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Case Report

Three-year Follow-up after Autogenous and Xenogenic Jaw Bone Grafts

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Abstract

This case report assessed the three-year follow-up results after autogenous and xenogenic bone grafts of the jaw. Autogenous particulated bone with osteogenesis and osteoinductive properties and xenogenic Bio-Oss® (Geistlich Pharma AG, Wolhusen, Switzerland) graft materials with osteoconductive propertes were grafted into cystic cavities that remained after multiple cystic enucleation in the right upper posterior maxilla and the left lower posterior mandible. Six months later, increased radiopacity in the grafted area was seen. Three-year follow-up results with clinical and panoramic radiography after autogenous and xenogenic bony mixtures in jaw are reviewed and discussed.

Key words: Bone substitutes, Bone regeneration, Odontogenic cyst, Osteoinduction, Osteoconduction

Introduction

Odontogenic cysts occur in the oral and maxillofacial region and are divided into developmental and inflammatory cysts. Developmental cysts are dentigerous cyst, odontogenic keratocysts, and calcifying odontogenic cysts[1]. Inflammatory cysts include periapical cysts. Surgical strategies for cysts are curettage, enucleation, marsupialization, and jaw resection. Treatments are determined by the cyst type, lesion size, potential possibility of recurrence, patient age, presence of impacted tooth, and the potential for pathologic fracture. Enucleation is considered the preferred cure for cysts of the jaw[2]. However, this requires that the defective regions of the jaw be regenerated by bony resorption and the repetitive process of apposition. The success of bony healing is related to the size of defective parts, the anatomical site, and patient age[3].

If the defective sections are large, bone grafts are recommended for fast recovery, appropriate support of teeth and alveolar bone, prevention of clinicopathologic fracture, recovery of gingival tissues, and promotion of regeneration[4]. Among possible bone graft materials, autogenous bone grafts are considered the gold standard. Autogenous particulated marrow cancellous bone has a better capacity for osteogenesis than a cortical block bone graft. It can be harvested from several areas of the human body, with the anterior ilium as the most common donor site.

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However, autogenous bone grafts have some challenges. For example, the usable quantity in the intraoral region is limited, and harvesting an extraoral site requires additional surgery. Donor site complications can develop[5]. The limitations of allogenic bone or xenogenic bone grafts are possible disease transmission and immune reaction. Therefore, many bone substitutes have been developed through research on alloplastic bone.

Here we examine the bony regeneration results that demonstrate the strength of autogenous bone and xenogenic bone, and show appropriate use can minimize the weakness of bone grafts. This report provides three years of examples of radiologic images.

Case Report

A 70-year-old man was referred to the Department of Oral and Maxillofacial Surgery, Seoul National University Dental Hospital, for radiolucent lesions in maxilla and mandible. The patient did not have a specific disease except for controlled hypertension and diabetes mellitus. In a panoramic view, well-circumscribed cystic lesions surrounding the maxillary right third molar and mandibular left third molar were found. The lesions were clinically diagnosed as dentigerous cysts associated with impacted teeth. The treatment plan were cyst enucleation and bone graft after root canal treatment of mandibular left second molar (Fig. 1A, 1B).

After intraoral incision, the full mucoperiosteal flap was elevated to expose the intrabony lesions, and the bony window was prepared using a surgical bur. The cystic lesion was enucleated with extraction of mandibular third molar. Although the inferior alveolar nerve was exposed, the remained lesion was selectively removed under microscopic ×15 magnification to observe neurovascular bundles. The lesion in right maxilla was removed by same manner, and no complications, such as the perforation of lateral sinus wall, occurred. The progression of the lesion did not extend to the root portion of maxillary right second molar (Fig. 2). In clinical opinion, the two lesions had a definite cystic wall containing partially necrotic cystic fluid. The tentative diagnosis was an odontogenic keratocyst and multiple developed dentigerous cyst. Malignancy was ruled out, the bone graft was considered to promote bony healing in the old patient with diabetes mellitus. The exposed inferior alveolar nerve was covered with autogenous bone to prevent the occurrence of paresthesia following fibrous tissue healing around the nerve.

