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Case Report

Repair of a Complete Simple Distal Diaphyseal Transverse Fracture of the Radius and Ulna with Bone Plate and Screws in a *Toy Poodle* Canine

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Abstract

A seven-month-old neutered female *Toy Poodle* was presented with lameness on the right front leg after a minor injury. Radiographs revealed a complete simple distal diaphyseal transverse fracture of the right radius and ulna. Internal fixation of the fracture was performed by placing a 1.5 mm veterinary cuttable plate (VCP) 1.0 mm thick. Two weeks later the patient re-fractured the radius at the same site after a self-injury and a second operation was performed by placing a 2 mm VCP 1.5 mm thick.

Prevalence, diagnostics and surgical technique are discussed in this report. A comparison between surgical alternatives and their post-operative complications is also made.

Keywords: *Toy Poodle*; Dog; Radius

Introduction

Amongst the most common long bone fractures in dogs, the distal third diaphyseal of the radius and ulna is third. It is also the most common fracture site of the radius (85%) [1]. Miniature and toy breed dogs usually suffer from these fractures and it is frequently caused after a minor injury.

Diagnosis is predominantly based on imaging diagnostic techniques by using radiography or more advanced imaging, like computed tomography (CT) and magnetic resonance imaging (MRI).

Imaging is also essential for ascertaining the forces that act on the fractured bone and classifying the fracture, which will provide sensible information in order to determine the most appropriate treatment method and prognosis [2].

External coaptation, intramedullary (IM) pin, external skeletal fixation (ESF) and plate fixation have been reported as treatment options of distal radial fractures, with the latter two being the most successful, with the fewer complication rates [3] and thus offering an excellent prognosis.

Diaphyseal fracture complications are well recognized and they include delayed union, mal- and non-union as well as infections. Most miniature and toy breed dogs suffer from higher prevalence of fracture healing complications in the distal third of the radius, in comparison to larger breed dogs, due to the decreased vascular density in that site of the radius [4].

History

A seven month old neutered female *Toy poodle* was presented with no weight bearing lameness on the right front leg after she had jumped down off the sofa that morning. She was up to date with vaccinations and endo- and ectoparasitic treatment. The dog had undergone routine spay three days ago and she was on oral meloxicam 1.5 mg/ml (Metacamâ oral suspension; Boehringer Ingelheim, 0.2 mg/kg) every 24hrs.

Clinical findings

The patient was of good body condition weighing 3.8kg and her general demeanor was bright and alert. Thoracic auscultation was unremarkable. Heart rate was 136 beats/minute and breathing pattern was normal with 24 breaths/minute. Mucus membranes were pink and moist and capillary refill time was less than two seconds. Femoral pulse was synchronous and strong and rectal temperature was 38.6°C. Neurological examination was normal, although proprioception of the right front leg was abnormal through reluctance to move the leg.

When walking on the floor, she was non-weight bearing lame on her right front leg. During the orthopedic examination, there

was bruising and palpable swelling with crepitation on the distal end of the right radius but no obvious pain during manipulation of the site. There was a palpable fracture during manipulation of the distal part of the radius. Rest of orthopedic examination was unremarkable.

Diagnostic techniques

The patient was sedated with medetomidine 1 mg/ml (Sedatorâ Injectable solution; Dechra, 0.01 mg/kg) and methadone 10 mg/ml (Comfortanâ Injectable solution; Dechra, 0.3 mg/kg) via a 22-gauge intravenous catheter placed on the left cephalic vein.

One lateral and one craniodorsal radiograph views of the right and left radius were taken including the proximal and distal joints of the radius. Radiographs of the left radius were unremarkable. Radiographs of the right leg revealed a complete, simple, transverse fracture of the distal third of the diaphysis of the radius and ulna (Figure 1). While under sedation a splint bandage was placed to stabilize the fracture site and reduce further soft tissue and blood supply damage, which would impede the healing process. The patient was reversed with intramuscular injection of atipamezole 5 mg/ml (Atipamâ Injectable solution; Dechra, 0.05 mg/kg). She was discharged with oral meloxicam at 0.2 mg/kg q24hrs and tramadol 10 mg q12hrs (Tramadol Hydrochloride Tablets; Summit Veterinary Pharmaceuticals, 2.5 mg/kg).

