Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

CASE REPORT

Use of Porcine Cancellous Bone Graft of Radial Nonunion Fracture in a Dog

S. Y. Heo, H. B. Lee, M. S. Kim and N. S. Kim*

Department of Veterinary Surgery, College of Veterinary Medicine, Chonbuk National University, Jeonju, 664-14 Korea
*Corresponding author: namsoo@chonbuk.ac.kr

ARTICLE HISTORY

Received: April 12, 2011
Revised: October 20, 2011
Accepted: November 10, 2011

Key words:
Dog
Incorporation
Polymethylmethacrylate
Porcine cancellous bone graft
Radial nonunion

ABSTRACT

A 6-month, 1.3 kg, Yorkshire terrier was referred for treatment of a radial nonunion fracture. The nonunion fracture site had a 40 mm-long defect between both fracture ends, where a porcine cancellous bone graft was implanted. The surgical treatment of the nonunion fracture was accomplished using an external fixator and polymethylmethacrylate (PMMA). The dog had a successful clinical outcome, and a radiographic examination conducted at post-surgery week 16 revealed the incorporation of the porcine cancellous bone graft and the nonunion fracture site by newly formed bone, resulting in a complete union. Porcine cancellous bone graft should be considered as an alternative option to autografts when treating nonunion fractures with segment bones defects.

To Cite This Article: Heo SY, HB Lee, MS Kim and NS Kim, 2012. Use of porcine cancellous bone graft of radial nonunion fracture in a dog. Pak Vet J, 32(3): 468-470.

INTRODUTION

Middle and distal third fractures of the radius and ulna are common in dogs and cats (Welch *et al*., 1997; Larsen *et al*., 1999), respectively constituting approximately 8.5 and 14% of long bone fracture in dogs (Sumner-Smith and Cowley, 1970; Larsen *et al*., 1999). The incidence of these fractures is notably high in toy breed dogs, the major cause is falling and jumping. In addition, delayed union and nonunion complications after surgery are significantly higher in small breed dogs than in larger ones (Welch *et al*., 1997; Larsen *et al*., 1999; McCartney *et al*., 2010).

Segmental defects and nonunion fractures of the bones are generally treated with stable fixation and autogenous bone grafts. While the latter is the best choice, disadvantages of Autogenous bone grafts include infection, pain, insufficient blood supply, donor site instability, and premature closure (Younger and Chapmang, 1989). Allografts and xenografts are widely-used for the treatment of bone defects in human and veterinary medicine, although the allograft approach is limited by the need for bone requirement and potential for disease transmission (Finkemeier, 2002). These limitations have prompted increasing interest in xenografts.

This case report describes an atrophic nonunion of radius in a 6-month, 1.3 kg, Yorkshire terrier which was rectified surgically through by excision of the nonunion, Kirschner wires, polymethylmethacrylate (PMMA) using external fixation technique and a porcine cancellous bone graft (PCBG). The surgical procedure and outcomes of the technique used have been elaborated which might be of notable value to the pet practitioners, globally.

HISTORY AND CLINICAL FINDINGS

A 6-month-old, 1.3 kg, male Yorkshire terrier was admitted to Chonbuk Animal Medical Center with a fracture forelimb. The owner revealed that the dog had a falling. The clinical signs were showed lameness and pain in forelimb. The dog had a Diaphyseal fracture of the left radius and ulna. The fracture had been treated 2 months previously using a veterinary cutting plate. After 60 days in first surgery, the dog exhibited non-weight-bearing lameness on the affected limb. On physical examination, no fever was evident, but pain and crepitation on palpation at the fracture site were observed. Radiographs showed an atrophic nonunion, a sclerotic marrow cavity, re-fracture under the cutting plate (Fig. 1) with no visible callus formation, The surgical technique using an external fixator and a PCBG was finalized for the treatment after appropriate consent of the owner.

Patient preparation and anesthesia: Prior to surgery, the dog received 25 mg/kg intramuscular cephalexin (Methilexin; Union Korea Pharm, Seoul, Korea) for prophylaxis. The dog was premedicated by a subcutaneous injection of 0.02 mg/kg atropin sulfate (Atropine Sulfate Daewon®; Dae Won Pharm, Seoul, Korea) and the intravenous introduction of 6 mg/kg propofol (Anepol IN®; Ha Na Pharm, Seoul, Korea). Anesthesia was maintained with isoflurane and oxygen.

