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Treatment of Cats Distal Diaphyseal and Supracondylar Femur Fractures with Dynamic Intramedullary Cross Pinning Technique

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Abstract: This study was conducted on 12 cats with 11 supracondylar femur fractures and one distal diaphyseal femur fracture. Fracture properties, operation details, postoperative complications, and radiographic images of the cases were recorded. The supracondylar fractures in the study were classified according to Salter-Harris, and they were determined as type I in 1, Type II in 7, and Type IV in 3 of them. Dynamic intramedullary cross pinning technique was applied to patients with Salter-Harris type II, type I and distal diaphyseal femur fractures, dynamic intramedullary cross pinning, and intercondylar screw application, as for that, was applied to patients with Salter-Harris type IV fractures. It was observed that 8 of the 12 patients who were operated on used their extremities after removing the bandage on the relevant extremity. In two patients with Salter-Harris type IV fractures, lameness was observed due to fractures in other regions, but extremity movement returned to normal after healing the bone. A patient with a Salter-Harris type IV fracture, due to the extent of the damage to the joint as a result of trauma, had narrowing and limping in the joint angle. In a patient with a Salter-Harris type I fracture, pin migration occurred five days after the operation, and the cross-pinning technique was applied in a second operation. In consequence of the findings, it was observed that the dynamic intramedullary cross pinning technique was influential in the treatment of supracondylar femur fractures in cats.
Keywords: *Cat, Femur, Intramedullary pinning, Treatment.*

Kedilerin Distal Diyafizer ve Suprakonduler Femur Kiriklarinin Dinamik Intramedüller Çapraz Pin Tekniği ile Tedavisi

Özet: Bu çalışma, 11 adet suprakondiler femur kırığı ve 1 adet distal diafizer femur kırığı tespit edilen 12 kedide gerçekleştirilmiştir. Olguların, kırık özellikleri, operasyon detayları, operasyon sonrası oluşan komplikasyonlar ve radyografik görüntüleri kaydedilmiştir. Çalışmadaki suprakondiler kırıklar Salter-Harris'e göre sınıflandırılmış olup; 1 tanesinde tip I, 7 tanesinde Tip II, 3 tanesinde Tip IV kırığı belirlenmiştir. Kırıklardan Salter-Harris tip II, tip I ve distal diafizer femur kırığı olan hastalara dinamik intramedüller çapraz pin tekniği uygulanmış, Salter-Harris tip IV kırığı olanlara ise dinamik intramedüller çapraz pin ve interkonduler vida uygulaması yapılmıştır. Operasyonu gerçekleştirilen 12 hastanın 8'sinde ilgili ekstremitedeki bandajın çıkarılmasından sonra ekstremitelerini kullandıkları tespit edildi. Salter-Harris tip IV kırığı olan 2 hastada diğer bölgelerdeki kırıklar sebebi ile topallık görüldü fakat kemik iyileşmesi tamamlandıktan sonra ekstremite hareketinin normale döndüğü görüldü. Salter-Harris tip IV kırığı olan bir hastada travma sonucu eklemdeki hasarın büyüklüğü sebebiyle eklem açısında daralma ve topallama görüldü. Salter-Harris tip I kırığı olan bir vakada operasyondan 5 gün sonra pin migrasyonu gerçekleşti ve ikinci bir operasyon yapılarak çapraz pin tekniği uygulandı. Elde edilen bulgular sonucunda kedilerde oluşan suprakondiler femur kırıklarının tedavisinde dinamik intramedüllar çapraz pin tekniğinin etkin olduğu görülmüştür.
Anahtar kelimeler: *Femur, İntrameduller pin, Kedi, Tedavi.*

Introduction

Supracondylar fractures are more often seen in young patients (Rathnadiwakara et al., 2020). These fractures are mostly encountered as isolated fractures involving the distal metaphyseal region of the femur. Besides, these fractures may present as multi-component fractures accompanied by corpus and condyle fractures (Chandler and Beale, 2002). Due to the localization of the fracture, anatomical reduction and stabilization of this type of fracture can be difficult. Minimal dissection should be performed to ensure early bone healing and continuity of regional alimentation. Supracondylar fractures are fractures that can be anatomically reduced and stabilized, or biological osteosynthesis can be achieved with a minimally invasive technique (Beale, 2004; Fossum, 2013).

