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Treatment of supracondylar femoral fractures in young cats and dogs using "Arrow Pin" technique

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Abstract

Distal femoral fractures are frequently encountered in young cats and dogs due to road traffic accidents, falling from heights or animal bites. Among the treatment modalities, "Arrow pin technique" is a modified version of application of intramedullary pins for fixation of femoral diaphyseal/metaphysical (supracondylar) fracture. The arrow pins used at the Veterinary Teaching Hospital were "custom made" by cutting a locally available stainless steel pins or Kirschner wires into predetermined length and making one end flat and smooth followed by making groves on either side of the flattened end using a file to give the appearance of arrowhead, and shaping the opposite end as a trocar point. The pin insertion was accomplished aseptically through lateral approach on the distal femur, through the trochlear groove under general anesthesia in both species. The clinical efficacies of this arrow pin technique in the two species were evaluated retrospectively. All the cats (n=4) and dogs (n=5) were client owned and <1-year-old, with supracondylar distal femoral fractures. Following the clinical and radiological examinations, the type and location of the fracture, details of the fixation method applied, postoperative clinical and radiological results were assessed. Based on the radiographic examination, supracondylar femoral fractures were categorized as 5 transverse and 4 oblique overridden closed fractures. Following the insertion of intramedullary arrow pin, rigid stabilization was achieved and which were evident radiographically. The patients were able to bear weight on the affected limb in 3-5 days and started walking normally from day 14 postoperatively. Complete healing and return to function with no complication were recorded in all the cases. The study demonstrated that the single "custom made" arrow pins provided proper stability and acceptable resistance to rotational and axial forces in distal femoral fractures and confirmed that it would provide a significant fracture reduction in supracondylar distal femoral fractures in young cats and dog at comparatively low cost.

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Introduction

Fractures involving the distal femoral physis are one of the most common fracture types in young dogs and cats [1-5]. Caudal bowing of the distal femoral end is the common reason for distal femoral fractures [6]. Epiphyseal fractures are commonly seen in young animals while supracondylar or intracondylar fractures are more common in mature dogs [4]. Open surgical repair is essential for almost all supracondylar femoral fractures in dogs and cats to facilitate normal function of stifle joint and maintain further growth of physis [7,8]. There are several techniques those have been practiced for the stabilization of these fractures. Surgical stabilization of fractures can be accomplished by placement of cross pins, dynamically loaded cross pins, or a single intramedullary (IM) pin, small contoured plates, cancellous bone screws [5,8,9].

During a period of six months (from July-December 2018), out of all major surgical interventions (n=486) carried out in the Veterinary Teaching Hospital, 145 (30%) were open reduction of fractures and of which distal femoral fractures were the most common type. However, the outcome following the correction of distal femoral fracture with conventional pin insertion proved to be a challenge as the anatomical supracondylar location poses less resistance to axial and rotational forces. Here we report the application of a custom made stainless implant called "arrow pin" and evaluate the efficacy in stabilizing the distal femoral fractures (supracondylar) in cats and dogs. Arrow pins were made by using regular stainless steel rods (n=3) and Kirschner wire (n=6) of selected size (0.045"-0.065"). One end was heated and flattened by pounding on it with a hammer to obtain the suitable thickness. Then 3-4 groves were made on either side of the flattened end by filing to resemble an arrow head according to Ramesh et al [4]. This type of implants has already been used in dogs with limited data but their application in cats has never been reported. According to the authors knowledge this is the first attempt in cats to repair distal femoral fracture using arrow pin technique and follow up study for few dog cases.

Figure 1: Radiographic images of distal femoral fractures. Five transverse and 4 oblique overridden closed fractures were identified among all supracondylar femoral fractures in **A**, dog **B**, cat **C**, gait of the dog on day 1.

