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Successful management of tibial fracture in a dog with minimally invasive fixation

Seyed Reza Javadi[1], Hamed Azad[2], Azin Aghajani Amiri[2]*

[1]Department of Surgery and Radiology, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran.
[2]Faculty of Veterinary Medicine, Babol Branch, Islamic Azad University, Babol, Iran.

(*) Corresponding Author: azin.aghajani.amiri@gmail.com

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Abstract

A 5-month-old Spitz dog with a history of a vehicle accident and leg injury was referred to the Tehran Pet Clinic located in Amol city. The patient's clinical signs included non-weight-bearing lameness of the affected limb, swelling, pain upon palpation, and a crepitus sound in the lower leg area. After radiological evaluations of the affected area, a fracture of the tibia and fibula was identified, and the fracture was stabilized using a minimally invasive method. Tibial fractures are one of the most common types of fractures in dogs, which is due to the minimal muscular tissue coverage around them. Tibial fractures typically occur as a result of severe trauma; common causes include vehicle accidents, rough play, and gunshot wounds. In most cases, surgical intervention is necessary. The goal of the intervention is solely to stabilize the tibia, and stabilization of the fibula is rarely performed. The use of minimally invasive techniques for tibial fracture stabilization has gained particular popularity in recent years. This is because using this technique can greatly help preserve blood supply and stimulating faster bone repair processes, resulting in a shorter recovery period and quicker return to normal activity for the patient. Reducing surgery time lowers the risk of infection in the patient and significantly reduces the need for subsequent surgeries. This case report describes a successful minimally invasive fixation of a tibial fracture in a Spitz dog.

Introduction

Tibial fractures are a common occurrence in dogs and cats. In dogs, tibial fractures account for 20% of all long bone fractures (Boone *et al*., 1986; Johnson *et al*., 1986). Tibial fractures typically occur as a result of severe trauma. Common causes include vehicle accidents, rough play, and gunshot wounds. The fracture can be either closed or open, but a higher percentage of tibial fractures occur as open fractures due to the lesser amount of soft tissue surrounding them, especially in the cranio-medial portion, compared to other bones (De Camp, 2015).

Non-surgical stabilization of this bone's fracture through casting or the use of splints is possible, especially in immature animals with minor fractures and instabilities. However, in most cases, surgical intervention is necessary. The goal of the intervention is solely to stabilize the tibia, and stabilization of the fibula is rarely performed. The use of minimally invasive techniques for tibial fracture stabilization has

gained particular popularity in recent years (Barnhart, 2020).

The reasons for using this technique include preserving blood supply and stimulating faster bone repair processes, resulting in a shorter recovery period and quicker return to normal activity for the patient (Johnston and Tobias, 2018).

Minimally invasive fracture repair (MIFR) optimizes osteosynthesis by maintaining biological healing factors. This "less is more" approach to tissue dissection and fracture exposure and management, which characterizes MIFR, offers several advantages compared to more traditional open surgical treatments. However, it also introduces distinct challenges and considerations for surgeons participating in the operation.

One of the most significant distinctions between MIFR and the original guidelines established by the Arbeitsgemeinschaft fur osteosynthesefragen (AO) group is the requirement for more thorough presurgical planning a nd understanding. Presurgical planning for implant size is crucial with interlocking nails in open reduction and MIRF procedures, but it is less critical with plates. In traditional repairs, plates can be repeatedly adjusted until they fit anatomically, unlike the fixed approach required in MIRF cases (Barnhart, 2020).

Surgeons must possess a deep understanding of regional anatomy to reduce patient morbidity and aid in fracture repair. This knowledge is crucial when arteries, veins, and nerves are not directly visible. Identifying “safe” and “unsafe” zones for MIFR implant placement is essential. Additionally, careful consideration is required for optimal screw or pin placement, as repositioning during a small MIFR incision is significantly more challenging than during an open approach. Earliness in MIFR is crucial for bone alignment and limb length restoration. Delayed fracture repair complicates anatomical alignment and lengthening, necessitating invasive methods. Managing muscle contraction and early callus formation while minimizing soft tissue handling poses significant challenges, potentially rendering MIFR unfeasible (Barnhart, 2020). Complications can also include less rigid fixation, poor bone healing, and insufficient stability at fracture edges. However, with appropriate case selection, these items are not statistically significant (Hudson *et al*., 2009).

Patient observations and history

Patient description

A 5-month-old neutered male Spitz dog, weighing 5 kg and with a history of a vehicle accident and leg injury, was referred to the Tehran Clinic located in Amol city. The patient's clinical signs included non-weight -bearing lameness of the affected limb, swelling, pain upon palpation, and a crepitus sound (crackling) in the lower leg area. Other clinical signs for ruling out internal organs trauma include: capillary refill time or CRT (0.5 s), pulse rate was in a normal range (150 times per minute), the respiratory pattern and sound were normal, there was a history of urination and defecation, and the dog had an appetite.