Intramedullary pins, plates, external fixators, and screws are used in the treatment of distal femur fractures. For all that, the technique of osteosynthesis with the intramedullary pin has

found a wide area in the treatment of fracture operations, and it cannot be used in the treatment of distal femur fractures due to the short distal fragment, segmental or near-joint fractures (Beale, 2004; Chandler and Beale, 2002; Ramesh et al., 2018; Scotti, 2007; Zahn and Matis, 2004). Due to these reasons, different techniques were used to perform pin stabilization of distal femoral fractures. These techniques used Kirshner (K) wires, or Steinman pins were used crosswise to pass from the medial and lateral condyle to the proximal fragment, or rush-style and dynamically crossed to pass through the intramedullary canal (Simpson and Lewis, 2003). External fixators can be used in the treatment of this type of fracture; however, they are not preferred much in bones such as femur and humerus due to the presence of dense muscle mass around them and their anatomically close position to the body (Langley-Hobbs et al., 1996; Worth, 2007).

Distal physeal fractures usually occur in young patients who have not completed their bone development, and Salter-Harris type II fractures are common among these fractures. The treatment of distal physeal fractures is usually provided with pins. However, any configuration that will create pressure on the physis during reduction is tried to be avoided (Beale, 2004). Different pins oriented along the fracture line from the lateral of the medial and lateral condyles are deflected from the opposite cortex of the diaphysis and directed proximally, and the remaining pins in the distal fragment are cut as short as possible and buried at the bone level. This placement method is called the dynamic intramedullary crosspinning technique. Dynamic intramedullary crosspinning technique has been reported to give good results in supracondylar fractures or distal diaphyseal fractures (Sukhiani and Holmberg, 1997). In the condyle fractures involving the articular surface accompanying supracondylar fractures, stabilization should be achieved by open reduction. The condition of condyle fractures may be more complex and difficult than observed on preoperative radiographs. To reduce or prevent the development of osteoarthritis, it is essential to achieve the complete anatomical reduction of the condyle. In cases where condyle fractures are suitable for operation, rigid reduction and stabilization should be achieved by using one or more lag screws and anti-rotational wires (Beale, 2004).

In the study conducted, it is aimed to treat distal diaphyseal and supracondylar femur fractures commonly occurring in cats with the dynamic intramedullary cross-pinning technique, which is easy to apply, inexpensive in terms of cost, and provides good stabilization and reduction.

Material and Method

A document was obtained from the ethics committee of Kırıkkale University Animal Experiments stating that there was no need for an ethics committee for this study (2021/31). The informed consent form was obtained from the owners of the animals included in the study. The age, gender, weight, race, localization of the fracture, and how it was shaped were recorded in our study. The heart rate and respiratory rate, rectal temperatures, mucosal colors, and capillary filling times of the cats used in each case were recorded. Palpation of the affected bone, presence of crepitation, soft tissue damage, and neurological examination of the extremities was performed. Blood was collected from each patient for a preoperative complete blood count. This hematological examination was performed to learn the general condition of the patient and to prevent a possible complication that may occur in the postoperative period.

Orthogonal preoperative radiographs were taken to determine the location and type of the fracture and to make the Salter-Harris classification. Preoperatively, the affected limb was immobilized with a modified Robert Jones bandage (RJB) until operation. The patient was operated on during the period when the patient's health condition was suitable for operation. Food restriction was applied to the animal 12 hours before the operation, and no water restrictions were applied.

In preparation for the operation, an intravenous cannula was placed into the cephalic vein first. For pre-anesthesia, 0.08 mg/kg medetomidine (domitor, zoetis, USA) and 0.2 mg/kg butorphanol (Butomidor, Richter Pharma, Austria) were administered intramuscularly (im). 5-7.5 mg/kg dose of ketamine (Ketasol, Interhas, Turkey) was injected im. After the induction, an endotracheal tube was placed through the orotracheal route, and anesthesia was continued with 1-2% isoflurane (Isoflurane, Piramal, USA) using a semicircular inhalation device (SMS Company, Turkey). The animal was placed in a side-lying position with the relevant extremity on top. The extremity was shaved from the tarsal joint to the lumbosacral region, and necessary disinfection procedures were performed. In the postoperative period, amoxicillin (Synulox, Phizer, USA) subcutan (sc) at a dose of 10mg/kg for one week and meloxicam (Maxicam, Sanovel, Turkey) sc at a dose of 0.3mg/kg for 3 days was administered.

Various types (1-2 millimeter (mm) thickness) of K-wires made of stainless steel (LC 316) were used in our study. In the preoperative period, the width of the canal at the narrowest point of the

medullary canal (isthmus point) was measured from the radiographic images, and a wide K-wire size was chosen to fill 60-70% of this channel in total.

Supracondylar femur fractures were repaired using the dynamic intramedullary cross-pinning technique. After the necessary incisions were made, to better visualize the fracture line, the joint was flexed, and the fragments were reduced. K-wires were placed crosswise from the lateral and medial sides of the sulcus trochlearis, and their progression was ensured by contacting the opposite cortex along the intramedullary canal, and fracture fixation was complete (Figure 1). The fracture line and joint area were washed with isotonic sodium chloride (0.9%) and closed according to the incision line technique.

