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Evaluation of the efficacy of Autogenous Dentin Graft in bone defect of Rabbit: an animal study

Dental Science

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ABSTRACT

Aim: Aim of this study was to evaluate the efficacy of autogenous dentin graft in bone defect of rabbit.

Material and method: 6 rabbit were selected for this study and divided into 3 groups. Group 1 and 2 are experimental group, group 3 control group. Mechanically bony lesions were created in rabbit mandible and tibia unilaterally and graft material is placed and defect is sutured. Autogenous dentine graft used in this study. Animals were sacrificed for histological observation of bone defect at 4th week and 6th week respectively

Result: group 1 and 2 shows bone formation in bone defect surrounding to dentine graft while as in group 3 (control grp) defect is not completely filled with bone.

Discussion: Many of the allografts and Xenografts on the market are not sterile since the sterilization process ruins the organic collagen aspect of the graft that many manufacturers want to keep intact. Autogenous dentine graft said to be gold standard and shows promising results and have many advantages

Conclusion: Within the limitations of this study, autogenous dentin graft material made from extracted teeth may have potential as a bone graft material for bone formation.

KEYWORDS:

bone defect, dentine, autogenous graft etc.

Introduction

Many etiological factors can lead to the bony defect; it is serious illness and commonly occurs due to trauma, inflammation and subsequent abscess formation in bone. In severe form osteomyelitis that destroys the bone and leaves non-vital bone sequesters along the length of the bone.[1]

In field of endodontics pulpal infection may passes into periapical region and develop lesion like granulomas and cysts. The incidence of cysts within periapical lesions varies between 6 and 55%.[2].

Surgical intervention for bony defect is recommended only after nonsurgical techniques have failed. For treatment of such bone defects bone grafts are used as a filler and scaffold to facilitate bone formation and promote wound healing. According to bone healing mechanism, they can be categorized into the osteogenic, osteoinductive, osteoconductive. Among the many different types of bone graft materials, autogenous graft is considered the gold standard since it is capable of osteogenesis, osteoconduction and osteoinduction. Its advantage is rapid healing without immune rejection. [4]

Dentin has both inorganic and organic contents similar to those of human bone; dentin also contains bone morphogenic protein which promotes differentiation of mesenchymal stem cells into chondrocytes and consequently enhances bone formation.[5]

Rabbit is the primitive and most commonly used species for various studies.

Material and method:

The protocol of this study was approved and permission was taken from the ethics committee, formed as per rules and regulations

Committee for the **P**urpose of **C**ontrol and **S**upervision of **E**xperiment on **A**nimals [i.e. **CPCSEA**] number BVDUMC/1794/2014-15 of Bharati Vidyapeeth University Medical College, Pune.

Six, 3-months-old New Zealand white rabbits of either sex and of weight 1.5kg - 2kg were obtained from the **National Institute of Bioscience, Pune. CPCSEA** Reg. No. 1091/PO/07/abc. Animals were kept in cages in the central animal house They were divided into 3 groups, 2 rabbits in each group.

Group I: Experimental group, animals were sacrificed 4th week after experimental procedure for histological evaluation

Group II: Experimental group, animals were sacrificed 6th week after experimental procedure for histological evaluation

Group III: Control group animals were sacrificed 6th week after experimental procedure for histological evaluation

Method:

In all 6 rabbits, the experiments were carried out in the lower border of the mandible and in the tibia unilaterally Animals were anesthetized by an intramuscular injection of Ketamine HCl 35 mg per kg of body weight

The sectioning of anterior teeth of rabbit were done by using carbide bur and straight hand piece with micro motor under copious irrigation of chlorhexidine 0.2%. In this experiment for graft preparation smart dentin grinder is used to create powder form of dentin graft material.

In the mandible, an incision was made through the skin over the inferior border of the mandible unilaterally. In the tibia, an incision was made over the tibia unilaterally standardized bone defects were created in the bone using a carbide bur no. 0, 1 held in surgical straight hand piece. Defects filled with prepared dentin graft material which was placed in the cavity by carefully by using small head spatula and sutured.

Antibiotic and analgesic administration (2 ml/kg of body weight) was continued during the first 3 days after surgery. After experimental period tissue were prepared for histological examination.

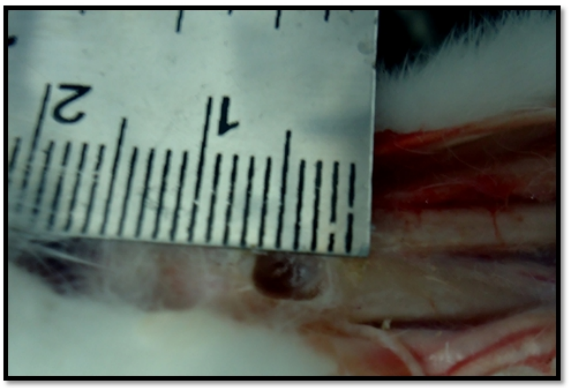

Fig1.Mechanically created lesion in mandible approx. 5mm in size

Results

4th week (experimental group): The defects were filled with a variable quantity of irregular woven bone trabeculae with primitive bone marrow, cellular tissues and grafted material. Experimental sites showed new bone formation localized in the graft areas as well as at the host bone-graft interface.

