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CASE REPORT
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Type IV Monteggia Fracture in a Puma Cub (*Puma concolor*) - Surgical Treatment

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ABSTRACT

***Background*:** Monteggia fracture is an injury characterized by a bone discontinuity affecting the ulna associated with radial head dislocation. This type of fracture has been rarely reported in human and veterinary literature and even more rarely in studies on wild animals. Herein, we report the case of a puma cub (*Puma concolor*); also known as cougar) with functional weakness of the right forelimb following an automobile trauma who was diagnosed with type IV Monteggia fracture. The cub underwent osteosynthesis of the radius and ulna, which was associated with reduction of humeroradial dislocation, to achieve functional recovery of the injured limb until its reintroduction into the wild.

***Case*:** A traumatized puma cub was treated for lameness and functional weakness of the right forelimb. The nature of the trauma is unknown, but probably secondary to vehicle collision. Following intramuscular chemical sedation with ketamine and xylazine, a physical examination was conducted, revealing that the cub was a young male with permanent incisors and deciduous canines. Radiographic examination revealed fractures in both ulna and radius, along with right humeroradial dislocation, which is a characteristic feature of type IV Monteggia fracture. The cub underwent surgical osteosynthesis associated with correction of the dislocation. Osteosynthesis was performed using locking neutralization plates on both radius and ulna. In addition, a figure-of-8 antirotational suture was performed with steel wire over the head of the radius and condyle of the humerus to reduce the radial head dislocation. After surgery, the animal appeared comfortable, with weight bearing of the operated limb. Bone healing of the fractures was verified within 75 days. It was recommended that the implants should be removed before reintroducing the animal into the wild.

***Discussion*:** Monteggia fractures are an uncommon type of fracture, with only a few reports published in veterinary literature. Despite the lack of information, especially in wild animals. This type of fracture has been reported to be caused by direct high-energy, for example, automobile trauma or falls. Monteggia fractures are difficult to be identified by physical examination, and radiographic examination with at least 2 orthogonal projections is defined as the "gold standard" of diagnosis. These fractures must be treated surgically as early as possible to avoid excessive surgical manipulation and complications. Complications include swelling of the limb, muscle contraction, and inflammation of the soft tissues. The surgical technique may vary depending on the surgeon's preference and patient's characteristics. Furthermore, when bone fragments can be anatomically reconstructed and maintained in position, rigid stabilization methods should be used, such as locking plates. In the feline analyzed in this report, osteosynthesis of the radius and ulna combined with the antirotational suture enabled bone healing and functional recovery of the limb. The osteosynthesis associated to the antirotational suture contributed to the maintenance of the joint congruence, which is extremely important for maintaining an acceptable joint function. Early surgical intervention and appropriate handling of the animal contributed to its successful recovery and reintroduction into the wild. The implants used in the osteosynthesis of the radius and ulna were removed before the animal was released, due to the non-biodegradability of the materials.

Keywords: feline, felidae, wild animal medicine, radius and ulna, humeroradial subluxation, osteosynthesis

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INTRODUCTION

Giovanni Battista Monteggia defined Monteggia fracture in 1814 as a bony discontinuity of the ulna accompanied with radial head dislocation [1]. According to Bado's adaptation in 1967, Monteggia fracture may involve an associated bone discontinuity of the radius [14].

Jose Luis Bado in 1967 proposed an adaptation of the definition of Monteggia fracture based on the principles of human orthopedics [6] and the type of fractures of the ulna and possibly, the radius, as well as the direction of radial head dislocation. Monteggia fractures are classified into 4 types [14]: Type I: characterized by cranial displacement of the radial head and ulnar fracture at any level with cranial angulation; Type II: caudal dislocation of the radial head and ulnar fracture with caudal angulation; Type III: craniolateral or lateral dislocation of the radial head and ulnar fracture with caudal angulation; Type IV: characterized by cranial displacement of the radial head, fracture of the proximal third of the radius, and fracture of the ulnar diaphysis [1,2].

Independent of the type of the fracture, surgical intervention is always recommended [1]. The purposes of surgery are to stabilize the ulna and where applicable, the radius (if fractured), and re-establish the humerus–radius–ulnar joint and annular ligament (if torn) [10]. Therefore, radial head dislocation should also be corrected to re-establish the humeroradial axis [9,10].