Cortical and cancellous bone were harvested from the anterior ileum of the patient and crushed to small particles using a bone crusher. Bio-Oss® (Geistlich Pharma AG, Wolhusen, Switzerland) of particle size range 0.25∼1.0 mm were used for xenogenic bone material. The autogenous and xenogenic bone were combined at a volume ratio of 2:1. The mixture was immediately grafted to the defect in the maxilla and mandible (Fig. 3). Primary closure was performed without tension. Although postoperative swelling was observed no specific complications occurred. The suture material was removed one week after the operation, and the pathological diagnosis was confirmed to be an odontogenic keratocyst. Routine check-ups were performed at 1 week, 3 months, 6 months, 1 year, 2 years, and 3 years after the operation by clinical examination and panoramic radiography. Bony healing showed satisfactory progress without recurrent radiolucency or specific lesion (Fig. 1C∼1H).

Discussion

Bone grafts can be planned to promote bone regeneration of a defect that occurs after enucleation of odontogenic and nonodontogenic cysts. Three biologic processes are usually involved in new bone formation within a bone graft: osteogenesis, osteoinduction, and osteoconduction. Osteogenesis requires surviving osteoblasts and osteoblast precursors to repopulate the graft and to form new bone, which occurs mainly in autogenos cancellous bone grafts. Osteoconduction involves replacement of the graft by osteoprogenitor cells from the host; bone resorption takes place simultaneously with bone apposition. Osteoinduction, a more recently recognized form of bone formation, occurs when bone morphogenic proteins are activated. These proteins attract host mesenchymal cells and program them to form cartilage, and subsequently bone. Osteoinduction occurs in autogenous bone grafts. Osteoconduction occurs more often where the resorptive process occurs, in xenogenic and alloplastic bone than in autogenous bone[6,7].

