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Bone Substitues in Prosthodontic Service

M.RATHINAVELPANDIAN[1], ASHISH.R.JAIN[1], RAGAVENDRA JAYESH[2], NARASIMMAN[1] and R. PRADEEP[1]

[1]Department of Prosthodontics, Tagore Dental College and Hospitals ,Chennai, India.
[2]Department of Prosthodontics, Sree Balaji Dental College & Hospital, Bharath University, Chennai-600100, India.

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ABSTRACT

The use of artificial bone graft substitutes has increased as the surgical applications widen and the availability of allograft bone decreases. The ideal graft substitute should reabsorb with time to allow and encourage new bone formation whilst maintaining its properties as an osteoconductive scaffold until it is no longer required. A potential disadvantage of some synthetic substitutes is their long dissolution time. Autologous bone grafting is currently considered as the gold standard to restore bone defects. However,clinical benefit is not guaranteed and there is an associated 8–39% complication rate. This has resulted inthe development of alternative (synthetic) bone substitutes.

Key words: Prosthodontic, Clinical, Surgical.

INTRODUCTION

Bone

Bone is a natural composite material, which by weight contains about 60% of mineral, 30% of matrix & 10 % of water. Bone is also living tissue, with about 15% of its weight being due to its cellular content. The matrix of bone is comprised of Type 1 collagen that is highly alinged, yielding a very anisotropic structure. This component of bone is predominantly responsible for its tensile strength. The mineral component is in the form of calcium phosphate know as hydroxyappatite (HA)[12].In the body, bone serves a number of functions, such as functions such a providing the cells. Found in marrow, that differentiate into blood cells & also acting as a calcium reservior. There are 2 types of bone, compact or cortical bone, and cancellous or trabecular(also know as spongy bone). Compact bone is very dense, consisting of parallel cylindrical units(osteon) found in the shaft of long bones as well as on the outter surface of smaller bone in the body[13].Trabecular bone is less dense & is made up of an array of rods & struts that form an open-cell foam, the pores of which are filled in by marrow. This type of bone is found at the ends of long bones & inside smaller bones.

Bone Graft Materials

Replacement of bone is a complex & demanding udertaking. Bone formation occurs when osteoblasts secrete collagen molecules & ground substances. The collagen molecules plymerize to form collagen fibers. Calcium salts precipitate in the ground substance along the collagen fibers to form osteoid. Osteoblast become trapped in the osteoid & then are called osteocyes.

Mature compact bone is composed of approximately 30% organic matrix & 70% calcium salts. 90% to 95% of the organic matrix is collagen fibers & the remainder is the gelatinous medium called ground substance, which is composed of chondroitin sulfate & hyaluronic acid.

Bone formation in grafting is characterized by three types of bone growth:

1. Osteogenesis:

Is the formation of a new bone by osteoblast derived from the graft material itself.

2. Osteoinduction :

Is the ability of a material to induce the formation of osteoblast from the surrounding tissue at the graft gostsite. Which results bone growth.

3. Osteoconduction :

Is the ability of a material to support the growth of bone over a surface.

Autograft

Fresh autogenous bone graft is deemed as the most efficient graft material since it provides the highest number of viable osteoprogenitor cells and contains noncollagenous matrix protein and growth factors as the osteoinduction property. It also carrying bone mineral and collagen which provide a scaffold for osteoconduction mean (Betz, 2002; Keating and McQueen, 2001a, b; Ladd, 1999; Linovitz, 2002). After transplantation autogenous bone graft become thoroughly incorporated into the grafted spot with neither initiation of immune reaction nor potential for disease transmission (Keating and McQueen, 2001a, b[1]; Ladd, 1999; MacNeil, 1999). Antibiotic application is contraindicated as well. Predominantly some antibiotics such as kanamycin and neomycin are not only bactericidal but also cellucidal and should be avoided in bone grafting procedures (Fox, 1984)[2]; Hulse, 1980; Zamprogno, 2004)[3].