Ethical approval

This procedure was carried out in accordance with the guidelines for animal experimentation of the Faculty of Veterinary Medicine and Animal Sciences, University of Peradeniya, Sri Lanka. Pet owner's consent was obtained for all the cases in order to perform the surgery.

Case report

Anamnesis and arrow pin preparation

Less than one-year-old crossbred cats (n=4) weighing 1.8±0.7 kg and dogs (n=5) weighing 11.8±3.2 kg were referred to VTH, University of Peradeniya. Type of the fracture and the severity were assessed by physical examination and radiographs of the affected limbs (Figure 1 and Table 1). Based on the radiograph and the size of the bone marrow of the patient, diameter of the intramedullary pin was determined. Then the pin was "custom made' by cutting the pin into required length and one end was prepared manually to make flat and smooth. This was achieved by pounding with a hammer on the heated end of the pin [4]. Finally, the flat end was given arrow shape by making grooves using a file while the other end was shaped like a trocar. Finished pin resembled an "arrow" (Figure 2).

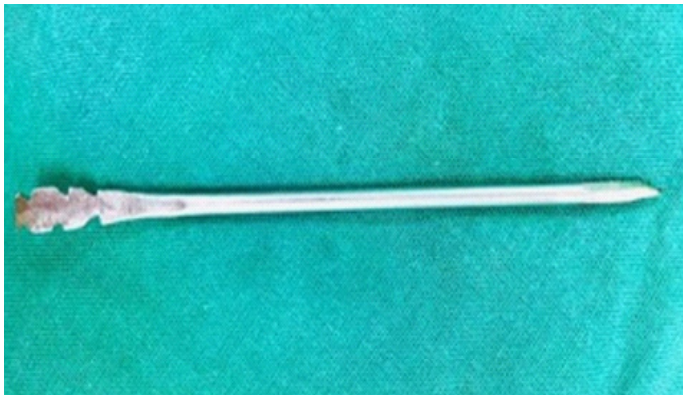

Figure 2: Arrow pin. Based on the radiograph and the size of the bone marrow of the patient was determined and diameter of the intramedullary pin was decided. Pin was cut into required length and one end was made flat and smooth by pounding with a hammer. Grooves on either side of the flat end were made using a file to resemble an arrow head while the other end was shaped as a trocar.

Figure 1: Details of the patients.

Case No	Species	Breed	Sex	Age (Months)	Location	Type of fracture
1	Feline	Crossbred	Female	12	Supracondylar distal femoral	Transvers overridden
2	Feline	Crossbred	Male	9	Supracondylar distal femoral	Transvers overridden
3	Feline	Crossbred	Female	3	Supracondylar distal femoral	Oblique overridden
4	Feline	Crossbred	Female	2 ½	Supracondylar Distal femoral	Transvers overridden
5	Canine	Crossbred	Female	6	Supracondylar distal femoral	Oblique overridden
6	Canine	Crossbred	Female	6	Supracondylar distal femoral	Oblique overridden
7	Canine	Crossbred	Male	5	Supracondylar Distal femoral	Transvers overridden
8	Canine	Crossbred	Female	3	Supracondylar Distal femoral	Transvers overridden
9	Canine	Crossbred	Male	4	Supracondylar Distal femoral	Oblique overridden

Less than one-year-old crossbred cats (n=4) weighing 1.8±0.7 kg and dogs (n=5) weighing 11.8±3.2 kg were referred to Veterinary Teaching Hospital, University of Peradeniya. Type of the fracture and the severity were assessed by physical examination and radiographs of the affected limbs

