




# Tibial fracture correction, rehabilitation, and release of a Jaguarundi (*Herpailurus yagouaroundi*) in Costa Rica

Corrección de fractura de tibia, rehabilitación y liberación de un Jaguarundi (*Herpailurus yagouaroundi*) en Costa Rica

Correção de fratura da tíbia, reabilitação e reintrodução de um Jaguarundi (*Herpailurus yagouaroundi*) na Costa Rica

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## Abstract

This paper describes the medical-surgical approach, rehabilitation, and release of a *Herpailurus yagouaroundi* suffering from a comminuted fracture to the distal third of the left tibia. The tibial fracture was the result of vehicular trauma that occurred on a main highway within a biological corridor in the northern region of Costa Rica. The feline was rescued by officials from the Costa Rican National System of Conservation Areas (SINAC) and was treated at the Small Animals and Wildlife Hospital (HEMS) of the School of Veterinary Medicine (EMV) from the National University of Costa Rica (UNA). The medical-surgical approach included homeostatic restoration of the patient, collateral tests (laboratory test and diagnostic images) and correction of the tibial fracture using an external skeletal fixator with titanium bars and anchors. The patient received post-operative care and rehabilitation before a successful release into its natural habitat.

**Keywords:** Jaguarundi, fracture, external fixation, wildlife, trauma.

## Resumen

Describimos el abordaje médico-quirúrgico, rehabilitación y liberación de un *Herpailurus yagouaroundi* que presentaba una fractura conminuta del tercio distal de la tibia izquierda. La fractura de tibia fue el resultado de un trauma por colisión vehicular ocurrido en una carretera principal dentro de un corredor biológico en la región norte de Costa Rica. El felino fue rescatado por funcionarios del Sistema Nacional de Áreas de Conservación de Costa Rica (SINAC), y fue atendido en el Hospital de Especies Menores y Silvestre (HEMS), de la Escuela de Medicina Veterinaria (EMV) de la Universidad Nacional de Costa Rica. El abordaje médico-quirúrgico incluyó la restauración homeostática del paciente, pruebas colaterales (prueba de laboratorio e imágenes diagnósticas) así como la corrección de la fractura tibial mediante fijador esquelético externo con barras y anclajes de titanio. El paciente recibió atención postoperatoria y rehabilitación previo a su liberación exitosa en su hábitat natural.

**Palabras clave:** Yaguarundi, fractura, fijación externa, vida silvestre, trauma.

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## Resumo

Descrevemos a abordagem médico-cirúrgica, reabilitação e reintrodução de um *Herpailurus yagouaroundi* que apresentava uma fratura cominutiva do terço distal da tíbia esquerda. A fratura da tíbia foi o resultado de um trauma por colisão veicular ocorrido em uma estrada principal dentro de um corredor biológico no norte da Costa Rica. O felino foi resgatado por funcionários do Sistema Nacional de Áreas de Conservação da Costa Rica (SINAC), e foi atendido no Hospital de Espécies Menores e Silvestres (HEMS), da Escola de Medicina Veterinária (EMV) da Universidade Nacional da Costa Rica. A abordagem médico-cirúrgica incluiu a restauração homeostática do paciente, teste de laboratório e imagens diagnósticas bem como a correção da fratura tibial por meio de fixador esquelético externo com barras e âncoras de titânio. O paciente recebeu atendimento pós-operatório e reabilitação para ser liberado em seu habitat natural. A reintrodução foi bem-sucedida.

**Palavras-chave:** Jaguarundi, fratura, fixação externa, vida selvagem, trauma.

## Introduction

The jaguarundi (*Herpailurus yagouaroundi*) is one of five native species of wild cats in Costa Rica with geographical distribution ranging from Mexico to Argentina. Even as an adult, the jaguarundi is tiny, weighing approximately 5 kg. It has small, round ears on a flat, long, low skull. Its tail makes up around two-thirds of its body, and its limbs are comparatively short. Even though its body shape suggests that it is a land animal, the jaguarundi can move easily in trees. Its diet is based on small mammals, birds, and reptiles (Caso and Carvajal, 2015). Feline species such as the jaguarundi (as well as the ocelot and the southern tiger cat) have been affected by the deforestation occurring for agricultural purposes in countries like Argentina, leading to a loss of approximately half of their original Atlantic Forest area and altering the ecosystems where felines live (Cruz et al., 2018).

The present case report describes the surgical medical approach of a jaguarundi that suffered a comminuted tibial fracture on its distal third due to being hit by a car, its subsequent rehabilitation, and release back into the wild. Affections of the musculoskeletal system in canines and felines, whether domestic or wild, cause pain and generate alterations in movement. These conditions can be the result of orthopedic trauma or a skeletal disorder (Ettinger and Côté, 2017). One of the most common musculoskeletal conditions in wild cats is fractures of traumatic origin. If fractures become comminuted, there are few treatment options available (Ferreira et al., 2018). In instances of long bone fractures, there are several approaches for correction, including metal implants (internal and/or external). The use of the first external skeletal fixator was implemented by Parkhill in 1897 and Lambotte in 1902 (Hernigou, 2017), and today represents an excellent option for the correction of fractures.