At presence of sufficient amount of oxygen and under compression mesenchymal cells will differentiate into bone, while they can also be differentiated into cartilage at the insufficient level of oxygen. Fibrous tissue is produced when mesenchymal cells are positioned under tension with adequate level of oxygen (Zamprogno, 2004)[7].

The potential sources of viable cells in autogenous bone graft are the periosteal cells, the endosteal cell, the bone marrow cells and the cells of the bone (Hulse, 1980)[8]. The importance of viable cells in bone graft was stated by Gray and Elves (1979)[9]. They showed with different amount of periosteum, endosteum and marrow.

Example donor site – chin, Mandibular boby/ ramus, Maxillary tuberosity

Allograft

Use of allogenous bone graft or bone allograft is becoming more common in human as well as veterinary medicine since it does not carry the weaknesses (Fleming *et al*., 2000; Griffon, 2002; Griffon *et al*., 1996)[4] of bone autograft and could be provided in an unlimited quantity. This graft material can be utilized alone or as an extender for autogenous bone graft (Betz, 2002)[5]. Allogenous bone graft materials have osteoinduction potential owing to the presence of growth factor in the graft material which include insulin-like growth factor type II, transforming growth factor-â, platelet derived growth factor, fibroblast growth factor and bone morphogenic proteins. These growth factors are in the matrix and are being released by osteoclastic resorption (Bauer and Muschler, 2000; Fleming *et al*., 2000; Ladd, 1999)[6]. The efficacy of the osteoinduction and osteoconduction potential of the allogenous bone grafts completely relies on the graft stable fixation and the close contact between the graft and the recipient bed (Sinibaldi, 1989)[10]. The allogenous bone graft could be prepared in different manners such as radiation, freez-drying, freezing and ethylene oxide sterilization. Fresh allograft is not longer consumed owing to its potential to stimulate the severe immune response as well as transmit the infection (Keating and McQueen, 2001a, b)[11].

Example: FDBA and DFDBA

Xenografts

Xenografts are bovine in orgin and carry the theoretical risk of transmission of bovine spongiform encephalopathy. Xenograft are animal bone substitution materials. (BH) bovine hydroxyapatite is the most widely used and reported xenograft material[7]. These materials are chemically treated to eliminate any trace of organic material and conserve the material part, which has similar properties to human bone matrix. This mineral scaffold, which is porous and perfectly biocompatible, favors colonization of bone tissues, starting at the grafted site[8]. Immunogenic and disease transmission risk from animal to man, such as bovine spongiform encephalopathy (BSE or

mad cow disease) should not be neglected. Such risk exist when a organic part is retained in the biomaterial. Xenograft should undergo specific proparation via different processes to eliminate the contamination risk while respecting quality standards[9].

Example: Bovine hydroxyapatite, Natural coral

DISCUSSION

Following extraction of a tooth, a dimensional loss of bone height and width is a natural occurrence during the healing phase. "the loss of crestal bone height and labial plate after tooth extraction is due in part to the constriction of clot within the alveolus and the thin labial cortical plates remodeling in response to inadequate blood supply after the extraction". It is documented that following tooth extraction the loss of bone height and width may be 40% to 60%.Current avenues of research in molecular biology, progenitor cell use, and biomimetics scaffolds holds promise for the future of bone replacements by defining and employing the complex of stimuli and processes that can result in bone formation. Postnatal progenitor cells have demonstrated the capacity to differentiate into a multitude of cell types. Mesenchymal stem cells can be harvested from bone marrow and demonstrate extensive proliferative ability and the capacity to be guided into bone-forming cell types.

CONCLUSION

Determining which material to use for different clinical indications is based on many factors, including the size and location of the bone tissue defect as well as the structural, biologicaland biomechanical properties of the graft itself. To further improve decision making regarding which bone substitute graft to use to treat bony defects, more standardized research is recommended to explore the full potential.

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