Premedication, anesthesia and surgical approach

All the nine patients were given first aid for the fractures on the day of their presentation by administrating analgesics (meloxicam 0.2mg/kg, Alina Combine Pharmaceutical Pvt. Ltd., Karachi, Pakistan) subcutaneously, and stabilization of the fracture with a Robert Jones bandage to prevent further damage. A complete blood count and serum biochemistry showed no abnormalities. All feline patients were given 2% xylazine (Special T Products Ltd., Liverpool, U.K.) and 10% ketamine (Rusan Pharma Ltd., Mumbai, India) (1:10) combination as the anesthesia. Other five canine patients were prepared with diazepam (Verve Human Care Laboratories, Pharma City, India) 0.2 mg/kg intravenously and induction of anesthesia was achieved with propofol (Aculife Healthcare Pvt. Ltd., Sachana, Gujarat) 4mg/kg intravenously. General anesthesia was maintained by propofol at the dose rate of 0.4mg/kg/min. The surgical site was aseptically prepared by clipping hair and disinfecting with isoprophyl alchohol, chlorhexidine gluconate and povidone iodine. The patient was positioned in lateral recumbence with the fractured limb upwards. Sterile drapes were used to cover the distal part of the limb and rest of the patient leaving only the site of operation opened.

A skin incision was made over the cranio-lateral aspect of the stifle joint starting at a point below the mid shaft of the femur extending distally up to the lateral aspect of the tibial crest. Then the subcutaneous tissue was incised to expose the fascia lata and patella tendon. Next the fascia lata muscle and the joint capsule were incised to expose the distal articular surface of the femur. After reduction of the fracture fragments to their normal position, the “arrow pin” was inserted in a normograde fashion through the trochlear groove directing the trocar end towards the medullary cavity of the proximal fracture fragment (Figure 3). Arrow end part of the pin was inserted into the trochlear by gentle tapping on the “arrow head” without causing damage to the articular cartilage. Arrowhead of the pin was lodged inside the cancellous bony part of the distal femur in a way that stifle movement was not interfered. After the fracture repair, the surgical site was flushed with sterile normal saline, joint capsule and the fascia lata were sutured with simple interrupted sutures using chromic catgut (2-0) and the skin closure was accomplished using 2/0 suture nylon in simples interrupted pattern. Finally, modified Robert Johns bandage was applied.

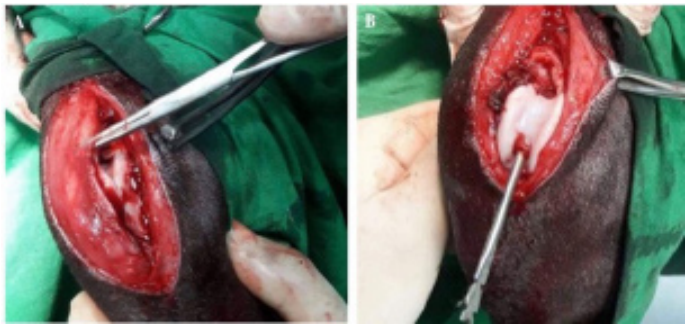

Figure 3: Surgical application of the Arrow pin. **(A)**, Fascia lata and joint capsule were incised to expose the distal femur. **(B)**, The Arrow pin was passed in an normograde fashion from trochlear groove directing it towards the medullary canal of the proximal fracture fragment using needle holder.

Results & discussion

The current study demonstrated that the single “custom made” arrow pins provided acceptable resistance to rotational and axial forces in distal femoral fractures and confirmed that it would provide a significant fracture reduction in supracondylar distal femoral fractures in young cats and dogs (Figure 4). All the four cats and five dogs in this study gained their partial weight bearing ability from the 3-5 days postoperatively. History of the all nine cases revealed that the main cause of fracture was traumatic injury by road traffic accident. All nine patients were treated post-operative antibiotic therapy and it showed effective control of secondary bacterial infections in the patients, since none of them developed post-operative swelling or discharges in the surgical site.