Figure 1: Complete simple distal diaphyseal transverse fracture of the right radius and ulna (Craniodorsal and lateral radiographic view).

Prior to surgery, a plan was made to find the best treatment option. All forces needed to be counteracted (traction, compression, tension, torsion, shear) and thus ESF or bone plating had to be chosen (Table 1). Prognosis is excellent in both options due to high successful rates. The owners were advised in detail about complications of both options (delayed, mal- or non- union, infection and implant failure) and they were also made aware of the strict post-op care of the patient to facilitate the healing process.

	Traction	Compression/ Collapse	Rotation	Bending	Shearing
Cast	-	-	+/-	+/-	+/-
IM pins	-	-	-	+	-
Tension Band	+	-	+/-	+/-	+/-
External Fixator	+	+	+	+	+
Interlocking nail	+	+	+	+	+/-
Bone Plate	+	+	+	+	+

Table 1: Ability of different implants to counteract forces (Noel 2016).

Post-op care management was a contributing factor and eventually bone plate fixation was elected. Plate, screw, drill and tap sizes were determined (Table 2).

Treatment

Two days later, the dog was admitted to undergo an orthopedic surgery. The patient was premedicated with medetomidine 0.005 mg/kg and methadone 0.3 mg/kg via a 22-gauge intravenous catheter placed in the left cephalic vein. General anesthesia was then induced with propofol 10 mg/ml (PropoFloä Injectable solution; Abbott, 4 mg/kg) intravenously. She was intubated with a number 4.5 cuffed endotracheal tube and maintained under general anesthesia on 2% isoflurane (Isofloâ; Abbott) in oxygen using a T-piece circuit and 0.5L reservoir bag. Oral meloxicam was administered by the owner earlier in the morning. Pre-operative cefuroxime 100 mg/ml (Zinacefä Injectable solution; GlaxoSmithKline, 20 mg/kg) was administered intravenously and repeated perioperatively at 90 minute intervals on a prophylactic basis. Surgical rate of 5 ml/kg/hr of Lactated Ringer's fluids were given intravenously throughout the anesthetic time.

The right front leg was clipped surgically from the shoulder to the foot, foot was bandaged and rest of the leg was cleaned aseptically using 4% chlorhexidine gluconate (Hibiscrubâ; Kwhito). In theatre, the patient positioned in a dorsal recumbency with the operated limb drawn caudally.

Screw size	1.5	2.0	2.4	2.7	3.5	4.0	4.5	5.5
Screw type	Cortical	Cortical	Cortical	Cortical	Cortical	Cancellous	Cortical	Cortical
Glide hole mm (lag screw)	1.5	2.0	2.4	2.7	3.5	4.0	4.5	5.5
Pilot hole mm	1.1	1.5	1.8	2.0	2.5	2.5	3.2	4.0
Size of tap mm	1.5	2.0	2.4	2.7	3.5	4.0 cancellous tap	4.5	5.5

Table 2: Implant guide [5].

Surgical spirit was applied on the surgical site and sterile bandage was applied on the foot. Scalpel blade number 15 was used for skin and subcutaneous tissue incision in the craniomedial aspect of the radius extended from the proximal shaft to the carpus. The deep antebrachial fascia was incised in between the extensor carpi radialis and pronator muscles proximally. The distal part of the incision was directed parallel to the extensor muscle. Gelpi retractors were used to retract the extensor carpi radialis laterally. Extreme care was taken of the cephalic vein. Cranial surface of the bone was exposed and periosteal elevators were used to elevate soft tissues around the bone to reduce soft tissue trauma during bone plate and screw application [6,7].

