

Original Research Article

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Use of Hybrid External Fixation Technique in the Repair of Long Bone Fractures in Dogs

J. Radhakrishna Rao*, V. Gireesh Kumar, T. Madhava Rao,
D. Pramod Kumar, K. Chandra Shekar Reddy and K.B.P. Raghavender

Department of Veterinary Surgery and Radiology, College of Veterinary Science, P V Narsimha Rao Telangana Veterinary University, Rajendranagar, Hyderabad-500030, India

*Corresponding author

ABSTRACT

In this study Hybrid External Fixator (HEF) Type Ia was employed in the stabilization of 4 distal fractures of radius-ulna and 2 femoral (1 distal and 1 supracondylar) fractures in 6 dogs. Immediate postoperative radiographs revealed good alignment and apposition of the fracture fragments in all the dogs. The mean time of sufficient callus formation was 45.33 ± 5.10 . Postoperative radiographs showed restitution of cortico-medullary continuity by 45th to 60th postoperative days in all the dogs. The complete weight bearing was ranging from 34th -60th postoperative day with a mean of 42.16 ± 4.54 . The fixator was found rigid and stable till the completion of bone healing in all the dogs. The mean time of the fixator removal was 45.33 ± 5.10 days, with a range of 30 days to 60 days. In one dog valgus deformity was observed. Wounds due to the pressure exerted by the fixator observed in one dog with supracondylar femoral fracture and loosened K-wires were found during removal of ring fixator in two dogs. HEF Type Ia stabilization technique was well suited for the repair of distal and supracondylar fractures of long bones in dogs in this study and resulted in excellent clinical patient outcome with a few negligible minor complications.

Keywords

Hybrid external fixator, long bone fractures, dogs.

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Introduction

External skeletal fixators (ESF) are commonly employed in veterinary orthopaedics as treatment of choice in fracture management of long bones. ESF usually applied to the severely comminuted, open, infected, non union fractures and in the management of growth deformities in bones. The main concept in fracture treatment is to achieve the fastest possible healing and enable the patient to use the affected limb for walking early (Aron, 1998 and Shahar, 2000). There are three types of

external skeletal fixators: 1. Linear ESF (LESF), 2. Circular ESF (CESF) and 3. Hybrid External Fixators (HEF). Hybrid External Fixators (HEF) have a combination of linear and circular fixators in which a linear fixator component having a connecting rod with thread at one end, is articulated on one of the lateral holes of the circular fixator with nuts and washers. Fractures involving metaphyseal region of all long bones are relatively common in veterinary practice. The ring fixator

stabilizes a short distal fracture fragment (juxta- articular segment) with tensioned K-wires and the linear component on the long construct allows axial micro-motion which stimulates callus formation (Goodship and Kenwright, 1985). Application of HEF is easy, less time consuming and well tolerated by the patient and allow postoperative adjustments of frame (Fossum, 2013 and Radasch, 2014). Metaphyseal fractures have a short juxta- articular bone segment precluding the use of many implant systems as they are often comminuted making anatomical reduction of bone segments impossible and of questionable mechanical benefit (Radasch, 2014). Hence HEF can be used clinically to manage supracondylar or juxta- articular bone fragments of fractures of long bones. The objective of the present study was to evaluate the efficacy of HEF Type Ia in the repair of long bone fractures of dogs

Materials and Methods

Six dogs of different breed, age, sex and body weight were presented to the Teaching Veterinary Clinical Complex, PVRNRTVU, Hyderabad, Telangana state, with fractures of long bones (radius-ulna and femur), were first examined as a clinical routine and if any soft tissue injuries were present also recorded. The dogs were also observed for loss of function, abnormal mobility, deformity or change in angulation of the affected limb, signs of local swelling, pain and crepitation at the fracture site (Fig.1). Neurological status of the dog was assessed and the dogs with neurological signs were excluded from the study.

The dogs were prepared aseptically for the surgery and general anaesthesia was induced with Ketamine and Xylazine at the rate of 10 mg/ Kg and 1.0 mg/Kg body weight, respectively, intramuscularly and the

anesthesia was maintained by giving incremental doses of Propofol at the rate of 4 mg/Kg body weight intravenously.