Surgical procedure: The dog was placed in a dorsally recumbent position with the affected limb elevated. Drape the limb out from a hanging position to allow maximal manipulation during surgery. All surgical procedures were conducted under sterile conditions. The metal plate was removed and the fracture site was approached routinely. The atrophic nonunion having a 40 mm-long defect between both fracture ends was identified and exposed circumferentially. A ranger was used to completely excise the area of nonunion down to the bleeding bone. The fracture site having a 40 mm-long defect between both fracture ends was the site of implantation of the PCBG (TS-GBB®; Taesan Solutions, Seoul, Korea) (Fig. 2). Two full through pins at the proximal fragment of the radius bone and one at the distal fragment of the radius and metacarpal bones were inserted. The exposed pin ends were bent over to lie parallel to the bone in the area between the pin. A small amount of PMMA was applied to the lateral and medial sides of the bent pins as a sealant. Once the PMMA had cured, the reduction of the fracture site was assessed visually prior to the closing of the wound. Postoperatively, 25 mg/kg cephalexin (Methilexin; Union Korea Pharm, Seoul, Korea) and 2.2 mg/kg carprofen (Rimadyl®; Pfizer Animal Health, New York, NY, USA) administered subcutaneously for 10 days. A modified Robert Jones bandage was applied to the repaired limb and mobility was curtailed by restriction to a cage for 2 weeks.

The graft region of the fracture site was monitored by radiography at 2-week intervals until 18 weeks after surgery, and computed tomography (CT) scans were done

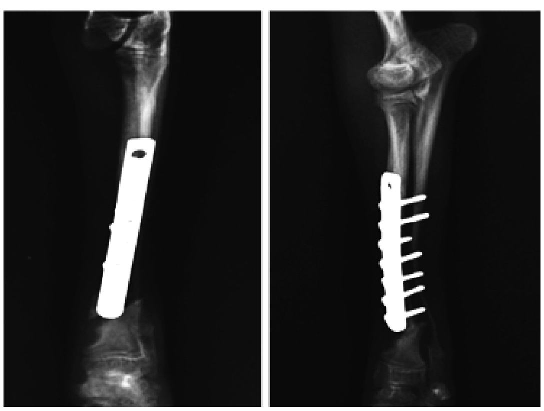

Fig. 1: Preoperative cranicaudal and lateral radiograph showing atrophy nonunion of fracture and re-fracture of radius and ulna.

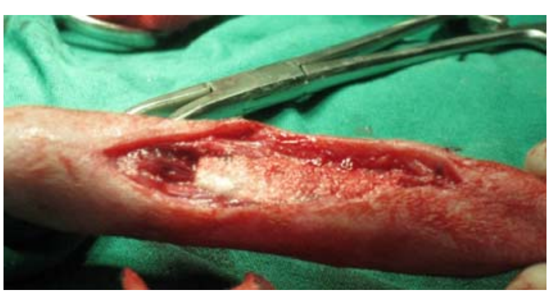

Fig. 2: Intraoperative view of nonunion site just after the PCBG graft.

at week 4 and 10 (Fig. 3). The radiographic images revealed the absence of resorption and the incorporation of the PCBG, as well as the replacement of the fracture site by newly formed bone, resulting in complete union between the graft and host bone. The PCBG was uniform and its density subsequently progressively decreased as remodeling proceeded. Weight bearing commenced at post-surgery week 4. Lameness due to proximal pin loosening was evident at 12 weeks. However, this did not affect the outcome. The external fixator was removed at post-surgery week 16 weeks. Radiography conducted at that time revealed complete radiographic healing (Fig. 4). No untoward complications were apparent in the subsequent 3 months.

DISCUSSION

A good outcome was presently achieved in the atrophic nonunion of radius with a PCBG using an acrylic external fixator. The PCBG was observed to be incorporated and absorption with the host bone and also triggered new bone formation at the fracture site. Previous study was evaluated biological response of procine bone in the maxilla defect of rabbits. These authors reported those intraosseously implanted xenografts are biocompatible, absorbable, allowing bone neoformation (Nannmark and Sunnerby, 2008). Incorporation of bone graft is a complex, long process that occurs following serial phases with biological interaction. The factors acting on the incorporation are revascularization, new bone formation, and integration of the graft and the host (Stevenson *et al.*, 1996).

