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Application of bilateral free-form external skeletal fixation for tibial fracture in a dog: A case study

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Abstract

A pup weighing 9.5Kg bodyweight presented with a history of dog bite injury accompanied open fracture of left tibia. The pup was stabilized and Post-bite anti-rabies vaccination regimen followed. Under balanced anaesthetic protocol the fracture was stabilized using a linear bilateral free-form epoxy external skeletal fixation (ESF) system. Postoperatively, monitoring and radiographic imagings demonstrated significant improvement in gait and complete radiographic union by the third and 45th postoperative day. The pup showed no complications and returned to normal ambulation after ESF removal. This case illustrates the effectiveness of linear bilateral free-form ESF in managing open diaphyseal fractures in young dogs, highlighting its benefits in terms of stability and adaptability.

Keywords: Dog, External Skeletal Fixator (ESF), Tibia, Fracture

Introduction

External skeletal fixation (ESF) is a technique for minimally invasive fracture stabilization that employs percutaneous pins connected externally to create a rigid framework or scaffold (Van-EE and Geasling, 1992) [5]. ESF has advantageous such ease of placement and removal, accessibility for open wound management and less cost involvement in execution by minimalistic orthopaedic instruments (Ness, 2006) [9]. Typically, the components of external skeletal fixators are constructed from metal, predominantly stainless steel, and are referred to as fixed frame ESF. A notable drawback of these fixed frames is their limited adaptability in terms of shape, size, and orientation. In contrast, free-form fixators are lightweight and more cost-effective, allowing for greater flexibility in pin direction and size, independent of the connecting bar's dimensions. Numerous biomechanical studies have explored the use of acrylic and epoxy polymers in ESF components (Willer *et al.*, 1991; Roe and Keo, 1997; Tyagi *et al.*, 2014a) [1, 2, 3]. Biomechanical comparisons have indicated that multiplanar and circular designs of epoxy-pin ESF outperform uniplanar designs (Tyagi *et al.*, 2014) [3]. Furthermore, epoxy pin ESF systems demonstrated comparable mechanical strength under compression loading (Tyagi *et al.*, 2014) [3].

History

A three-month-old, female Kanni pup was presented to Veterinary Clinical Complex, VCRI, Salem with a history of dog bite injury accompanied by non-weight-bearing lameness of torsion in left hind limb. On clinical examination, it revealed a grade III open fracture of tibial mid shaft (Figure -1&2). Radiographic assessment, Medio-lateral left hindlimb tibial region view witnessed an oblique overriding open tibial fracture protruding through skin, necessitating delayed surgical intervention (Figure -3).

The pup was initially stabilized with analgesic meloxicam@0.1mg per Kg, fluid therapy Lactated Ringers solution, antibiotic amoxicillin-clavulonic acid@10mg per kg Intravenously bid for 5 days and wound dressing with temporary axial fracture immobilization with Modified Robert Jones Bandage (PVC splinting) until the confirmation of healthy aseptic fractured wound (Figure -4). The preoperative blood and biochemical parameters were within the normal range.

Patient preparation and Anaesthesia

Eight hours off feed done preoperatively. The affected limb was prepared for aseptic surgery. The balanced general anaesthesia achieved perioperatively by atropine sulphate @ 0.04 mg/kg IM, xylazine @ 1.1 mg/kgIM, butorphanol @ 0.2 mg/kg IM, diazepam @ 0.5 mg/kg IV as pre-medications, induction and maintenance using ketamine @ 5 mg/kg IV and isoflurane inhalant agent respectively.

Surgical procedure

After restraining the animal in lateral recumbency with sound limb on upper side, the surgical site was scrubbed with 7.5% povidone iodine solution. Fracture reduction was done. Subsequently, by keeping the bone fragments in alignment, the K-wires (1.5 mm) were introduced perpendicular to the long axis of the bone, from caudo-medial to cranio-lateral and craniomedial to caudo-lateral directions using a low-speed electric drill avoiding the major vessels, nerves and muscular attachments. To reduce the possibilities of thermal necrosis, pouring of cold normal saline solution was continued throughout the bone drilling (Egger *et al.*, 1986; Clary and Roe, 1995) [6, 2].

The K-wires were first inserted close to fracture site into the smaller fragment followed by larger fragment and subsequently the procedure was repeated eccentrically in both the segments. The K-wires were crossed with each other at an angle of 70° to 90° in a way that they did not interfere with each other in the medullary cavity. Finally, the K-wires in the same plane were bent 2 cm away from the skin towards the fracture site. Then the side bars for both proximal and distal sites were prepared by using additional K-wires. The bent K-wires along with side bars were then joined with the help of adhesive tape or fish net thread to form a temporary scaffold. The epoxy putty was prepared by mixing the epoxy hardener and resin for 2 minutes and then evenly applied it over the temporary scaffold and the side bars. The epoxy fixator so formed was then allowed to harden for a period of 20 minutes (Figure -5).

Post-operatively, Amoxicillin cloxacillin @ 10mg/kg and tramadol @ 2 mg/kg were given orally for 5 days along with regular cleaning and dressing of the surgical wounds was performed with 1% povidone iodine solution till the removal of fixators.

Orthogonal radiographs were taken immediately after application of fixator to determine the level of fracture reduction and the placement of K-wires and also on 10th, 20th, 40th, and 45th days, post-operatively to evaluate the fracture healing, status of fixation, fixator and complications; Once radiographs showed fracture healing with bridging callus on 45th day, the fixator was removed (Figure -6).