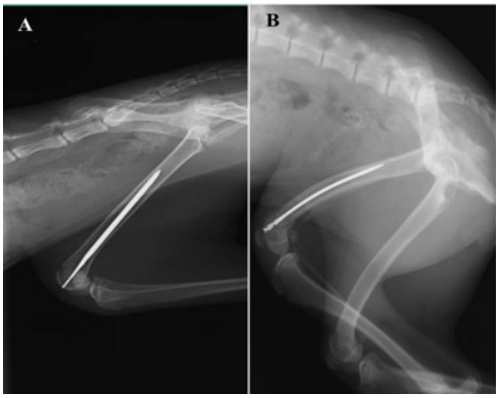

Figure 4: Shows post-surgical radiographs of the patients **(A)**, cat at 7 days **(B)** and **(C)**, dogs at day 7 and 14. All the four cats and five dogs recovered without any post-operative complications such as, pin migration or bending.

The challenges posed to veterinarian in correcting supracondylar fractures are insufficient bone mass for orthopedic implants, presence of soft cancellous bone and availability of minimal area for considerable bending forces 10]. Several techniques for stabilization of supracondylar fractures in femur were reported such as intramedullary pins, rush pins, crossed pins, mini plates, and collisoin cruciate screws [8]. Intramedullary pins resist bending forces but are very poor in countering the rotational and axial forces [11]. Certain study found that crossed pins to be significantly stronger than single intra medullary pins and also crossed pins are indicated in cats and small dogs [5]. Treatment of supracondylar fractures of femur by crossed pin technique provides more than one point fixation and increase the stabilization of the fracture fragment which leads to early fracture union [12].

Among the few well established techniques for repairing distal femoral fractures, some methods have inherent drawbacks such as, improper reduction or pin placement, muscle tie-down, soft tissues irritation and joint pain or arthritis due to injuries by cut ends of pins and pin migration. Moreover, some techniques need secondary surgical intervention for removing the implants. Finally, some complications ended with loss of function and motion of stifle joint [13]. However, in order to overcome these challenges, arrow pin along with external fixation (Robert Jones Bandage) was found to be helpful in distal end femoral fracture.

There are several methods that are being practiced in VTH for the correction of long bone fractures such as, Steinmann pin or Kirschner pin insertion, external coaptation using plaster of paris bandage application with or without splints, and application of slings. During the period of last six months, 54% of fractures in dogs and cats presented to VTH were corrected with intramedullary pin insertion. This method was commonly used to correct femoral, ulnar-radius, tibia-fibula, and humeral fractures. Arrow pin technique which was used in stabilization of supracondylar femoral fractures maintains proper fracture fixation and immobilization in the four cats and five dogs. During the present case study patient preparation before the surgery and the anesthetic protocols followed during the surgery were found satisfactory in all nine patients with regards to the reduction of fracture and quality of recovery of the patients. The four cats and the five dogs recovered without post-operative complications. Fixation of the supracondylar fractures of femur was accomplished successfully with the arrow pin technique in comparison to the other methods that were being used. This method provided a successful fracture repair with minimum trauma to the condyles and the other structures of the stifle joint.

Some of the factors to be considered in of our study are the low number of animals and subjective assessment of mobility during the postoperative period. However, there is a potential to claim that the arrow pin technique is a better method for fixation of supracondylar femoral fractures in young cats and dogs provided that proper scaled-based assessment for mobility and pain is used in extended study in future using fundamental results we obtained.

Clinical significant

In conclusion, our study results confirmed that the single arrow pin technique provided proper stability and acceptable resistance to rotational and axial forces in distal femoral fractures and confirmed that it would provide a significant fracture reduction in supracondylar femoral fractures in young cats and dogs. The results could not be compared due to dearth of literature and first reported case study on arrow pin technique in cat and dog in Sri Lanka.

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Author's contributions

RWMHR was responsible for conducting all experiments, acquisition of data and all the data analysis and drafting of the manuscript. DDNDS was involved in design of study concept, drafting and revising of the manuscript. HMSW was a major contributor in conception and design of the study, interpretation of data, drafting and revising the manuscript. All authors contributed to the interpretation of the data and approved the final manuscript.

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