Once the fracture site was located (Figure 2) bone holding forceps were used to maintain the reduction of the fracture. A 1.5 mm 8-hole VCP of 1.0 mm thickness was first cut to accommodate 4 holes proximal to the fracture site and 3 holes distal to it. It was then contoured as needed and prestressed over the fracture line as always advised [3] by leaving a 1 mm gap between bone and plate in order to ensure transcortical contact. Using a drill driver and a drill bit with 1.1 mm pilot hole, 7 holes were drilled on the cranial surface and perpendicular to the long axis of the radius. All holes were measured and tapping was performed with a 1.5 mm tap. The tension surface of the radius is the cranial, where the plate was applied [8], and it was secured by placing 1.5 mm cortical screws with the aim of a screw driver (Figure 3). First, the screws were inserted into the holes closest to the fracture line (about 1cm from it) without fully tightening them. Remaining screws were placed and then sequentially tightened [5]. The surgical site was lavaged with sterile 0.9% saline solution. Deep antebrachial fascia and subcutaneous tissue were sutured in separate layers with 2-0 metric poliglecaprone 25 (Monocryl 3-0) in simple continuous pattern. External simple interrupted sutures were done on the skin using 2-0 metric Nylon suture (Ethilon 3-0).

Post-op radiographs of the right radius showed good apposition and alignment with less than 1 mm gap in between the fragments. The length of the plate and the screws were of appropriate size and the screws were not going through the ulna. The distance of the screw closest to the proximal fragment to the fracture line is less than 1cm but not on the fracture site (Figure 4). Splint bandage was applied.

Figure 2: Fracture site.

Figure 3: Internal fixation with bone plate and screws on the cranial surface of the radius.

The patient was reversed with atipamezole 0.025 mg/kg intramuscularly and recovered uneventfully. She was discharged with oral pain relief as before surgery. Additionally, 50 mg BID of oral amoxicillin-clavulanic acid (Nisamox Tablets; Bayer, 13 mg/kg) was dispensed to be administered q12hrs. The owner was advised to cage rest the dog for 6 weeks and only 3-4 minutes on lead walks for toileting.

Figure 4: Post-op radiographs (lateral and craniodorsal views).

Figure 5: Radiographs of refracture (lateral and craniodorsal views).

Progress and outcome

By day fourteen post-operatively the wound had healed and the patient was ambulatory. The bandage was changed every 2 - 3 days until the suture removal, when it was finally removed.

The day after the last check, the dog was presented for non-weight bearing lameness on the right leg. The owner reported that she was constantly banging the cage door when this happened. The patient was 10/10 lame on the fractured leg and the distal part of the radius was at an abnormal angle. Physical examination was otherwise unremarkable. The patient was immediately sedated with intramuscular injection of medetomidine 0.005 mg/kg and methadone 0.3 mg/kg. Lateral and craniodorsal radiographic views showed refracture of the same site of the radius and plate fracture (Figure 5). All screws were still in place. A splint bandage was re-applied until surgery.

General anesthetic doses and pre-operative preparation was performed as discussed for the first operation. Craniomedial approach was performed. Fracture site was exposed (Figure 6) and the plate, which was fractured on the lateral side, was removed along with the screws. A 2 mm VCP of 1.5 mm thickness was contoured and pre-stressed and then secured in the cranial aspect of the radius with 2 mm cortical screws, five proximal and four distal to the fracture site. The pre-existing holes were used (Figure 7). Closure was achieved as with the first operation.

Figure 6: Re-fracture of bone and plate fracture.

Figure 7: Second fracture repair.

Lateral and craniodorsal post-op radiographs showed good apposition and alignment with less than 1 mm interfragmentary gap. Length of the plate and screw size were appropriate. Screws were not going through the ulna and their diameter did not exceed 1/3 of the diameter of the radius (Figure 8). Splint bandage was applied and the patient was discharged with same medications as with first operation.

By second post-op check, fourteen days later, wound had healed and the patient was ambulating very well. The bandage was changed every 2-3 days until suture removal. Afterwards, it was changed weekly for four weeks. Four weeks post-op the patient was sedated by intramuscular injection of medetomidine 0.005 mg/kg and butorphanol 10 mg/ml (Torbugesicâ Injectable solution; Zoetis, 0.3 mg/kg) and lateral and craniodorsal radiographs were taken. They revealed cortical continuity, gradual diminish of the fracture line and good implant stability (Figure 9). At that point, the bandage was removed as there was sufficient bone healing and minimal carpal flexion. Strict rest was continued for another four weeks, when radiographs were repeated under sedation with the same regime used at four-week post-op radiographs. There was loss of fracture line and complete bone healing (Figure 10). There was also improvement of carpal flexion. The owners were instructed to start on short walks on the lead three times daily, which length should be increased weekly by five minutes. Hydro- and physiotherapy was initiated in order to improve carpal flexion. Four weeks later, off lead walks could be started, which length should gradually increase.