The fixator was removed by cutting the K-wires with a plier on radiographic conformation of fracture healing. The cut wires were then pulled out and the wire tracts were cleaned and flushed with povidone iodine. Oral administration of tramadol @ 2 mg /kg body weight and daily dressing of wire tracts was advised for 5 days after fixator removal.

The clinical lameness scores were used for subjective evaluation of the patient (Lee *et al.*, 2019) [8].

Discussion

The External Skeletal Fixation has several types based on the configurations which applied and connecting rods/apparatus. It can be used alone or in combination with internal fixation devices for a wide variety of fractures and orthopaedic conditions. In veterinary orthopaedics type I, II linear fixators

predominated in use followed by free form ESF (Beever *et al.*, 2018) [10].

Road traffic accident (RTA) has been reported to be the major cause of fracture among animals (Braden *et al.*, 1995; Aithal and Singh, 1999, Harasen, 2003) [4]. However, in the present study, falls from a height during the fights were the major cause along with RTA. In closed fracture reduction limits soft tissue trauma, preserve vascular supply and adjacent supportive tissue. Additional placement of pins in proximal and distal portion provided additional stability. A gap of 10-20 mm kept between fixator side bars and skin was adequate to allow the expected soft tissue swellings, facilitate pin tract care and cleaning of the wound. The total time required in passing K-wires, applying fixator, hardening was about 58mins. Use of epoxy-pin ESF did not impede open wound management and wound drainage. A Flushing wound with sterile normal saline and 0.5% povidone iodine was effective in controlling infection and facilitating healing within one month. Besides stabilizing the fracture, ESF allowed normal healing of surrounding soft tissues. Rigid immobilization allows revascularization of traumatized soft tissues and reduces the risk of infection. No post-operative infection or inflammation was observed during the course of period (50days) after surgical repair. Standing, walking and running gait scores significantly increased during post-operative days. The fixator components were radio-opaque, but they did not interfere with radiographic evaluation of the fracture because, the connecting bars/rings were positioned away from the fracture site. The fixator assembly was removed easily by cutting the epoxy-pin columns with a pin cutter and pulling the pins out using pliers. The wire tracts flushed with 0.5% povidone iodine solution healed without complications. ESF using epoxy not only provide stable fixation of bone fragments but also allow early soft tissue and wound management, healing. ESF are effective in terms of stability and the technique is minimally invasive, needs minimal instrumentation and can be practised by field veterinarian.

Radiographic union: Radiographically bone union evident by formation of periosteal and endosteal callus formation. The periosteal callus formation neither exuberant nor with minimalistic fragment motion (Johnson *et al.*, 1989) [11]. This bone union considered at least 3 or four cortices filled with callus in two orthogonal radiographic views. The tibial plateau angle evaluated on lateral projection of x ray during follow up. Lateral radiographs revealed clear view of the fracture fragments as compared to Anterio-posterior view in the present study.

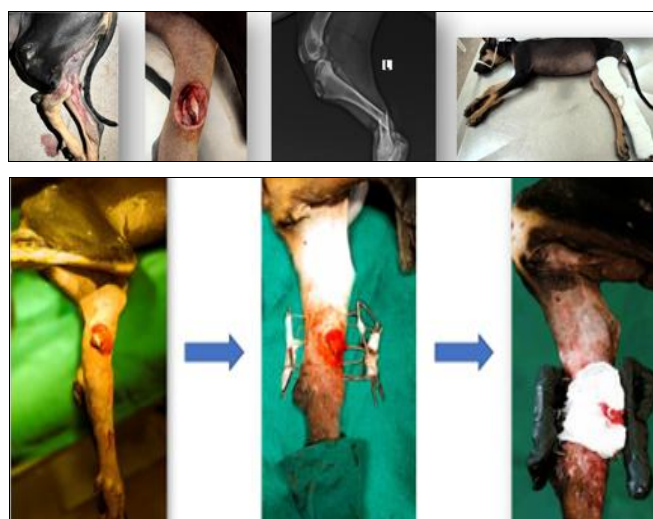




Fig 1-5: Surgical procedure and Clinical Union of tibial fracture using ESF

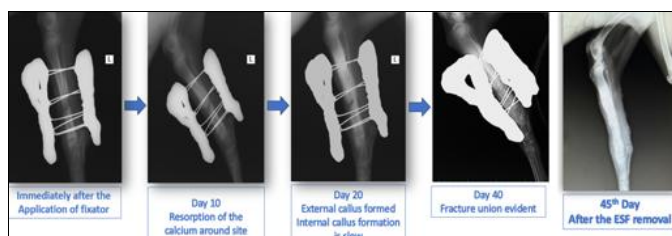


Fig 6: Radiographic union of tibial fracture using ESF

Conclusion

External Skeletal Fixation (ESF) is a viable and effective treatment option for dogs with tibial open fractures. Epoxy-pin ESF is easy to apply, inexpensive, lightweight compared with stainless steel ESF, and versatile. The results demonstrate that ESF provides stable fixation and alignment of the fractured bone, effective management of open wounds and prevention of infection, rapid return to weight-bearing and functional activity, acceptable complication rates and satisfactory owner satisfaction. It's also a minimally invasive technique, reducing tissue trauma and promoting healing, adjustable and customizable frame design, allowing for precise fracture reduction and stabilization, easy access for wound care and management, reducing the risk of infection (Sherman, *et al.*, 2023) ^[13].

In conclusion, ESF is an effective in non juxtra articular open tibial fractures and maintaining near anatomical frontal and rotational alignment in dogs these complex injuries.

Conflict of Interest

Not available

Financial Support

Not available

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