Figure 1: Intraoperative view of pin insertion to the femur condyle.

Postoperative care RJB was applied to the operated extremity for 2-3 weeks by changing it once a week. Skin sutures were removed after 14 days. Owners of the patient were instructed to keep the patient at cage rest for 30 days and to perform a passive movement (flexion and extension) of the affected limb after removal of the RJB to improve joint motion.

Craniocaudal and mediolateral images of the involved extremity were taken immediately after the operation. Follow-up radiographs were taken at regular intervals (2 weeks - 12 weeks). Radiographs taken were evaluated for the status of fracture reduction, stability of the implant, progression of fracture healing, and any complications that may occur.

Results

Dynamic intramedullary cross pinning technique was applied to treat supracondylar femur fractures in 12 cats in our study. Of the implanted cats, 8 are hybrid, 2 are angora cat, 1 is Russian blue, 1 is British shorthair. Of the patients, 4 were male, 8 were female, their average age was 13 months, and their weight range was 3.65 kilogram (kg). Of the patients, 10 fractures were caused by falling from a height, 1 by a traffic accident, and 1 by the pressure applied on them. Of the patients, Salter-Harris type I fractures were observed in 1, Salter-Harris type II fractures in 7, Salter-Harris type IV fractures in 3, and diaphyseal femur fractures in 1 patient. In addition to these fractures, 5 of the cats had pneumothorax, 1 had caput femoris fracture, 1 had a segmented diaphyseal femur fracture, and 1 had bilateral humerus condylar fracture. In the dynamic intramedullary crosspinning technique for supracondylar femur fractures, in 3 cases, 2 K-wires of 2mm thickness were used, in 7 cases, 2 K-wires of 1.5 mm thickness were used, and in 2 cases 2 K-wires of 1 mm thickness were used. In 3 cases with Salter-Harris type IV fractures, an intercondylar screw (2.0 mm) was placed to stabilize the condyles together with the K-wires. In eight cases, it was observed that they used their extremity after removing the bandage on the relevant extremity (2 weeks later). In two cases with Salter-Harris type IV fractures, apart from the supracondylar femur fracture, limping was observed due to fractures in other extremities (inability to bear weight). However, it was observed that he used his extremity after the healing of other fractures was completed. In a case with a Salter-Harris type IV fracture, narrowing and limping were observed in the joint angle due to damage to the joint caused by trauma. In a case with a Salter-Harris type I fracture, 5 days after the operation, it was observed that pin migration was formed because there was no restriction of movement area, and then it was treated with crosspinning application. Apart from this, no complications such as postoperative pin migration, pin, and screw breakage were encountered in any animal. On radiographic examinations made, it was determined that sufficient callus tissue was formed on the 35th and 40th days. In 10 of the patients, full recovery and return to normal extremity movements were achieved without complications (Figure 2). There was a delay in healing due to pin migration in 1 of the patients and the development of infection in the surgery area in 1 of the patients; however, after the use of antibiotics, the infection was suppressed, and recovery was observed (Table 1).

Table 1. Details and clinical outcomes of 12 cats postoperatively

Case no	Race	Age (Month)	Gender	Body weight (kg)	Fracture type	Cause of Trauma	Additional orthopedic injuries	Treatment method	Outcomes
1	Crossbreed	30	M	4	Salter-Harris Type IV	Falling from high	Fracture of humeral condylus (bilateral)	DICPT and ISA	Decrease range of motion and lameness
2	Crossbreed	24	F	3.5	Salter-Harris Tip II	Falling from high	Comminutedfemoral shaft fracture (lefthinlimb)	DICPT	Functional healing
3	Crossbreed	3	F	1.1	Salter-Harris Type II	Road traffic accident trauma	None	DICPT	Failure followup
4	Crossbreed	8	F	3.5	Salter-Harris Type II	Falling from high	Femoral shaft fracture (right hindlimb)	DICPT	Functional healing
5	Crossbreed	9	M	3.7	Salter-Harris Type II	Falling from high	None	DICPT	Functional healing
6	Russian Blue	3	F	1.2	Salter-Harris Type II	Falling from high	None	DICPT	Functional healing
7	Crossbreed	15	F	3.8	Salter-Harris Type II	Falling from high	None	DICPT	Failure follow up
8	British Shorthair	7	M	3.2	Salter-Harris Type IV	Falling from high	None	DICPT and ISA	Functional healing
9	Angora cat	24	M	4.6	Salter-Harris Type IV	Falling from high	None	DICPT and ISA	Functional healing
10	Angora cat	12	F	3.4	Salter-Harris Type II	Falling from high	Femoral head fracture	DICPT	Functional healing
11	Crossbreed	8	F	3,5	Diaphyseal Femur	Falling from high	Salter-Harris Type II	DICPT	Functional healing
12	Crossbreed	12	F	3,7	Salter- Harris Type I	Pressure induced fracture	None	DICPT	Pin migration