This report aimed to describe the surgical treatment of a type IV Monteggia fracture and the postoperative outcome of a young puma (*Puma concolor*) that underwent osteosynthesis of the radius and ulna using locking plates combined with a humeroradial antirotational suture.

CASE

We received a traumatized puma animal (*Puma concolor*) at Veterinary Center of Pontifical Catholic University of Minas Gerais (PUC Minas), Campus Poços de Caldas, Minas Gerais, Brazil. The animal weighed 13 kg of body weight, and had a history of lameness, edema, and functional weakness of the right forelimb. The nature of the trauma is unknown, but probably secondary to vehicle collision.

Prior to the physical, laboratory, and imaging examinations, chemical sedation was performed by intramuscular administration of ketamine[1] [Cetamin® 10% - 6 mg/kg] and xylazine[1] [Xilazin® 2% - 0,6 mg/kg]. After sedation, it was verified that the animal was a male and had permanent incisors and deciduous canines, which indicated that it was a young cub.

Craniocaudal (CrCa) and mediolateral (ML) radiographic projections of the radius and ulna revealed a complete, oblique, and simple fracture in the proximal 3rd of the radius diaphysis, which was associated with humeroradial dislocation, as well as cranial displacement of the radial head in relation to the articular surface of humeral condyles. A simple, complete, and transverse fracture was also observed in the proximal 3rd of the ulnar diaphysis. These findings were consistent with the characteristics of a type IV Monteggia fracture (Figure 1).

The animal underwent a surgical procedure for osteosynthesis of the radius and ulna, along with correction of the dislocation. Preanesthetic medication was administered in the same manner as previously reported, followed by intravenous induction of anesthesia with propofol[2] [Propovan® - 1 mg/kg] and maintenance of anesthesia with isoflurane[1] diluted in oxygen. Preoperative antibiotic therapy was given through intravenous administration of cephalothin[3] [Cefalotina Sódica - 30 mg/kg].

After extensive trichotomy and antisepsis with detergent and alcoholic chlorhexidine solutions of the

Figure 1. Craniocaudal and mediolateral projections in the radiographic examination of the right forelimb of a puma cub (*P. concolor*). Note the presence of a fracture of the radius and ulna associated with humeroradial dislocation (arrow). [Source: Centro Veterinário PUC Minas, 2022].

right forelimb, the animal was placed in the left lateral recumbency with the affected limb uppermost. A surgical procedure was performed on the elbow joint, with a caudolateral curved skin incision from the distal 3rd of the humerus to the middle 3rd of the diaphysis of the radius and ulna. The subcutaneous and deep antebrachial fascia is incised on the same line.

Antebrachial and intermuscular fasciae are incised from the borders of the lateral head of the triceps brachii, along a line that separates the extensor carpi radialis from the common digital extensor muscle. A similar incision is made between the anconeus and ulnaris lateralis muscles. These incisions are deepened to completely free the extensor muscles from the underlying bone [6].

After adequate exposure of the ulna and bone reduction, a 3.5-mm 6-hole hybrid locking plate was placed using 2 screws in the proximal segment and 2 in the distal segment. For osteosynthesis of the radius, a 3.5-mm reconstruction plate with 9 holes was placed on the cranial surface of the radius using three screws in the proximal segment and three in the distal segment.

To reduce the humeroradial dislocation and re-establish the relationship between the radius and humerus, 2 screws of 2.7-mm were placed, 1 over the radial head and the other over the humeral epicondyle, to create an antirotational figure-of-8 suture with absorbable braided polyester. The suture was anchored to the previously placed screws.

After stabilizing the abovementioned lesions, the fasciae and subcutaneous tissue were sutured with 3-0 polyglycolic acid in a simple continuous pattern. Skin was sutured with 2-0 nylon in a simple separate pattern.

Immediately after surgery, meloxicam[4] [Maxican® 0,2% - 0,1 mg/kg] and dipyrone[5] [D-500® - 25 mg/kg] were administered subcutaneously.

When the animal was still under anesthesia, a Robert Jones bandage was applied. The bandage was maintained for 3 days. A radiographic examination was also performed, with 2 orthogonal projections showing the correct contact and positioning of the plates on the bone fragments, and the reduction of the radial head displacement.