Figure 8: Post-op radiographs from second surgery (lateral and craniodorsal views).

Figure 9: Four weeks post-op radiographs (lateral and craniodorsal views).

Figure 10: Eight weeks post-op radiographs (lateral and craniodorsal views).

Discussion

Fracture of the distal third of the diaphysis of radius accounts 14% of all long bone fractures [1]. Miniature and toy breed dogs are quite susceptible to this type of fractures and is most common associated with minimal traumas, as happened with the patient in this case.

Clinical studies have shown that these types of dogs have a high incidence of delayed or non-union fractures in the distal third of the diaphysis of the radius [4,9]. The reasons are vascular, due to limited soft tissue coverage and decreased intraosseous circulation, and biomechanical, due to the pull of the digital flexor muscles [10].

Imaging techniques are needed pre- and post-operatively. Preoperative imaging will help to classify the fracture and will facilitate determining the forces that need to be counteracted in order to stabilize the fragments. This will consequently determine the best surgical technique that has to be performed in order to have the best chances of repair and as less postoperative complications as possible (Table 1). Pre-operative radiographs were used in this case to make a thorough surgical plan.

Frequent post-op imaging is required to evaluate the healing process by checking the apposition, alignment, activity and apparatus [11].

External coaptation, IM pins, ESF and internal fixation with bone plates have been reported as treatment options for radial fractures.

Fixation of these fractures by using the first two methods are not recommended cause both coaptation and IM pins have shown high incidence of delayed and non-union complications, 83% and 80% respectively [12,13].

External skeletal fixation is a successful method of repair [14] with its rate accounting 93% [13]. Though, the narrow radius of toy breeds along with their oval shaped cross section, makes the atraumatic application of ESF pins very challenging [15]. This technique offers a variable rate of complication (4 - 50%) [3] and some of the complications that can appear are apparatus failure, loosening of the pins, delayed and non-union fractures, pin tract drainage and neuromuscular damage [16]. In this case postoperative management and compliance of the owner was also a contributing factor.

For most surgeons, open reduction and bone plate fixation has been the treatment of choice for fractures involving the diaphysis of the radius and ulna. This technique was elected for the patient as it offers a very good prognosis (at least 89% successful rate) with a very low incidence of delayed or nonunion and low complication rate in general [13,17,18]. Additionally, long-term application of the plate does not seem to significantly affect the cortical density of the radius [19].

The most common plates used for these fractures are the dynamic compression plates (DCP), VCP and T-plates and the sizes are usually, 1.5 mm, 2.0 mm or 2.7 mm, based on the patient's size, bone size and fracture configuration. Plates can function as compression, neutralization or bridging plates. The plates are applied on the tension surface, which is either cranial or craniomedial. In this case, we used a 1.5 mm VCP with 1.0 mm thickness and a 2.0 mm VCP with 1.5 mm thickness. Both were used as compression plates.

Complications associated with bone plate fixation of radial fractures include angulation, implant failure, osteopenia, infection and thermal irritation [13,17,18]. Incorrect choice or use of apparatus [20] and decreased carpal flexion have also been reported as complications [15].

In this case, a stronger plate had to be applied during the second operation due to breakage of the first one. Decreased carpal flexion was also noticed due to the interference of the plate with the extensor tendons, which improved after the initiation of hydro- and physio-therapy.

Conclusion

Distal radial fracture is very common in miniature and toy breed dogs and is usually caused by minor injuries. Open reduction and bone plate fixation is the gold standard method for most surgeons cause, as from clinical studies, it provides an excellent outcome and offers a low complication rate.

Though, it is a challenging procedure which needs good pre-operative radiographs and thorough planning prior to surgery in order to classify the fracture, determine the acting forces and the tension surface of the bone and select the appropriate size of apparatus. Post-operative radiographs are also essential in assessing the bone healing.

