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Minimally Invasive Plate Osteosynthesis of Radius-Ulna Fracture using Circular External Fixator in a Dog

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Abstract : Fracture stabilization techniques continue to evolve and provide approaches that minimize the iatrogenic trauma associated with surgical procedures. Minimally invasive plate osteosynthesis (MIPO) is a recently described method of biological internal fixation performed by introducing a bone plate via small insertional incisions that are remote to the fracture site. Indirect reduction techniques can generally be utilized when performing MIPO. In this case report, we describe MIPO of a radius-ulna fracture by indirect reduction using circular external fixation for alignment and distraction in a dog.

Key words **:** minimally invasive plate osteosynthesis, radius-ulna fracture, circular external fixator, indirect reduction, dog.

Introduction

Fractures of the distal radius and ulna are the third most common type of fracture in dogs, representing approximately 8.5-17% of fractures (10). These fractures have a particularly high incidence in small and toy breeds and are often the result of minor trauma (1). These breeds of dog are particularly prone to delayed union and nonunion as well as refracture after plate removal for fractures of the distal radius and ulna (14). Inherent biomechanical instability, decreased intraosseous blood supply, and limited overlying soft tissue for provision of extraosseous circulation contribute to the higher frequency of delayed union or nonunion fractures at these sites (15). Biological fracture fixation techniques that limit iatrogenic surgical trauma while obtaining appropriate construct stability would be advantageous to promote healing of these bone fractures (13). A variety of treatment methods have been applied to radius-ulna fractures. Of these, open reduction for internal fixation (ORIF) with bone plating is often used to treat radius fractures in small-animal practices. ORIF requires wide exposure of the fracture site, which often results in substantial soft tissue trauma in the region of the fracture and can devascularize fracture fragments (12). Disruption of the extraosseous blood supply has the potential to increase the risk of delayed healing and to increase infection and complication rates (8,11). Minimally invasive percutaneous plate osteosynthesis (MIPO) is a popular treatment method for bone fracture in humans, and more recently in dogs (8,12,16). The MIPO technique decreases iatrogenic periosteal vascular disruption and has many biological advantages compared with the conventional bone plating technique (3,6,13). In addition, indirect reduction techniques are generally used for MIPO fracture stabilization. These techniques rely on aligning fragments by distracting the bone ends instead of manipulating the fracture site. Distraction may be achieved by traction and counter-traction applied to the limb as in the hanging limb technique, using an intramedullary pin or external fixation distractor (7). This report describes MIPO of radius-ulna fracture in a dog by indirect reduction using an external fixation distractor.

Case

A 3-year-old, 9 kg male Jindo was presented for evaluation of non-weight bearing of the right forelimb. Lameness began 11 days prior following a traffic accident. On physical and orthopedic examination, the dog was suspected to have a closed fracture with severe soft tissue swelling in the radius area. Radiographs revealed a distal diaphyseal transverse fracture (Fig 1A, B). Prior to surgery, the patient was premedicated with subcutaneous administration of 0.02 mg/kg atropine sulfate (Atropine sulfate Injection®, Jeil Pharm, Yongin, Korea) and intramuscular injection of 0.2 mg/kg butorphanol (Butophan Injection®, Myungmoon Pharm, Seoul, Korea). General anesthesia was induced using intravenous injection of 4 mg/kg propofol (Provive®, Myungmoon Pharm, Seoul, Korea) and maintained with isoflurane (Ifran®, Hana Pharm, Seoul, Korea) delivered with oxygen. Intravenous injection of 22 mg/kg cephazolin (Cefazoline Injection®, Chong Keun Dang Pharm, Seoul, Korea) and 3 mg/kg tramadol (Toranzin®, Shinpoong Pharm, Seoul, Korea) were also given at the time of induction. Preoperatively, the patient was positioned in dorsal recumbency with a foam pad placed under the shoulder. The limb was aseptically prepared using a hanging limb technique and draped. Orthogonal images of the entire antebrachium, including the elbow and carpus, were obtained intraoperatively using fluoroscopic guidance (Digital C-Arm Zen 2090 Pro, Genoray Co, Ltd, Sungnam,

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Fig 1. Preoperative radiographs. Craniocaudal (A) and lateral (B) views of the right radius and ulna. Radiographs revealed a distal diaphyseal transverse fracture.