Treatment of non-union or bone fractures with an external skeletal fixator made of PMMA has the advantages of being light-weight and low-cost, reduced operation time, and simplified application techniques (McCartney *et al*., 2010). This device provides good stability and greater versatility (Okrasinski *et al*., 1991). However, disadvantages include injury of soft tissue, difficulty in dressings, and pin loosening.

In humans, the most common site for nonunion of long bones is diaphysis of the tibia. In canines, the radius and ulna are the most common sites. In small dogs, this site has a higher chance of nonunion, due to a relatively low intraosseous blood supply and morphological differences (Welch *et al*., 1997). In one study, the complication rate was 75% with cast immobilization whereas complications occurred in only 12.5% of small dogs whose fractures were plated with cancellous bone grafting (Welch *et al*., 1997).

Nonunions are classified according to radiographic appearance, which correlates with the fracture biology (Slatter, 2003). Hypertrophic nonunions display prolific callus formation, have good vascularity and excellent healing potential given the right environment. These are treated with rigid stabilization, with or without compression and additional biologic stimulation in the form of bone grafting is not required. On the other hand, the atrophic nonunions are characterized by an absence of callus and atrophic bone ends, which may be tapered and osteopenic or sclerotic. Bone vascularity is deficient in them, and the bone has poor healing potential. They require augmentation to stimulate bone formation and need bone grafting.

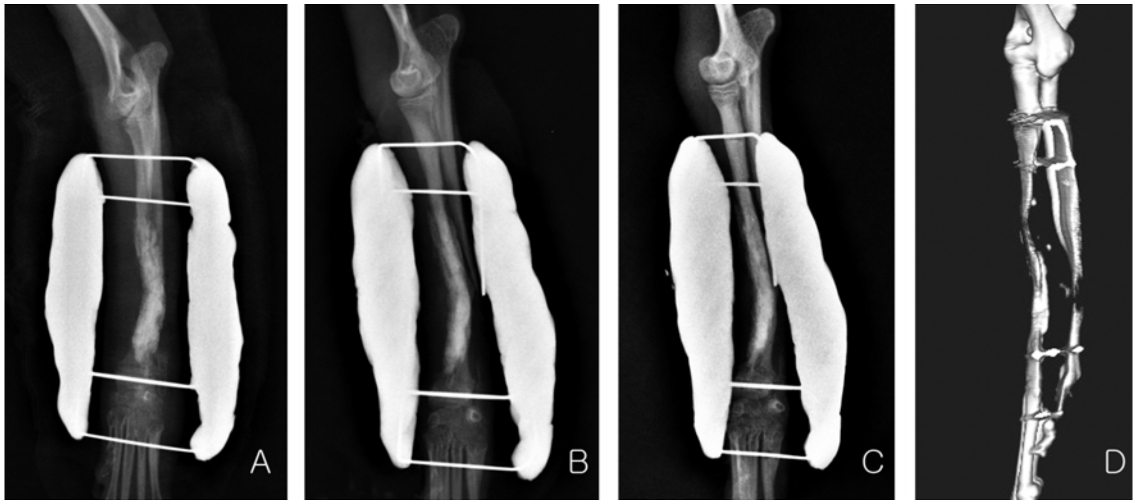

Fig. 3: Postoperative serial radiographic and CT scan images of changes after graft of porcine cancellous bone. Note the resorption and incorporation of graft material, and complete bony union of graft site, which resulted in complete union (A–C). (D) A three-dimensional reconstructed image compiled from data obtained at post-surgery weeks 0, 4, 8, and 10.

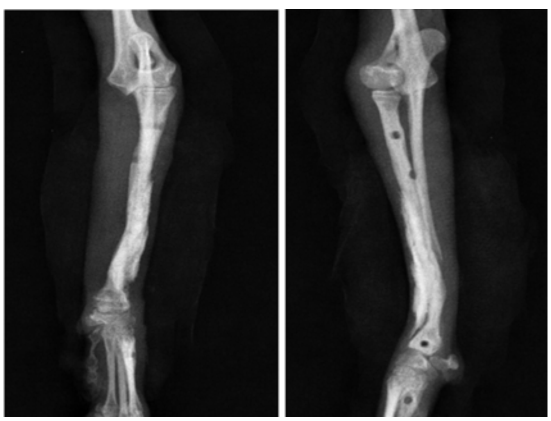

Fig. 4: Cranicaudal and lateral radiograph taken 16 weeks postoperatively, showing complete radiographic healing and incorporate of porcine cancellous bone and host bone.