Last but not least, vets always need to thoroughly inform and make the owners aware of all the possible complications, post-operative management and the long process of bone healing.

Bibliography

1. Harasen G. "Common long bone fracture in small animal practice - Part 2". *The Canadian Veterinary Journal* 44.6 (2003): 503-504.

2. Unger M., *et al*. "Classification of Fractures of Long Bones in the Dog and Cat: Introduction and Clinical Application". *Veterinary Comparative Orthopaedics and Traumatology* 03.02 (1990): 41-50.

3. Woods S and Perry KL. "Fractures of the radius and ulna". *Companion Animal* 22.11 (2017): 670-680.

4. Welch J., *et al*. "The Intraosseous Blood Supply of the Canine Radius: Implications for Healing of Distal Fractures in Small Dogs". *Veterinary Surgery* 26.1 (1997): 57-61.

5. Parsons K. "Internal Fixation – Practical Session: plating of the radius". Module 19 in PgC(SAS) Improve International, Swindon (2019): 6-8.

6. Johnson KA., "Approach to the Shaft of the Radius Through a Medial Incision". Section 5 in Piermattei's Atlas of Surgical Approaches to the Bones and Joints of the Dog and Cat, 5th edition, St. Louis, Elsevier Saunders 276-279.

7. Milovancev M and Ralphs SC. "Radius/ulna fracture repair". *Clinical Techniques in Small Animal Practice* 19.3 (2004): 128-133.

8. Fox DB. "Radius and ulna". Chapter 54 in Veterinary Surgery in Small Animal Volume 1, (Tobias, K., M., Johnston, S., A.) Canada, Elsevier Saunders (2018): 915-917.

9. Vaughan LC. "A Clinical Study of Non-union Fractures in the Dog". *Journal of Small Animal Practice* 5.2 (1964): 173-177.

10. Ramirez J and Macias C. "Conventional bone plate fixation of distal radius and ulna fractures in toy breed dogs". *Australian Veterinary Journal* 94.3 (2016): 76-80.

11. Langley-Hobbs S. "Biology and radiological assessment of fracture healing". *In Practice* 25.1 (2003): 26-35.

12. Lappin MR., *et al*. "Fractures of the radius and ulna in the dog". *The Journal of the American Animal Hospital Association* 19 (1983): 643-650.

13. Larsen L., *et al*. "Bone plate fixation of distal radius and ulna fractures in small- and miniature-breed dogs". *Journal of the American Animal Hospital Association* 35.3 (1999): 243-250.

14. Johnson A., *et al*. "Radial and Tibial Fracture Repair with External Skeletal Fixation: Effects of Fracture Type, Reduction, and Complications on Healing". *Veterinary Surgery* 18.5 (1989): 367-372.

15. Langley-Hobbs SJ and Hamilton MH. "The use of the AO veterinary Mini "T"-plate for stabilization of distal radius and ulna fractures in toy breed dogs". *Veterinary and Comparative Orthopaedics and Traumatology* 18.01 (2005): 18-25.

16. Egger EL. "Complications of External Fixation". *Veterinary Clinics of North America: Small Animal Practice* 21.4 (1991): 705-733.

17. De Arburn Parent R., *et al*. "Open reduction and cranial bone plate fixation of fractures involving the distal aspect of the radius and ulna in miniature- toy- breed dogs: 102 cases (2008-2015)". *Journal of the American Veterinary Medical Association* 250.12 (2017): 1419-1426.

18. Miyazaki Y., *et al*. "Clinical Outcomes and Complications after Open Reduction and Internal Fixation Utilizing Conventional Plates in 65 Distal radial and Ulnar Fractures of Miniature- and Toy-Breed Dogs". *Veterinary Comparative Orthopaedics and Traumatology* 31.03 (2018): 214-217.

19. Glennon J., *et al*. "The effect of Long-Term Bone Plate Application for Fixation of Radial Fractures in Dogs". *Veterinary Surgery* 23.1 (1994): 40-47.

20. Hunt J., *et al*. "The complications of diaphyseal Fractures in dogs: a review of 100 cases". *Journal of Small Animal Practice* 21.2 (1980): 103-119.