OSTEOSYNTHESIS TECHNIQUE IN THE HUMERUS OF THE HOARY FOX (*LYCALOPEX VETULUS*): CASE REPORT

Técnica de osteossíntese em úmero de raposinha-do-campo (Lycalopex vetulus): relato de caso

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Abstract

Wild carnivores are among the mammals most affected by road traffic accidents, contributing to population declines in several species. The hoary fox (*Lycalopex vetulus*) is classified as Vulnerable by the Brazilian Institute for the Environment and Renewable Natural Resources (ICMBio). This study describes the osteosynthesis of a complete humeral fracture in a subadult specimen rescued after a road traffic accident. The diagnosis was established by radiographic examination, which revealed a complete spiral fracture with bone fragmentation. Surgical treatment consisted of a smooth intramedullary pin, combined with cerclage using stainless steel wire. The patient showed satisfactory postoperative clinical recovery, with no complications and was discharged after 90 days. The technique proved effective for fracture stabilization and represents a viable alternative for orthopedic management in wild canids.

Keywords: wildlife; wild canid; orthopedic surgery; bone fracture.

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Resumo

Os carnívoros selvagens figuram entre os mamíferos mais impactados por atropelamentos, contribuindo significativamente para o declínio populacional de diversas espécies. A raposinha-do-campo (*Lycalopex vetulus*) encontra-se classificada como vulnerável segundo o Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). O presente estudo descreve o procedimento de osteossíntese de fratura completa de úmero em exemplar subadulto da espécie, vítima de atropelamento. O diagnóstico foi estabelecido por exame radiográfico, evidenciando fratura completa em espiral com fragmentação óssea. O tratamento cirúrgico consistiu na associação de pino intramedular liso à cerclagem com fio de aço. O paciente apresentou evolução clínica satisfatória no pós-operatório, sem intercorrências, recebendo alta após 90 dias. A técnica mostrou-se eficaz na estabilização da fratura, representando alternativa viável para manejo ortopédico em canídeos silvestres.

Palavras-chave: animais selvagens; canídeo silvestre; cirurgia ortopédica; fratura óssea.

Introduction

Carnivores are among the groups with the highest incidence of motor vehicle accidents and a high number of fatalities. Among them, however, wild canids are the most affected (Caceres, 2011). These numbers are certainly underestimated, as many animals killed on highways are not recorded due to the absence of carcasses, scavenging by other animals, displacement of injured individuals beyond highway concession areas, and even the intentional removal of carcasses by people (Lemos *et al*., 2013).

The hoary fox (*Lycalopex vetulus*) has experienced a continuous population decline resulting from road traffic accidents, as well as predation and diseases transmitted by domestic dogs. Regarding its conservation status, the species has been classified as Vulnerable by the Brazilian Institute for Biodiversity Conservation (ICMBio) due to its restricted distribution within Brazilian territory, primarily throughout the Cerrado biome (Abra *et al*., 2020; Lemos *et al*., 2013).

Surveys conducted at different wildlife rescue centers in the state of São Paulo have demonstrated the impact of road traffic accidents on this group. For example, 74 free-ranging crab-eating foxes (*Cerdocyon thous*) were rescued by the Center for Medicine and Research in Wild Animals of São Paulo State University, Botucatu Campus (Cempas/Unesp) over a ten-year period. Among these animals, 21 presented fractures of the appendicular and/or axial skeleton, representing 28.3% (21/74) of the cases, while appendicular skeletal fractures were observed in 42.8% (9/21) of these patients. In another survey involving 35 wild canids, including maned wolves (*Chrysocyon brachyurus*), crab-eating foxes (*Cerdocyon thous*), and hoary foxes (*Lycalopex vetulus*), 31.4% (11/35) of the animals died as a result of road traffic accidents (Marques *et al*., 2024; Zanoti, 2024).

Therefore, this study aims to present a case report on the humeral osteosynthesis technique performed in a hoary fox (*Lycalopex vetulus*) that was the victim of a road traffic accident.

Case report

A hoary fox (*Lycalopex vetulus*), estimated to be two years old, was rescued on SP-258 Highway in the municipality of Itararé, São Paulo, after being struck by a vehicle. The animal was stabilized and referred to the University Veterinary Clinic of the University of Sorocaba.

Physical examination revealed abnormal mobility, crepitation, and swelling of the right humerus. Radiographic examination demonstrated a complete, closed, spiral fracture with bone fragmentation in the diaphysis of the right humerus (Figure 1). Subsequently, the animal was referred for surgical treatment.

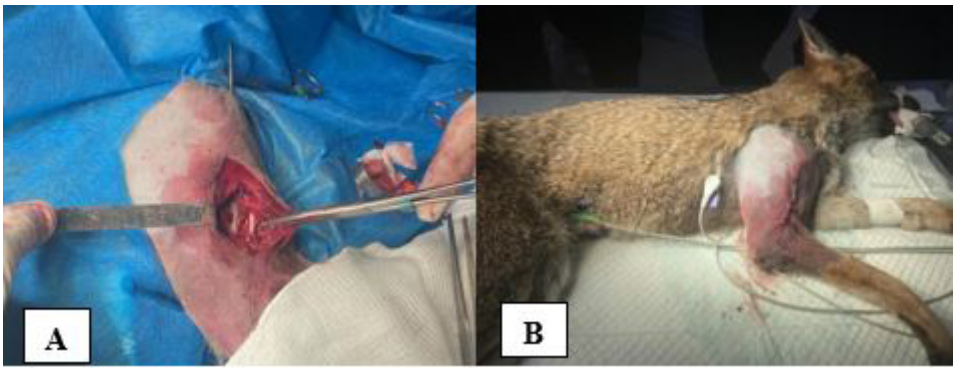
Figure 1 – Ventrodorsal (A) and mediolateral (B) radiographic projections demonstrating a complete spiral fracture with bone fragmentation in the right humerus of a two-year-old *Lycalopex vetulus* specimen

Source: Lima *et al*. (2026).