Patient preparation and positioning was done as per the standard procedure outlined by Harasen (2003), Piermattei *et al.*, (2006), Fossum (2013) and Toombs (2014). The fractures were reduced with limited open approach in 4 dogs and by open approach in 2 dogs. The full ring or 5/8th ring of 80 mm was applied to the short distal fragment with two tensioned K- wires of 1.0-1.5 mm in size with slotted bolts and nuts. The long proximal fragment was fixed with a linear type Ia External Fixator by using positive profile end threaded half pins of 2.0 mm size with 25 mm thread length and was articulated on circular element with Hybrid Connecting Rod (End Threaded rod of 4 mm in size) with paired washers and nuts to complete HEF Type Ia construct. In the present study, cleaning with normal saline and dressing of the pin and skin interface with 5% povidone iodine pads was found effective in rendering the sites clean and sterile in all the groups of dogs and Inj. Cefotaxime Sodium¹ was administered at the rate of 20mg/kg body weight as intramuscular injection twice daily for one week post operatively. Antibiotic therapy was prolonged for 3 to 5 days whenever needed.

Inj. Meloxicam² was administered at the rate of 0.2 mg/ kg body weight as intramuscular injection once daily pre operatively and post operatively for four days. Owners were advised to monitor the position of construct and to restrict the movement of the animal for 2 weeks after surgery and then to allow leash walking.

Clinical evaluation was routinely carried out at periodical intervals for the signs of swelling, exudation, weight bearing and

stability of the fixator in all the dogs. Radiographs were obtained immediately after Hybrid External Fixation of fractures of long bones and on 15th, 30th, 45th and 60th postoperative day and whenever possible on later dates, to evaluate bone healing.

1. Taxim injection 2. Melonex injection

Results and Discussion

HEF Type Ia was used in the repair of long bone fractures of dogs. Preoperative radiographs of the 6 dogs revealed distal fractures of radius-ulna in 4 dogs, distal fracture of femur in one dog and supracondylar fracture of femur in one dog. All the dogs had closed fractures. In the present study, hanging limb technique was adopted for the radius-ulna to enable indirect fracture reduction and pin placement (Fossum, 2013 and Toombs 2014) This provided a much more stable working environment greatly facilitating access to the entire circumference of the limb for HEF Type Ia fixator application. The fractures were reduced with limited open approach in 4 dogs and by open approach in 2 dogs. The limited open approach on medial aspect in radius-ulna provided satisfactory stabilization of fracture fragments (Feresse *et al.*, 2002; Clarke and Carmichael, 2006; Gemmil, 2007; Kirkby *et al.*, 2008; Sereda *et al.*, 2009; Jimenez - Heras *et al.*, 2014 and Radasch, 2014) and lateral and parapatellar approach for femur, found appropriate for the application of HEF for distal and supracondylar fractures. In this study HEF was combined with intramedullary pinning in reduction of fracture fragments in femoral fractures and it was tied-in with Linear ESF (Feresse *et al.*, 2002 and Kirkby *et al.*, 2008).

The fixator assembly was well tolerated by all the six dogs. In one dog valgus deformity was observed (Sereda *et al.*, 2009 and

Jimenez - Heras *et al.*, 2014). In one pup with supracondylar fracture of femur the function of the joint was lost and the soft tissue surrounding this was swollen and fibrosed as the pup was presented for treatment 10 days after occurrence of fracture. The pup was keeping its limb in extension position only during sitting and standing as there was separation of articular cartilage of the trochlea of the distal segment being fragile during surgical maneuvering of the fracture fragments but weight bearing was there while walking due to healed fracture fragments. The discharge from pins, decreased after few days postoperatively. Wounds due to the pressure exerted by the fixator also observed in one dog with supracondylar femoral fracture which were managed by treatment. Loosened K-wires were found during removal of ring fixator in two dogs (Kraus *et al.*, 2003; Clarke and Carmichael, 2006; Kirkby *et al.*, 2008; Sereda *et al.*, 2009 and Jimenez - Heras *et al.*, 2014).