## Case report

The patient was rescued by officials from the Costa Rican National System of Conservation Areas (SINAC - Sistema Nacional de Areas de Conservación) following vehicular trauma and was transferred to the Small Animals and Wildlife Hospital (HEMS - Hospital de Especies Menores y Silvestres) with mild neurological symptoms, skin abrasions, and a left posterior limb injury. Shock therapy was immediately administered in conjunction with intravenous fluids (2ml/kg/hr, IV, Lactate Ringer Injection USP Sterile Solution, Baxter, Costa Rica), analgesics (Meloxicam 0,2mg/kg PO SID for one day, then 0,1mg/kg PO SID for four days, 5mg/mL, Meloxic, Provet, Colombia) and antibiotic therapy (Cephalexin 30mg/kg PO BID for five days, 150mg,



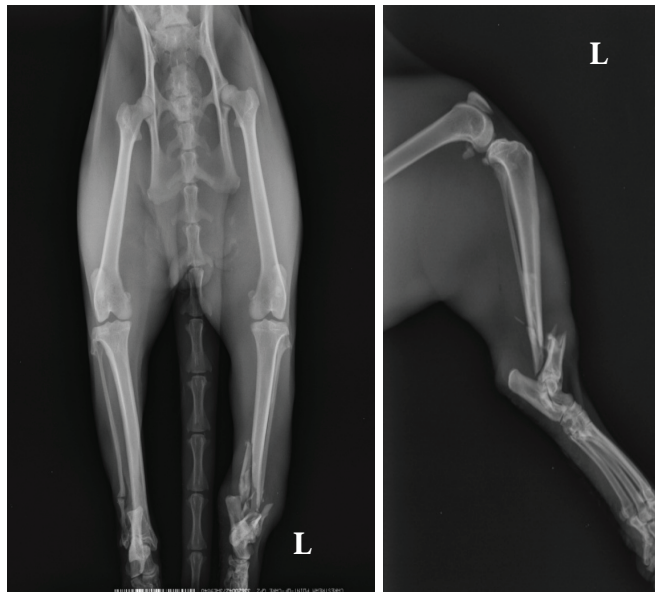
Rilexine, Virbac, Costa Rica). Later the feline's neurological system was evaluated, and ultrasonography, radiology, and laboratory tests were performed.

### Results of physical evaluation and diagnostic tests

No significant neurological alterations were found in the physical examination. The panicle, proprioception, biceps, triceps, patellar, and spatial positioning reflexes as well as superficial and deep sensitivity were evaluated without abnormal results; therefore, no specific medical images were needed for this system.

Results of complete blood count and blood biochemistry analysis did not differ significantly from those reported in other wild felids in Costa Rica (Jiménez-Soto, 2002). The ultrasonographic scan did not reveal alterations in the abdominal organs.

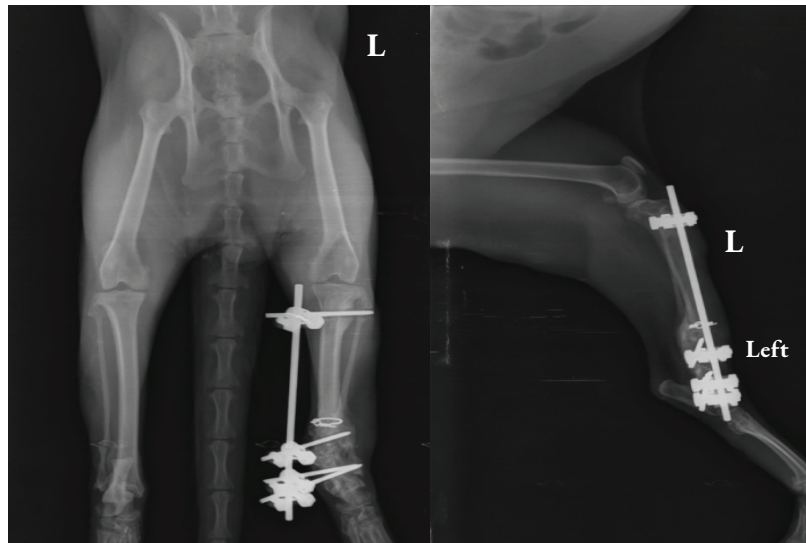
During the orthopedic examination, instability of the left distal tibial bone was detected without joint commitment, and radiological images were taken. The radiological study revealed, in the mediolateral and anteroposterior view, a comminuted fracture at the level of the distal third of the left tibia (Image 1).



**Figure 1:** Radiography in anteroposterior and mediolateral view of the left tibia. Photo by Servicio de Radiología, Hospital de Especies Menores y Silvestres, Universidad Nacional de Costa Rica.

### Surgical approach

The patient was stabilized and aseptically prepared to correct the fracture in the left hindlimb. Bone reduction was performed in an open surgery with a type 1A external skeletal fixator configured with bars and titanium anchors, fixed to the cortical bone using surgical steel nails (positive thread). A 23-gauge surgical steel cerclage was also placed in the distal third of the tibia (Image 2).