Autogenous cancellous marrow grafts are the most com-

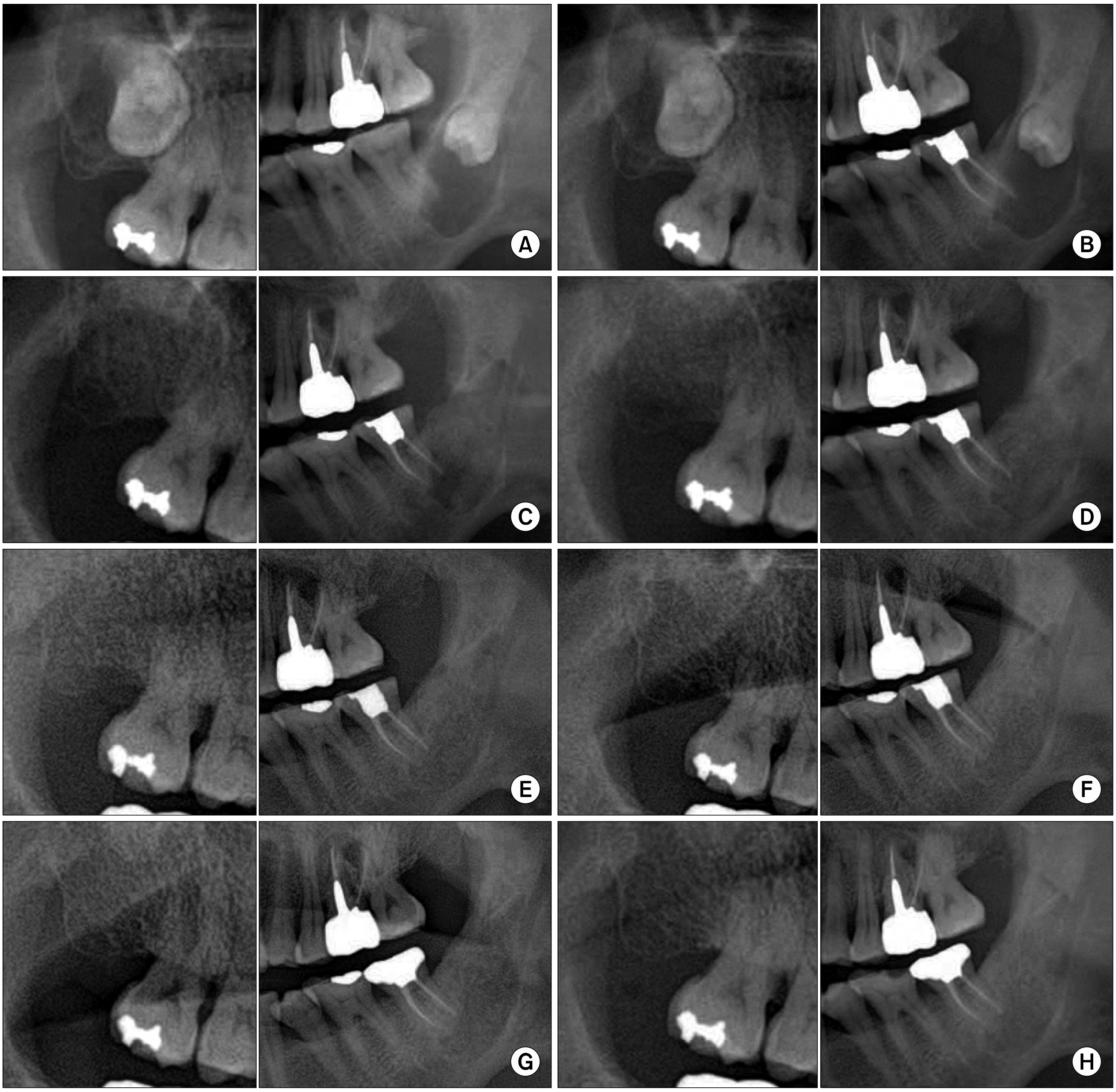

Fig. 1. Panoramic views of bony regeneration processes in the right upper posterior maxilla and the left lower posoterior mandible. (A) Pre-operative, (B) after endodontic treatment of left lower second molar, (C) post-operative 1 day, (D) post-operative 3 months, (E) post-operative 6 months, (F) post-operative 1 year, (G) post-operative 2 years, and (H) post-operative 3 years.

mon grafts used by oral and maxillofacial surgeons and give the most predictable results. They are used for the transplantation of more endosteal osteoblasts and marrow stem cells than any other graft. The healing mechanism begins with the initial survival of the transplanted osteocompetent cells. These cells are open to the local environment and survive by diffusion of oxygen and nutrients until the graft is revascularized by capillary ingrowth. Their mineral matrix is resorbed after revascularization allows osteoclasts to enter the area[7]. Autogenous bone graft have osteogenic potential and provide organic and inorganic substances essential for osteoinduction and osteoconduction. Revascularization of autogenous grafts occurs within 3 to 4 weeks[8], and the healing period is shorter than with other graft materials. Autogenous bone is frequently harvested from intraoral sites, often from the same quadrant as the surgery. Intraoral donor sites, however, typically yield comparatively limited graft volumes. If large quanti-

Fig. 2. Intra-operative photos showing two cystic cavities. One was around impacted right maxillary third molar (A), the other was around impacted left mandibular third molar (B).

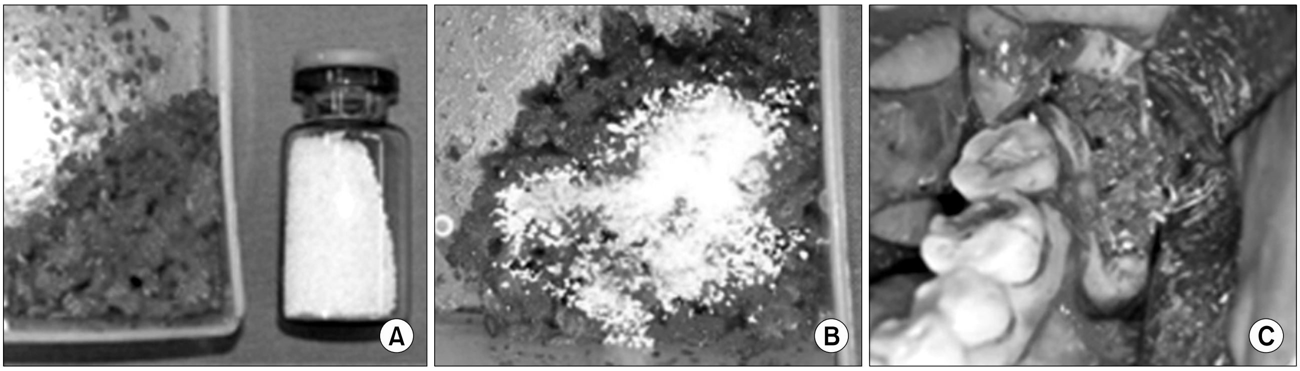

Fig. 3. Graft materials used. (A) Autogenous particulated marrow cortico-cancellous bone with xenogenic Bio-Oss® (Geistlich Pharma AG, Wolhusen, Switzerland) graft materials, (B) mixed state as a 1:1 ratio, and (C) grafted state in the left lower cystic region.