The dogs in this study showed partial weight bearing from 3rd – 6th postoperative day in all the dogs except in two dogs suffered with distal and supracondylar femoral fractures respectively where in only partial weight bearing was seen till the removal of fixator. The complete weight bearing was ranging from 34th -60th postoperative day (Fig.2). The mean time of complete weight bearing was ranging from 42.16± 4.54 (Harari *et al.*, 1996) Table 1.

Immediate postoperative radiographs revealed good alignment and apposition of the fracture fragments in all the dogs (Langley-Hobbs 2003 and Piermattei *et al.*, 2006) (Fig.3 and 4). The immobilization of fracture fragments was good in all the cases except in one case. Progressive bone healing was observed in post operative radiographs (Fig.5). Bone healing was seen from 15th

day onwards. Callus formation was evident from 21st postoperative day. Postoperative radiographs showed that fracture line

disappeared and showing restitution of cortico-medullary continuity by 45th to 60th postoperative days in all the dogs.

Table.1 Showing postoperative details of lameness score

Case No.	Preoperative	Postoperative Weight Bearing at the end of				
		1 Week	2 Week	4 Week	6 Week	Full weight bearing observed
Group IV						
1.	1	2	3	3	4	42nd day
2	1	3	3	4	4	30th day
3	1	2	3	3	4	60th day
4	1	2	3	3	4	50th day
5	1	2	3	3	4	37th day
6	1	2	3	4	4	34th day
Mean	1.0 ± 0.0	2.1 ± 0.16	3.0 ± 0.0	3.2 ± 0.21	4.0 ± 0.0	42.16±4.54day

1- No functional limb usage; limb carried most of the time, 2- Slight functional limb usage; limb carried during running but set down when walking, 3- Moderate functional limb usage and partial weight bearing; lameness evident, 4- Complete, normal functional limb usage.

Table.2 Removal of External Skeletal Fixator

Group IV	
Case No.	Days of ESF Removal
1	42
2	45
3	60
4	60
5	35
6	30
Mean	45.33 ± 5.10

Fig.1 Dogs showing dangling and non weight bearing on forelimb and hind limb



Fig.2 Postoperative complete weight bearing



Fig.3 Pre and Postoperative Radiographs of Radius-Ulna HEF Type Ia with full Ring showing proper alignment

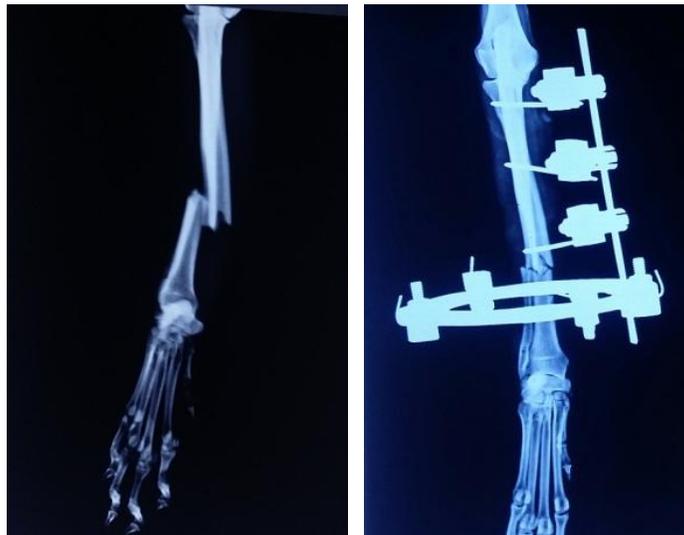


Fig.4 Distal fracture of femur in a nondescript dog and its stabilization HEF Type Ia with 5/8th ring showing proper alignment