The anesthetic protocol included pre-anesthetic medication with morphine 10 mg/mL (0.5 mg/kg), midazolam 5 mg/mL (0.3 mg/kg), and ketamine 10% (3 mg/kg); induction with propofol 10% (2 mg/kg) until the ideal anesthetic plane was achieved (Stage III according to Guedel's classification); orotracheal intubation using a size 5 endotracheal tube; and anesthetic maintenance with isoflurane and 100% oxygen under continuous multiparametric monitoring. To provide analgesia, infiltrative local anesthesia was performed along the surgical incision line, and a brachial plexus block was administered using 2% lidocaine without vasoconstrictor (4 mg/kg). Continuous infusion of dexmedetomidine 100 mcg/mL (0.5 mcg/kg/h) was maintained until the end of the surgical procedure.

The surgical approach was performed through the lateral aspect of the limb, with the incision extending from the glenohumeral joint to the humeroradioulnar joint. The aponeurosis between the triceps muscle (lateral head) and the brachialis muscle was incised to access the fracture site. The proximal and distal fracture segments were identified with the aid of an osteotome to improve visualization of the bone ends. Fracture reduction was then achieved using an intramedullary pin (2.5-mm smooth Steinmann pin), inserted retrograde and subsequently normograde, combined with cerclage wire to neutralize rotational forces (Figure 2). Following reduction and stabilization, muscle closure was performed using a fenestrated suture pattern (2-0 nylon), subcutaneous tissue apposition with absorbable suture material (3-0 Vicryl), and skin closure using a Sultan pattern with nonabsorbable suture material.

Figure 2 – (A) Intramedullary pin placement associated with cerclage wire fixation in the right humerus of a two-year-old *Lycalopex vetulus* specimen. (B) Final appearance of the surgical wound following osteosynthesis



Source: Lima *et al*. (2026).

Postoperatively, cephalothin (30 mg/kg) and meloxicam (0.5 mg/kg) were administered. The patient remained under care at a rehabilitation center and was discharged after 90 days without complications.

Discussion

This case report aims to contribute to clinical and surgical practice by illustrating to veterinary clinicians and surgeons a successful humeral osteosynthesis procedure in a wild canid. Following the patient's discharge, the technique employed was confirmed to have yielded a favorable outcome, corroborating a previous report of osteosynthesis in a hoary fox with a successful result (Barranco *et al*., 2016). Stabilization should be performed with minimal handling to avoid additional injuries.

Surgical treatment in exotic canids is challenging and, to achieve a positive outcome, it is important to follow the principles of surgical orthopedics adapted from other species, such as dogs and cats, tailoring the techniques to the specific characteristics of each case (Miwa; Calvo Carrasco, 2019). Among the techniques described in the literature, the most notable include osteosynthesis using interlocking intramedullary nails, locking plates and rods, linear external skeletal fixation, and hybrid linear-circular external fixation. These techniques are primarily recommended because they provide shorter bone healing times and, consequently, fewer complications when compared with traditional open fixation methods (Sabater González; Calvo Carrasco, 2019).

The surgical procedure described in this report was performed using an intramedullary pin inserted into the right humerus in combination with cerclage wire fixation. This technique offers biomechanical advantages by neutralizing the rotational, bending, and axial forces acting on the fracture site (Barranco *et al*., 2016). However, it results in a longer immobilization period and requires more intensive postoperative wound management throughout recovery. Considering that this species is free-ranging, prolonged immobilization is highly contraindicated in wild animals, and the use of this technique should therefore be carefully evaluated (Barranco *et al*., 2016). Furthermore, each patient should be assessed individually, as should the method selected for fracture stabilization and bone healing.

This consideration is based primarily on the fact that, after an extended recovery period under human care, the likelihood of successful reintroduction into the natural habitat becomes minimal. An alternative is to transfer the animal to zoological institutions, where it may continue contributing to species conservation under *ex situ* conditions, particularly because its origin is known, meaning that the exact location of the individual was accurately identified by the people who rescued it. Since 2018, the species has been included in the National Conservation Plan for Brazilian Canids, developed by the National Center for Research and Conservation of Carnivorous Mammals/Brazilian Institute for Biodiversity Conservation (Cenap/ICMBio), with the objective of prioritizing the protection of specific Cerrado habitats suitable for the species' survival (Lemos *et al*., 2020).

Additional studies involving a larger number of surgical procedures in wild carnivores are certainly needed to better evaluate the most appropriate fracture fixation methods, as well as to improve knowledge regarding fracture characteristics in these species (Marques *et al*., 2024). There is an urgent need to implement multidisciplinary actions aimed at reducing the number of wildlife roadkill incidents on Brazilian highways.

Final considerations

The osteosynthesis technique using an intramedullary pin associated with cerclage wire fixation was effective in stabilizing the complete humeral fracture in the hoary fox. The procedure resulted

in satisfactory functional recovery, demonstrating that it is a viable alternative for the orthopedic management of wild canids injured in road traffic accidents. &

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- **Ethical Approval:** The reported study did not require approval from an ethics committee, as it involved a clinical case routinely managed by the Wildlife Clinical Service of a private institution.
- **Data and Material Availability:** The data related to this article are available from the authors upon reasonable request.
- **Author Contributions:** Lima, I. T. de. *et al*. participated in the management of the reported case and in the preparation and writing of the manuscript.

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