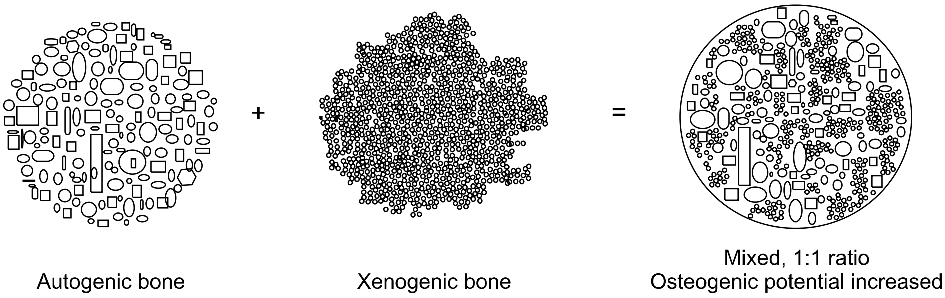

Fig. 4. Schematic drawing of composite bone graft performed in this clinical case, showing mixed bony particles with increased osteogenic potential.

ties of autogenous bone are needed, the ilium is usually used for donor site[9]. The anterior iliac crest provides easy access, a relatively large graft volume, and good quality tissue. However, complications such as persistent pain at the donor site are reported in 0∼49% of patients, functional disturbance 4.3∼17.0%, and paresthesia of the region distributed by the lateral femoral cutanous nerve in 2.9∼27.0%[5]. The resorption rate appears to be high within the first year after grafting, possibly because of the endochondral origin or lack of scaffolds for osteoconduction mechanisms[10].

Since a limited amount of bone is available at intraoral donor sites, several types of bone substitutes have been developed to replace the autogenous bone or to combine with autogenous bone. Bovine-derived or anorganic hydroxyapatite is a xenogenic material from which all organic components have been removed. This prevents induction of immune reactions or allergies *in vivo*. This material is similar to human cancellous bone both in its crystalline and morphological structure[8], it is highly biocompatible, and promote more early bone formation than other bone substitutes.

Bovine-derived hydroxyapatite appears to undergo physiologic remodeling with incorporation into the host bone. Although in some cases it appears to be rapidly replaced by the host bone[11], many investigators observed a slow resorptive activity[12], or no resorption[13]. de Vicente *et al.*[8] reported that Bio-Oss® particles remained 9 months after sinus lifting. This result might be because the mechanical properties of the grafted bone were compromised, affecting the support of the implants installed in the grafted bone[14]. In addition, the slow resorption of anorganic bovine bone is advantageous, because the augmented bone volume is stable over time until bone ingrowth takes place[8].

Therefore, in this study, a composite bone graft was planned using a mixture of autogenous and xenogenic bone material to promote osteogenic and osteoinductive potential of the autogenous graft, and to achieve the osteoconductive properties of xenogenic bone (Fig. 4). Through a composite graft, the morbidity of the donor site can be minimized by reducing the harvested volume, and new bone formation can occur wherever the autogenous bone particles are located. In a xenogenic solid graft, bone healing might be delayed because the new bone formation occurs in contact with the surface between the graft and host bone[15]. In addition, maintaining the graft size is possible until bone regeneration occurs because resorption is slow compared to application of autogenous bone only. In this study, an advantage might have been a decreased healing period compared to using only xenogenic bone. By combining small, uniform 0.25∼1.0 mm xenogenic graft particles, a completely non-porous revascularization structure could be made that supplied blood evenly, even though the autogenous graft had irregular particles. This overcomes several disadvantages of transplanting only particulated cancellous autogenous graft or xenogenic bone.

In this case report, after the removal of cysts comes from both maxilla and mandible, we performed bone grafts by blending autogenous bone graft particles with the xenogenic bone, Bio-Oss® in the remained intrabony defects. Immediately after surgery, radiolucency inferior to the mandibular left second molar was seen by panoramic radiography, with some remaining 3 months later. After 6 months, radiopacity had generally increased (Fig. 1). Bone grafts after enucleation will be determined by the size of lesion, a pathologic diagnosis of cyst, and patient age. Chiapasco *et al.*[16] reported that 87.6% of bony defects remained after 6 months, and 56.5% remained after one year, as observed by panoramic radiography, which showed cyst enucleation in the mandible. In the case presented here, a 70-year-old diabetic man whose host bone-forming capacity had decreased, received a transplanted autogenous and xenogenic graft together after after extraction of multiple cystic lesions from the maxilla and mandible. The bone graft regenerated safely. Our additional reports and results will be needed to compare patients who did not receive bone grafts with patients who received bone grafts with only autogenous or xenogenic bone.

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