In the postoperative period, a diet based on rats, chicken, and pork was administered. The animal was confined to a restricted space with environmental enrichment to reduce its inactive time and provide natural stimuli.

After 45 days of the surgical procedure, the animal was comfortable and showed normal range of movement. At this time, a new control radiographic examination was performed, and showed the antirotational suture failure, characterized by a slight advance of the radial head in relation to the condyle of the humerus. Intense bone proliferation was also observed adjacent to the fracture, which indicates the formation of bone callus. No changes were noted in the implants (Figure 2A).

The implants were removed after 75 days, so that the animal could be reintroduced into the wild. After the surgical procedure to remove the implants, an immediate postsurgical radiographic examination was performed (Figure 2B).

After 125 days, the animal showed good progression, with full weight-bearing on the operated limb and no restriction of movement. It was therefore reintroduced into its natural habitat.

DISCUSSION

Monteggia fractures have been rarely described in human [10] or veterinary literature and are even more rarely reported in studies on wild animals, indicating the importance of this report.

These fractures are caused by a direct high-energy impact on the forelimb, generally due to road accidents or falls [5,11]. In the current case, the nature of the trauma is unknown, but probably secondary to vehicle collision. The fracture resulted in functional weakness and edema of the right forelimb. Functional weakness, edema and rotation of the forelimb are frequently observed in this type of fracture [7]. It is possible to palpate the cranially or laterally displaced radial head [14]. However, in cases of severe edema, it can be difficult to identify the radial head via palpation [14], as observed in the present report.

Although the findings of physical examination are crucial, the diagnosis is based on imaging examination, such as radiography, with at least 2 orthogonal projections [14]. In fact, radiographic examination revealed that the puma cub had ulnar and radial fractures associated with humeroradial dislocation, consistent with the features of a type IV Monteggia fracture, according to Bado's classification [1,2,14].

In veterinary medicine, Monteggia fractures should be surgically treated [2]. Surgical intervention

Figure 2. Radiographic examination of a *Puma concolor*. A- Postoperative control 45 days after osteosynthesis of the right radius and ulna in mediolateral and craniocaudal projections, respectively. B- Immediate postoperative control radiographic examination after removing the metal implants from the right radius and ulna in mediolateral and craniocaudal projections, respectively. Fracture lines were not visible, and periosteal proliferative bone reaction in the ulna (bone remodeling phase) and small circumscribed and radiolucent areas in the radius and ulna were observed, resulting from the metal screws. [Source: Centro Veterinário PUC Minas, 2022].

should be performed as early as possible to avoid swelling of the limb, muscle contraction, and inflammation of the soft tissues [4]. In the present report, early intervention may have contributed to the functional recovery of the injured limb and the reintroduction of the animal into the wild.

The reduction method will depend on the surgeon's preference, presentation of the fracture, and size of the patient [2]. In this report, osteosynthesis of the ulna and radius was performed using locking plates in a neutralization configuration. These implants ensure to maintain the bone fragments anatomically reconstructed and fixed in position [10]. In addition, a figure-of-8 antirotational suture was performed by positioning 2 screws. This suturing technique enables better joint congruence and is extremely important for maintaining joint function [9]. Felines have movements of pronation and supination, mainly related to hunting, territorial defense, and social interactions. For this, the maintenance of the function of the joints, especially the proximal joints, plays a crucial role in enabling their reintroduction into the wild [3,8,9].

The method used to stabilize the fracture can influence postoperative evolution, such as the occurrence of complications [12]. In the current case, there were no significant complications, and the reduction of bone fragments was maintained. The partial loss of joint reduction, however, was not enough to compromise the function of the elbow joint due to bone remodeling [13].

The food provided, restriction of the space with as little contact with humans as possible, and use of environmental enrichment to stimulate rehabilitation of the limb, together with the surgical procedure conducted, resulted in good evolution of the animal's clinical condition.

In the circumstances of this case, the implants used in the osteosynthesis of the radius and ulna were removed, because the metallic materials are not biodegradable and also have a toxic and polluting potential for the ecosystem where the animal would be released.

MANUFACTURERS

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