooth.

A flap debridement procedure is indicated and it is confirmed the bone defect and irregular bone loss in the vestibular cortical plate. (Fig. 3).

With the pulpar involvement as main etiology an effort is done to find clinical evidence i.e. localized area of resorption and/or lateral foramen without confirmation. It is decided to use β -tricalcium phosphate "R.T.R." (Septodont) as a graft material. (Fig. 4).



Fig. 2: Initial X-ray showing the intrabony-two walls defect.



Fig. 3: After debridement, scaling and root planning a complicated bone loss is present.



Fig. 4: β -tricalcium phosphate "R.T.R." (Septodont) as a graft material.



Fig. 5: X-ray taken immediately after the surgical procedure showing the particles of β -tricalcium phosphate "R.T.R." (Septodont) in the defect.



Fig. 6: X-ray six months post-surgery where the particles of β -tricalcium phosphate "R.T.R." (Septodont) has been replaced with recently formed trabecular bone and the bone defect appears with some lateral reduction.

Case Report no.2

A second problem is identified at the periodontal examination in tooth 46 and confirmed with the X-ray. An extensive root resorption on the distal root is present (Fig. 7) with any symptom reported by the patient except some discomfort and “bad taste” occasionally. The root canal treatment was done at the same time than tooth 15 (eight years before). The clinical condition makes difficult to try endodontic retreatment or other treatment options like hemisection, the extraction

is indicated. In order to avoid the collapse of the residual alveolar bone and the socket, particles of β -tricalcium phosphate “R.T.R.” (Septodont) is used as graft material. (Fig. 8,9).

Conclusion

In concepts of Osteogenesis, remains today still open the debate as to which type of currently available bone grafting material is the best.



Fig. 7: X-ray showing extensive root resorption on the distal root of tooth 46.

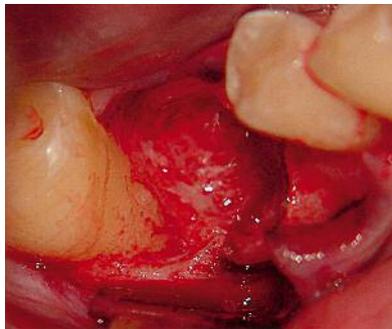


Fig. 8: Clinical view showing the extensive bone loss in the residual ridge after the tooth extraction. Notice the minimal width at the crestal area in the buccal and lingual plates and the attachment loss at the mesial root of tooth 47.



Fig. 9: Composite blood clot and β -tricalcium phosphate “R.T.R.” (Septodont) used as graft material prior the suture. In the area of resorption a cone shaped β -tricalcium phosphate “R.T.R.” (Septodont) is used and in the mesial root alveolus particles of β -tricalcium phosphate “R.T.R.” (Septodont) are used.



Fig. 10: X-ray taken immediately after the surgical procedure showing β -tricalcium phosphate “R.T.R.” (Septodont) in the bone defect and mesial root alveoli



Fig. 11: 6 months of clinical healing.



Fig. 12: X-ray 6 months post-surgery where the particles of β -tricalcium phosphate “R.T.R.” (Septodont) have been replaced by recently formed trabecular bone in the bone defect and mesial root alveolar.



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