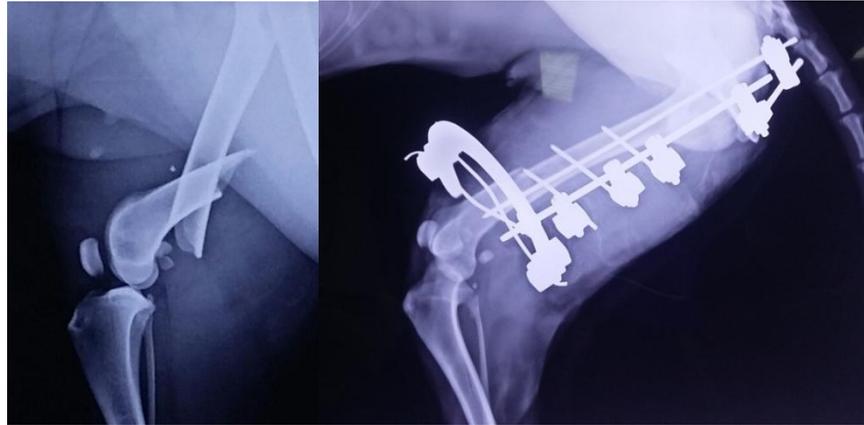
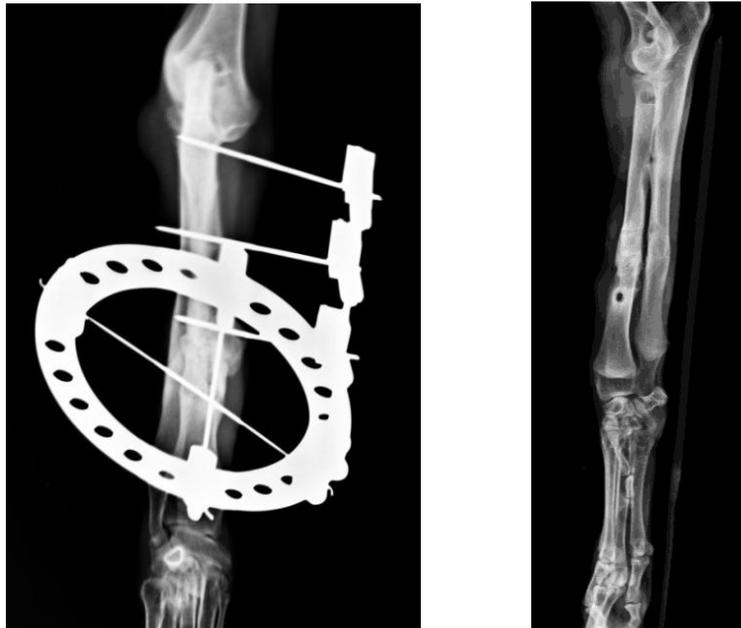


Fig.5 Progressive Bone healing of radius-ulna



Disappearance of fracture line and evidence of radio dense callus Formation, Restitution of cortico-medullary continuity. Distinct pin insertion site on distal fragment.

The fixator was removed after complete bone healing. The mean time of the fixator removal was 45.33 ± 5.10 days, with a range of 30 days to 60 days. (Clarke and Carmichael, 2006; Kirkby *et al.*, 2008; Sereda *et al.*, 2009; Jimenez - Heras *et al.*, 2014 and Radasch, 2014). The day on which the ESF assemblies were removed is presented in table 2.

Complications noticed were slight pin tract discharge, minor pin tract infection, and loosening of K-wires were seen in two dogs. Wounds due to pressure exerted by fixator was observed in one dog and slight valgus deformity of radius-ulna was seen in one dog. Slight osteolysis around K-wires was seen in two dogs at the time of fixator removal and resolved later (Aron and

Dewey, 1992). These findings did not disturb the stability of the fixator in all the dogs. All the fractures healed well and showed normal weight bearing in all the dogs.

In conclusion, the HEF Type Ia fixator was well tolerated by all the dogs and showed remarkable improvement in limb function with good fixator stability till the completion of bone healing. The hybrid external fixation technique (HEF) Type Ia can be considered for fracture stabilization of long bone fractures with short distal or supracondylar fractures in dogs. This is a biomechanically versatile technique and easy to apply, well tolerated by the patient, easy to disassembly, counteracts bending and rotational forces acting on fracture fragments and allow axial micro- motion of fracture fragments which is beneficial in fracture healing.

Authors' contribution

JRKR carried out the case study and analysis. VGK participated in scientific discussion, wise counsel and concrete suggestions. He also drafted and revised the manuscript. TMR participated in scientific discussion, coordination, sample collection and analysis. DPK, KCSR participated in scientific discussion. All authors read and approved the final manuscript.

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