Clinical findings

Radiological evaluations of the affected area revealed fractures of the tibia and fibula (Fig. 1).

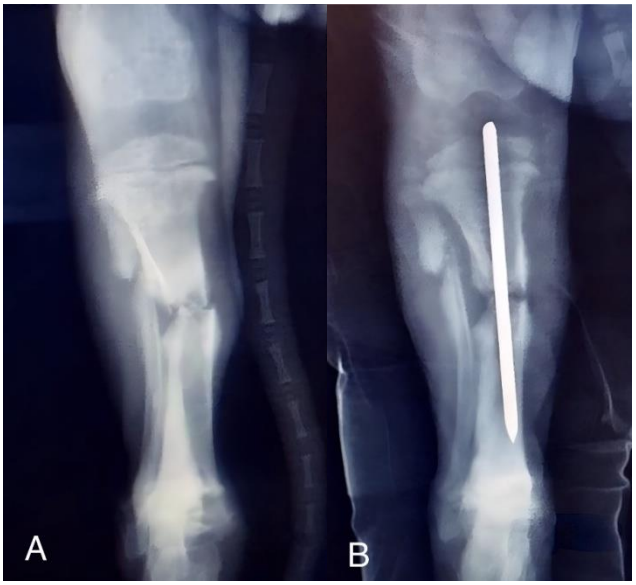

Fig. 1. Radiological images before (A) and after (B) surgery.

Treatment

The patient's surgical intervention was performed under general anesthesia. Premedication was administered using intramuscular medetomidine (Dorbene vet, Syva Co., Spain) at a dose of 40 µg per kg of body weight. This was followed by intravenous injection of a combination of ketamine (Alfasan-woerden Co., Holland) at 5 mg per kg of body weight

and diazepam (Chemidarou Co., Iran) at 0.3 mg per kg of body weight for anesthesia induction. For maintenance, an intravenous combination of ketamine and diazepam at half the dose and to effect was given.

After site preparation, two small incisions were made: one for the entry point of the intramedullary pin in the proximal part of the bone (yellow arrow), and another 2 cm incision for bone reduction at the fracture site (red arrow)(Fig. 2).

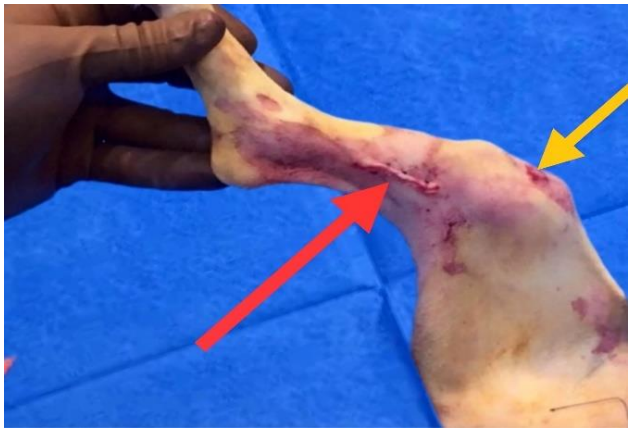

Fig. 2. An image of the surgical site after completion of the procedure. The yellow and red arrows are the sites of surgical incisions.

Intramedullary pinning was performed using a minimally invasive technique with a 3 mm pin to stabilize the fracture. After ensuring correct pin placement and fracture stabilization, the fascia and subcutaneous tissue were sutured using 3-0 Dexon absorbable suture (Supabon Supa Co., Iran) and the skin was closed using 4-0 Nylon suture. Subsequently, a Robert-Jones bandage was applied to the leg and left in place for one week (Fig. 3)(Fossum *et al*., 2007).

The patient regained the ability to bear weight on the affected limb the day after surgery, and after 40 days, fully returned to its normal routine.

Discussion

Fractures of the tibia and fibula are prevalent in dogs and cats, typically resulting from significant trauma. Tibial fractures respond well to treatment with minimally invasive fracture repair (MIFR) methods that maintain blood flow to fragmented pieces, boosting callus formation and enhancing the healing process.

