Evaluation of bone healing capacity of xenogenic tooth bone graft material with polydeoxyribonucleotide in bone defect surrounding an implant

Ji-Young Lee1, Young-Kyun Kim1,2,*, Pil-Young Yun1, Ju-Cheol Park3, Kyo-Jin Ahn1, Sooyeon Kim4

1Department of Oral and Maxillofacial Surgery, Section of Dentistry, Seoul National University Bundang Hospital, Seongnam, Departments of 2Oral and Maxillofacial Surgery, 3Oral Histology, School of Dentistry, Seoul National University, Seoul, 4KOREA INTERNATIONAL (GR.11), Seongnam, Korea

ABSTRACT

Purpose: The purpose of the study was to evaluate the bone healing capacity of a xenogenous tooth bone graft material with PDRN (polydeoxyribonucleotide) in a bone defect surrounding an implant in a beagle dog. We compared bone healing capacity between a xenogenic bone graft material (BioOss; Geistlich Pharma AG, Wolhusen, Switzerland) and xenogenous tooth bone graft material.

Materials and Methods: The immediate implant placement was done on the 2nd and 3rd premolar extracted sites on both maxilla in six beagle dogs. Artificial bone defects (four in each dog) were made with a length of 5 mm and width of 5 mm. Bone grafts were performed as follows: the xenogenous tooth bone graft material only in group 1; xenogenous tooth bone graft material mixed with PDRN in group 2; xenogenous bone graft material only in group 3; and xenogenous bone graft material mixed with PDRN in group 4. Sacrifices were performed 2, 4, 8 weeks after the experiment. Bone volume ratio around the implant was evaluated through micro-computed tomography.

Results: Bone volume ratio around the implant threads increased gradually over time. Groups 2 and 4 showed higher bone volume ratios than groups 1 and 3.

Conclusion: Within the limitations of the study, we conclude that application of a bone graft material mixed with PDRN might promote the bone healing process.

Key Words: Polydeoxyribonucleotides, Tooth, Bone

Introduction

Recently, in the reconstruction of bone defect, faster bone regeneration is required to achieve osseointegration of implant and recover the function. Although autogenous bone is known as the gold standard with its most excellent osteogenetic effect and its biocompatibility, it also has downside that its collection amount has the limit and donor site required additional surgery. To complement this, allogenic bone, xenogenic bone and synthetic bone have been developed and in recent years, the graft material using extracted tooth has been developed and is being used clinically. Also, we can apply the methods to promote the reduction of healing period and pain of surgical site and the differentiation of osteoblast. There were reports that polydeoxyribonucleotide (PDRN) was effective for the healing of burn and wound as it stimulated A2 purinergic receptor with the compound which includes a polymer and thus promoted skin reproduction without special side effects [1]. Also, Guizzardi et al. [2] reported it could play the role as a stimulant to growth of osteoblast when it was used for the reconstruction of bone defect. This study aimed to evaluate the
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bone healing process when applying xenogenous tooth bone graft material and growth factor (PDRN) at the same time after placing implant into the location where the tooth of beagle dog was extracted and forming a dehiscence defect in buccal and then to compare with existing xenogenous bones.

Materials and Methods

This study was performed after gaining the approval (IRB No. BA1203-100/013-01) of Institutional Animal Care and Use Committee, Seoul National University Bundang Hospital (Seongnam, Korea).

Graft material

**Xenogenic tooth bone graft material**

Extracted human tooth would be cut at cementoenamel junction. Soft tissue and foreign substances attached to the tooth would be removed and all endodontic soft tissues also would be removed. A hole with 0.2 mm in diameter would be made at intervals of 0.5 to 1.0 mm from the surface through the pulp chamber. It would be washed using alcohol ether and decalcified for 2 hours with 0.6 N HCl. It would be decalcified through the repetition of distilled water decalcification for 30 minutes. The decalcified block would be manufactured into a bone chip of 1.0 to 3.0 mm×1.0 mm. After that, the manufactured bone chip would be decalcified, defatted, and dewatered to reduce the mineral to less than 5% weight and remain Type I Collagen as a main ingredient.

**BioOss (Geistlich Pharma AG, Wolhusen, Switzerland)**

This is the anorganic bovine bone which has long been used and was proved to be excellent osteoconductive material through a lot of researches.

**Polydeoxyribonucleotide (Placentex®, Mastelli, Sanremo, Italy)**

As a low molecular deoxyribonucleic acid (DNA) fragment which has the average molecular weight 350 KD, this increases tissue activity and works as the tissue regeneration activator. One ample (3 mL) has about 5.625 mg of PDRN sodium.

**Allocation and anesthesia of experimental animal**

As an experimental animal, 6 clinically healthy beagle dogs, which weighed average 8 to 10 kg, were used. They were used without the distinction of sex and were divided into 2nd week, 4th week, and 8th week groups in the experiment. They were raised in each cage and fed with commodified hard food (Dog Chow GoldPet, #35520; Cargill Agri Purina Inc., Pyeongtaek, Korea) and were fasted for 12 hours of experiment. Atropine 0.005 mg/kg (DAI HAN Pharm. Co., Ansan, Korea) was injected under their skin and about 15 minutes later, they were induced to general anesthesia through the intramuscular injection of Zoletil 5 mg/kg (Zoletil 50; Virbac S.A, Carros, France) and xylazine 0.2 mg/kg (Rumpun; Bayer Korea, Ansan, Korea) were injected into the muscle. After that, 6.5 size endotracheal tube was intubated and connected to anesthesia machine (Datex-Ohmeda; GE Healthcare, Piscataway, NY, USA). And then, the anesthesia was maintained using Enflurane 2.2% (JW Pharmaceutical, Hwaseong, Korea) and oxygen 3.0 L/min. Before the surgery, Cefazolin 30 mg/kg (Chong Kun Dang Pharm, Cheonan, Korea) was injected into the muscle as antibiotic.

**Surgery**

**Tooth extraction**

After general anesthesia, the infiltration anesthesia was done with of 2% Lidocain HCl (contains 1:100,000 epinephrin) to minimize bleeding during surgery. We extracted the 2nd and 3rd premolars in both sides of mandible of beagle dogs using dental forceps and drills.

**Immediate Implant placement and bone graft (Fig. 1)**

We exposed alveolar bone by elevate the mucoperiosteal flap around the extracted socket after making a crestal incision. After drilling, we placed implant with 3.7 mm in diameter and 8 mm in length (Zimmer HA; Zimmer dental Inc., Carlsbad, CA, USA). In the buccal area of the implant, we formed a dehiscence defect with 5 mm in length and 5 mm in diameter intentionally and performed bone graft. Bone graft materials were hydrated for more than 10 minutes in saline or PDRN according to each group. And we divide the groups as follows according to its materials.

Group 1: Graft of xenogenic tooth bone graft material which was hydrated with saline in the 2nd premolar in the left of maxilla

Group 2: Graft of xenogenic tooth bone graft material which was soaked in PDRN in the 3rd premolar in the left maxilla