**Figure 2.** Post-surgical radiological study. Anteroposterior and mediolateral view of left tibia. Photo by Servicio de Radiología, Hospital de Especies Menores y Silvestres, Universidad Nacional.

### Case follow-up

Once the surgical procedure was completed, the patient remained in an isolated room in the HEMS for five days and was then transferred to a rehabilitation facility with amenities and structures that did not allow the animal to perform complex climbing or jumping. Following 22 postoperative days, the patient showed expected evolution by walking and jumping with all four limbs. Radiological reevaluation was performed 30 days after surgery, and consolidation of the fracture was observed with secondary bone callus formation and remodeling around the fracture lines. Bone fragments from the comminuted fracture were included within the bone healing area. The patient showed adequate limb support. The external skeletal fixator was removed under deep sedation, and the stability and firmness of the tibia were confirmed. Cerclage wire was placed on the bone callus, and because the surrounding area showed no adverse reaction, it was not removed (Image 3).

### Rehabilitation and release

The animal remained in a pre-release cage for 10 days post-surgery (Figure 4) where physical therapy exercises were performed, and movement was regulated. Management did not change its natural behavior (hunting and evasion of human contact), and after the respective evaluation, the patient was considered suitable for re-entry into the wild. Ensuring behavioral competence is crucial when considering the release of wildlife, particularly to prevent undesirable interactions with human populations in the future (Goldenberg et al., 2022). Once the animal made a full recovery and was deemed fit to remain free, it was transferred to a protected area near the location where the accident occurred but far from the highway.



**Figure 3.** Radiographic image of the post-removal external skeletal fixator.



**Figure 4.** Jaguarundi inside the rehabilitation cage. Photo by Dr. Mauricio Jiménez Soto

## Discussion

In Costa Rica, traumatic injuries in wild animals are an emerging problem and generate negative effects on animal health, ecosystem dynamics, and even humans (Rodríguez-Morales et al., 2013). The impact of the spatial occupation of humans in ecosystems and terrestrial spaces where wild species inhabit is a common phenomenon in many tropical countries such as Costa Rica, representing a threat to local wildlife (Jiménez-Soto et al., 2018) sin embargo, el Estado no cuenta con recursos económicos ni el personal capacitado para



atender las emergencias en animales de vida libre. Por ello el proyecto Diagnóstico, control de enfermedades y manejo de animales silvestres, del Hospital de Especies Menores y Silvestres (HEMS). Roads and urban spaces in areas used as biological corridors by wild species increase accidents that affect people and animals. Despite the increasing number of wildlife accidents in recent years, there is limited medical-scientific information on the approach of injured wild animals on the roads of Costa Rica. To develop evidence-based medicine that can be shared among professionals and used to apply the best practices, research linked to medical treatments must be implemented and capitalized during wildlife rehabilitation (Goldenberg et al., 2022).

In the present case report, the injury suffered by the patient is one of the most commonly seen in long bones. Tibia fractures are the most common musculoskeletal injuries (Lin et al., 2018) in both humans and animals (Nicetto and Longo, 2017). The decision to perform surgical correction of the tibia in the jaguarundi using an external skeletal fixator stemmed from the ease of application and diversity of modulation offered by this orthopedic device (Bible and Nir, 2015). The ease of application allows for using the device alone or combined with other implants to improve bone stabilization (Beever et al., 2017). In humans (mainly children), some of the fractures at the tibial level can be healed without surgical intervention (Iobst, 2016), however, in animals most need a surgical approach to correct the fracture. In the case of wild species, care is intensified because staff must be rigorous, especially in cases where release is an objective (Pollock, 2002). Healing of a bone fracture is a process that involves intense management including biological and mechanical factors, among others (Matson et al., 2017). According to Lavini et al. (2014), fractures involving the distal tibial area are associated with a higher percentage of complications. In the specific case of the tibia fracture described in this report, the postsurgical evolution of the jaguarundi showed expected results in bone healing in regards to quality and time, which indicates that the surgical method used was adequate. Minimizing the extent of postsurgical interventions kept the contact of the animal with humans to a minimum and, therefore, inappropriate attachment behaviors were scarce, which resulted in a successful release. The medical postoperative care that a bone fracture requires is decisive in the healing process, and even though periodic evaluations contribute to the optimal care of possible postoperative complications, in the specific case of the jaguarundi described above, it was essential to keep interactions with the animal to a minimum for the jaguarundi to maintain the behavioral competencies necessary for a successful wildlife release (Goldenberg et al., 2022).

## Conclusion

The correct choice and use of surgical implants for treating fractures is paramount for a successful medical-surgical resolution. External skeletal fixators represent a highly versatile option for correcting fractures, especially in the tibia. In the specific case of wild animals, post-surgical recovery time is vital for a successful resolution, particularly in cases where the animal will be released back into the wild. The cases of accidents suffered by wildlife on roads in Costa Rica are a current conservation problem; consequently, measures to minimize human impact on wildlife are of special importance and should be a high priority when considering urban development.

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