6th week (experimental group): a large quantity of bone tissue closed experimental defects' surface that formed by a highly cellularized immature trabeculae and mature bone, with large medullary space. Within the bridge, there was quantity of osteogenic connective tissues, which were a highly cellularized.

6th week (control group): Fine trabeculae of woven bone (immature bone) covered most of the defect surface. The defect was not completely filled by bone. Bone trabeculae were discontinuous in the centre and continuous at the margins.

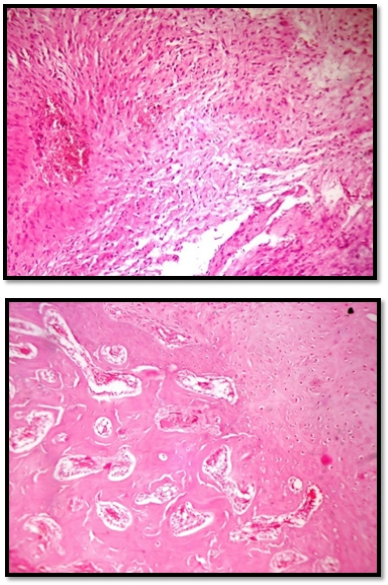

Fig.2 histological section of experimental group 1 and 2 showing sights of bone formation

Discussion

The current study aims to evaluate the efficacy of autogenous dentin graft in bone defect of rabbit, in which ground dentinal chips of rabbit (autogenous) were used as a graft material and placed into the mechanically created bony lesion in rabbit's mandible and tibia.

Size of the defect affects the healing, the defects of 5 mm in diameter were chosen because it was a size for efficient dentin grafting. However, larger defects will increase the risk for fracture of the tibia and cannot therefore be used.6

Tooth dentin and cementum contain a number of bone growth factors including type I collagen and bone morphogenic protein (BMP). Type I collagen accounts for 90%, with the rest consisting of noncollagenous proteins, biopolymer, lipid, citrate, lactate, etc. Noncollagenous proteins are phosphophoryn, sialoprotein, glycoprotein, proteoglycan, BMP, etc. They can perform the role of promoting bone resorption and bone formation.7

Many studies have proven that dentine has both osteoinductive and osteoconductive properties, bone morphogenic protein promote cartilage and bone formation, differentiating undifferentiated mesenchymal stem cells into chondrocytes and osteogenic cells. Noncollagenous proteins of dentin such as osteocalcin, osteonectin, phosphoprotein, and sialoprotein are known to be involved in bone calcification. Tooth mainly composed of HA (hydroxyapatite) and - TCP (tri-calcium phosphate), which are osteoconductive bone graft material.8

Dentin is better than allograft for the following reasons: A) It is a harder substance and therefore acts as a better scaffold. B) It resorbs slower than allografts and therefore much more aligned with bone remodeling profiles. C) Since the Dentin, in our procedure, is also autologous, this provides added benefits vs. an external material that is introduced such as allografts. The fact it is autologous makes it recognizable by the body, and specifically by progenitor cells at the site of implantation. D) Since it is an autograft, it eliminates the risk of disease transmission that exists with allografts. E) Dentin also crest of alveolar bone to its original volume at the site and in the long run does not lose height due to its density.9

The biocompatibility of a dental material is an important requirement because the toxic components present in the material could produce irritation or even degradation of surrounding tissues.[10]

In this experiment for graft preparation smart dentin grinder is used to create powder form of dentin graft material of size between 300 – 1,200 microns. Shapoff et al. reported that the particle size of graft materials influenced later bone formation. Bhaskar et al, reported that the ideal particle size of bone graft materials is 500 μm and that the between particle distance is 150 μm.11

The choice of experimental time was based on experience from other animal studies of osseous replacement resorption (4th week, 6th week and 8th week). In the study by Lars Anderson, concluded that dentoalveolar ankylosis is a long term process over several years in humans and in animals having a higher bone turnover rate a shorter period is necessary otherwise all dentin will probably be replaced by bone. Using 8 weeks showed to be an adequate time in that both ankylotic fusion and initial osseous replacement resorption could be seen. To be able to study further progress longer observation periods will be necessary in future studies.

Histological data has the benefit of allowing us to observe a number of features depending on the type of stain that is used. In our study, Z-N staining was used. This was a suitable stain for identifying the newly formed bone following decalcification of the specimens[12].

The histological observation (result) of all samples in this study reveals that, at 4th week in experimental group, the defects were filled with a variable quantity of irregular woven bone. At 6 weeks the experimental group showed a large quantity of bone tissue which had healed the experimental surface defect. Healing was achieved by a highly cellularized immature trabeculae and mature bone. At 6 weeks the control group defect was not completely filled by bone. Bone trabeculae were discontinuous in the centre and continuous at the margins.

Nampo, et al introduced alveolar bone repair using extracted teeth for the graft material. DSP is a dentin-specific noncollagenous protein involved in the calcification of dentin[13]

Dentin could possibly be available from teeth in the same patient e.g. wisdom teeth and used as autogenous graft or as allograft from e.g. the high number of premolar extractions carried out in the society before orthodontic treatment.

Conclusion

Within the limitations of this study, autogenous dentin graft material made from extracted teeth may have potential as a bone graft material for bone formation.

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