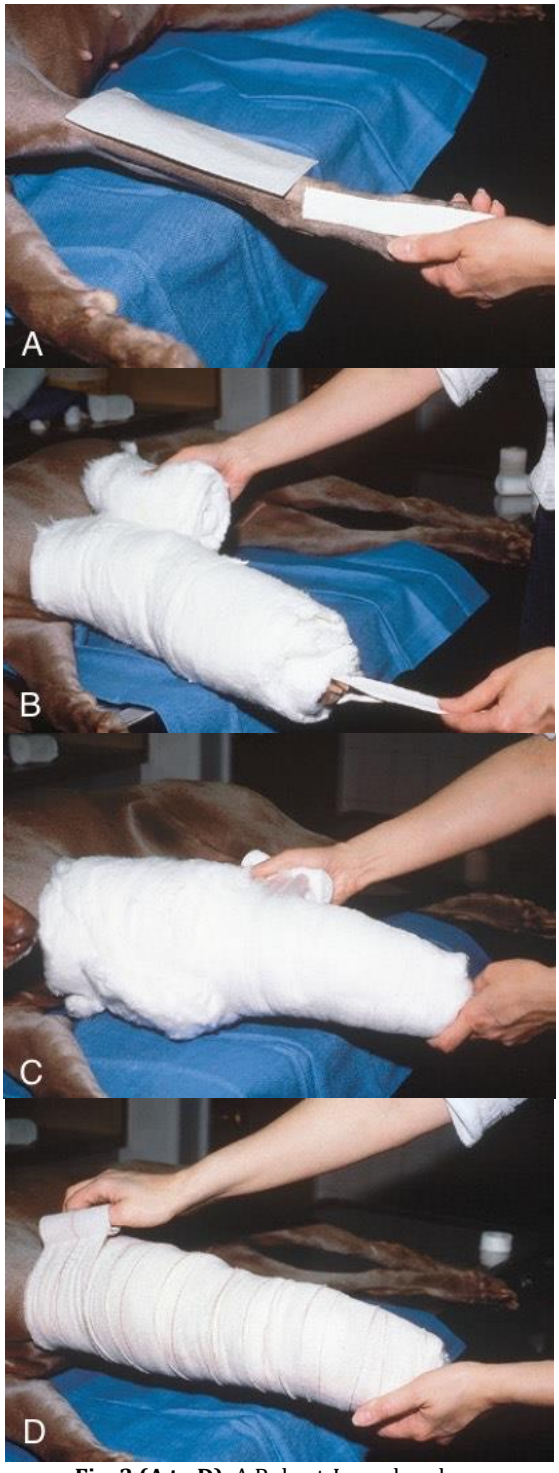

Fig. 3 (A to D). A Robert-Jones bandage.

The use of MIFR techniques for treating tibial fractures has demonstrated a reduction in surgical duration, a quicker healing period for fractures, and decreased patient morbidity, while also lowering complications compared to conventional open

reduction and internal fixation methods (Beale *et al*., 2019).

The conventional approach to fracture repair has centered on “anatomic reduction and rigid internal fixation.” This enables the reconstructed bony structure to distribute the weight-bearing load alongside the orthopedic implant, thus reducing the chances of implant fatigue and failure. Nevertheless, anatomic reduction necessitates extensive surgical exposure and time during the procedure, which may jeopardize the fracture's blood supply and elevate the likelihood of postoperative infection (Harasen, 2002).

MIFR is beneficial because it prevents damage to soft tissues and fracture fragments, thereby optimizing healing potential. Moreover, minimally invasive methods are generally less expensive and simpler to implement than more invasive implants (Lee, 2001).

In MIFR techniques, “Normograding” (inserting the pin at the proximal end of the bone, guiding it to the fracture site, and then extending it into the distal fragment) is preferred because it reduces disturbance at the fracture site and enables the distal fragment to be extended to its full length (Harasen, 2002).

MIFR is most effective for acute fractures that present with a fresh hematoma. MIFR can be highly effective in fractures present for less than two weeks. In cases of chronic fractures that need substantial reduction to restore length and alignment, muscle contracture and prior callus development might hinder sufficient indirect reduction. In such instances, it might be required to expose the fracture area to obtain the correct length and proper alignment. Chronic fractures with slight displacement and minimal need for reduction might be an exception, as they tend to respond positively to the MIFR technique. Numerous cases like these can also heal properly through external cooptation. Chronic fractures managed with MIFR might gain advantages from percutaneous administration of biological healing catalysts, like platelet-rich plasma or stem cells. Complementary methods, like shock-wave treatment or magnetic therapy, might also assist in enhancing the biological condition of fracture recovery (Beale and Mc Cally, 2019).

A surgeon's correct understanding of the fracture's position and type, along with their right decision in choosing an appropriate fixation method that doesn't interfere with blood supply and bone healing processes, and can even accelerate them to some extent, has a direct relationship with the success rate of the surgical outcome (Johnston and Tobias, 2018).

The use of up-to-date methods such as minimally invasive techniques can be important for us in several ways. Firstly, by reducing the surgery time, the stress and pressure on the patient is significantly decreased. The incidence rate of surgery-duration-related infections also decreases proportionally. A more comfortable recovery period is predicted for patients, and a faster healing process is expected as well (Harasen, 2002).

In summary, this case report was a documentation of managing tibial fracture fixation using a minimally invasive method.

Acknowledgment

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Conflict of Interest

The authors do not have any potential conflict of interest to declare.

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