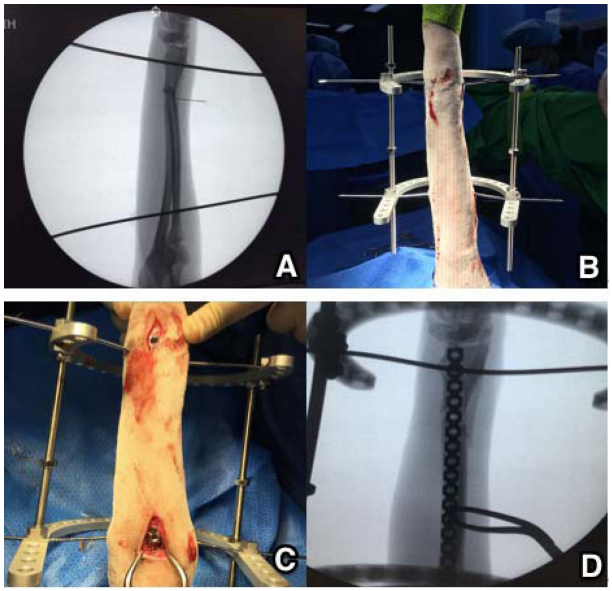

Fig 2. Intraoperative fluoroscopy images and views. (A) Distal and proximal wire were inserted parallel to the articular surface in the medial-to-lateral plane. (B) Ring of the preassembled fixator attached to the two wires using wire fixation bolts and nuts. (C) Precontoured plate was passed along the tunnel in a proximal to distal direction. (D) Fluoroscopy image after insertion.

Korea) to evaluate displacement of the fracture segments and develop a strategy for reduction. A 2-ring circular fixator (IMEX Veterinary Inc, Longview, USA) was applied to the antebrachium and used to distract the fracture segments and to facilitate and maintain reduction during plate application. The initial fixation wire was placed in the medial-to-lateral plane through the distal radius fragment, parallel to the distal articular surface of the radius. A second fixation wire was then inserted through the proximal radial metaphysis, parallel to the proximal articular surface in the medial-to-lateral plane (Fig 2A). Distal and proximal wires were attached to the ring of the preassembled fixator using wire fixation bolts and nuts (Fig 2B). Once the fracture was distracted to anatomic length, reduction was performed observing the plane of flexion and extension of the carpus relative to that of the elbow. After the fragments had been aligned, a distal skin incision approximately 2 cm in length was made on the dorsal side of the radius. The initial epiperiosteal tunnel was created with a periosteal elevator from the distal incision. Next, Metzenbaum scissors were used to create an extraperiosteal tunnel in a distal to proximal direction. A proximal insertion incision was created after measuring the proximal extent of the plate. The precontoured plate (compression locking plate, BS Corem, Wanju, Korea) was passed along the tunnel in a proximal to distal direction (Fig 2C). Following insertion, the correct position was confirmed with fluoroscopy using two views (Fig 2D). Two and three screws (2.0-mm locking screw, BS Corem, Wanju, Korea) were inserted in both the proximal and distal radial fracture segments, respectively. We were able to confirm the alignment and position of the plate by fluoroscopy whenever necessary. Final additional fixation was achieved with three screws at the distal holes of the proximal fragment of the plate. Routine closure of the surgical wound was performed in layers. Postoperative radiographs (Fig 3A) revealed that axial alignment was not completely achieved. A Robert-Jones splinting bandage was applied for 4 days to prevent postoperative swelling. Postoperative radio-

Fig 3. Postoperative (PO) radiographs. (A) Immediate after surgery. (B) PO 2 weeks radiographs showed small callus formation around the fracture site. (C) PO 4 weeks radiographs revealed establishment of a bony bridge.

graphs (Fig 3B) showed small callus formation around the fracture site at 2 weeks. At the 4-week follow-up, radiographs showed establishment of a bony bridge (Fig 3C). The patient was able to use the limb 3 days postoperative and was able to walk without any support 4 weeks postoperative.

Discussion

The MIPO technique is a safe and effective method with the advantages of less soft tissue injury, reduced blood loss, lower risk of bacterial infection, and decreased postoperative pain (3,4,6). Despite these advantages, MIPO is technically demanding also has the additional disadvantage of non-accurate reduction. Obtaining appropriate alignment can be challenging during MIPO because the fracture is not exposed and indirect reduction techniques must be used (6). Because of the limited view provided the fragments may be not tightly compressed, which could increase the risk of delayed union or non-union. In human medicine, several studies have reported that the rate of delayed union or nonunion is 5-17% (4), and the rate of femoral and tibial rotational malalignment after MIPO surgery was reported to be 38.5% and 50%, respectively (2).

However, Pozzi *et al*. reported that the MIPO technique using external fixation resulted in acceptable reduction and alignment of both simple and comminuted fractures of the radius and ulna because it is possible to continuously evaluate rotational alignment during surgery (13). Another advantage of this technique is easy distraction of the bone segments, even in the presence of severe muscle contraction (7). Medium to large animals with significant muscle contraction and fragment overriding and old fractures are typically plated following open reduction because of the difficulty in achieving reduction of two-piece fractures. In such patients, however, an external fixator can be used during the operation as a distraction device to allow indirect reduction through the amount of longitudinal distraction force (5). Therefore, MIPO using an external fixator not only makes reduction easier, but also helps to preserve the blood supply to bone.

Conclusion

In the present case, MIPO using an external fixator was applied for the treatment of diaphyseal fracture of the radius and ulna in a dog. Our patient showed rapid bone healing times without any other sequelae, although axial alignment could not be completely achieved. Therefore, MIPO using external fixation can be a good treatment option for fracture without the disadvantages of conventional MIPO.

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