The treatments of segmental bone defects resulting from nonunion or tumor resection are most challenging problems in veterinary orthopedics. Autogenous bone grafting is currently the clinical standard for bone defect. However, the use of autografted bone has several disadvantages including limited and harvesting, which requires an additional operative procedure that can cause pain, neurovascular injury, or infection at the donor site (Younger and Chapman, 1989). Despite these limitations, allografts are increasingly being used clinically. However, allografts carry the risks of disease transmission, difficulty in obtaining, and rapid resorption, relative to autologous bone (Finkemeier, 2002).

Clinical and experimental studies showed that the use of bovine and porcine xenogenic bone for repairing bone defects have reported good results. Recently, a clinical study used a bovine cancellous bone autograft to fill a defect of an aneurysmal bone cyst in a Labrador Retriever, and reported that the progress of the grafted lesion indicated healthy osteoconduction and native bone production (Worth *et al*., 2007). In a previous report, bovine cancellous bone acted as an osteoconductive material and was replaced by newly-formed bone in a mandible bone defect (Berglundh and Lindhe, 1997). Kim *et al*. (2004) placed heat-treated porcine cancellous bone in a tibia bone defect of a beagle dog, and reported that this osteoconductive material stimulated new bone formation and mechanical properties similar to human cancellous bone. In this case, PCBG demonstrated effective osteoconductivity, resulting in complete union in defect site and incorporation of the graft in host bone. The good clinical outcome in the present case indicates that the procedure should be considered as an alternative option to autografts when treating nonunion fractures with segment bone defects.

REFERENCES

Berglundh T and J Lindhe, 1997. Healing around implants placed in bone defects treated with Bio-Oss®. An experimental study in the dog. Clin Oral Implants Res, 8: 117-124.

Finkemeier CG, 2002. Bone-grafting and bone-graft substitutes. J Bone Joint Surg Am, 84-A: 454-464.

Kim SH, JW Shin, SA Park, YK Kim, MS Park, JM Mok, WI Yang and JW Lee, 2004. Chemical, structural properties, and osteoconductive effectiveness of bone block derived from porcine cancellous bone. J Biomed Mater Res B Appl Biomater, 68: 69-74.

Larsen LJ, JK Roush and RM M cLaughlin, 1999. Bone plate fixation of distal radius and ulna fractures in small- and miniature-breed dogs. J Am Anim Hosp Assoc, 35: 243-250.

Nannmark U and L Sennerby, 2008. The Bone Tissue Responses to Prehydrated and Collagenated Cortico-Cancellous Porcine Bone Grafts: A Study in Rabbit Maxillary Defects. Clin Implant Dent Relat Res, 10: 264-270.

McCartney W, K Kiss and I Robertson, 2010. Treatment of distal radial/ulnar fractures in 17 toy breed dogs. Vet Rec, 166: 430-432.

Okrasinski E, A Pardo and R Graehler, 1991. Biomechanical evaluation of acrylic external skeletal fixation in dogs and cats. J Am Vet Med Assoc, 199: 1590-1593.

Slatter D, 2003. Textbook of small animal surgery. 3rd Ed, W.B. Saunders, Philadelphia, USA, pp: 1849-1861.

Stevenson S, SE Emery and VM Goldberg, 1996. Factors affecting bone graft incorporation. Clin Orthop Relat Res, 324: 66-74.

Sumner-Smith G and AJ Cawley, 1970. Nonunion of fractures in the dog. J Small Anim Pract, 11: 311-326.

Welch JA, RJ Boudrieau, LM Dejardin and GJ Spodnick, 1997. The Intraosseous Blood Supply of the Canine Radius: Implications for Healing of Distal Fractures in Small Dogs. Vet Surg, 26: 57-61.

Worth AJ, KG Thompson, MC Owen, MR Mucalo and EC Firth, 2007. Combined xeno/auto-grafting of a benign osteolytic lesion in a dog, using a novel bovine cancellous bone biomaterial. N Z Vet J, 55: 143-148.

Younger EM and MW Chapman 1989. Morbidity at bone graft donor sites. J Orthop Trauma, 3: 192-195.