M: Male, F: Female, DICPT: Dinamic intramedullary cross pinning technique, ISA: Intercondular screw application

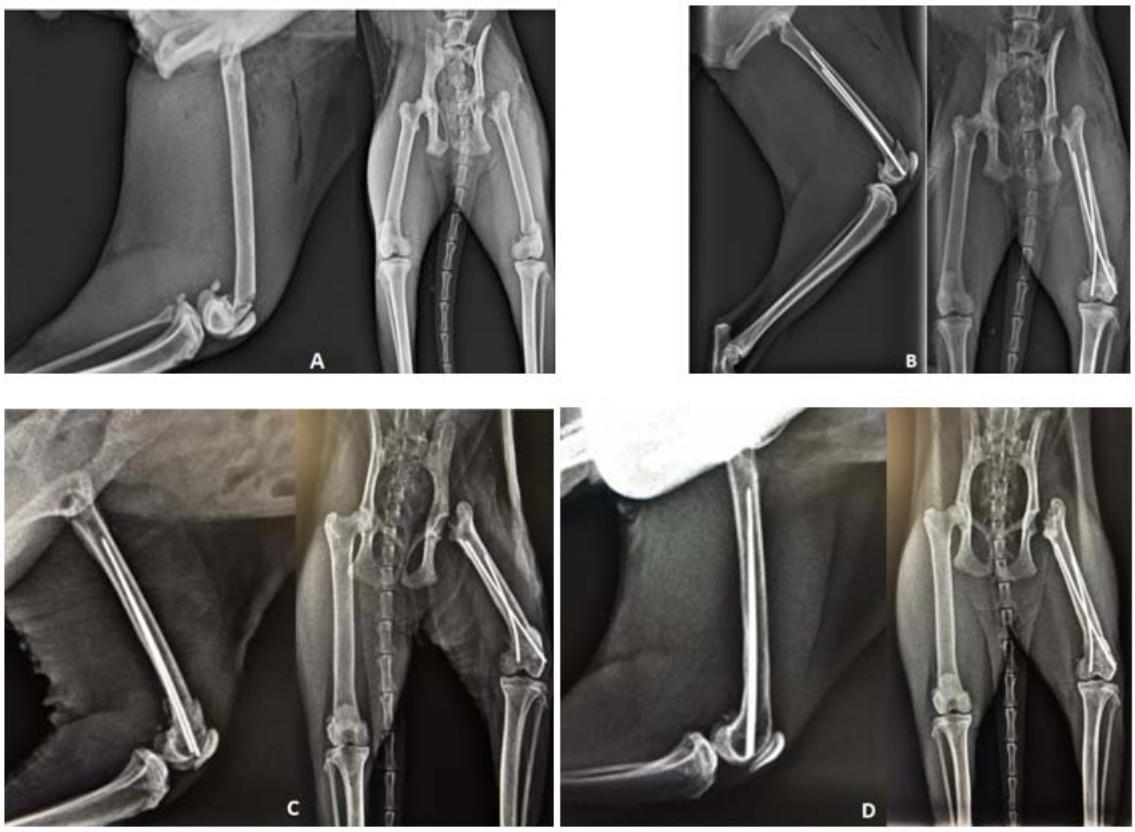

Figure 2: Craniocaudal and mediolateral radiographic views of femur fracture before (A), postoperatively (B), 2 weeks (C) and 2 months (D) after dynamic intramedullary cross pinning of femur fracture.

Discussion

Plates, external fixators, rush pin, cross-pin and single or stack pin implementation of intramedullary (IM) pin are frequently used fixation methods in simple distal femur fractures in cats and dogs. Plate osteosynthesis and external fixator application are frequently preferred in distal femur fractures. Nevertheless, it is known that plate and external fixator application, which is one of these techniques, is disadvantageous compared to IM pin application in terms of time and cost (Altunatmaz, 2017; Beale, 2004). IM pins resist bending force but are very weak against rotation (Syam et al., 2012). Cross pins are significantly stronger than single IM pin applications (Sukhiani and Holmberg, 1997). Cross pins are indicated for simple transversal or short oblique fractures in cats and small dogs, and adult animals (Lidbetter and Glyde, 2000; Sukhiani and Holmberg, 1997). It is stated that cross-pin fixation of femoral supracondylar fractures, compared to single pin fixation, increases the stabilization of the fracture fragments by contacting the bone at more than one point, thus providing early fracture union (Aithal et al., 1998). Complications such as pin migration, osteomyelitis, instability, lameness, nonunion, and malunion were reported in pin applications (Newton, 1985; Stigen, 1999). Lidbetter and Glyde (2000) stated that a supracondylar femur fracture predisposed the animal to soft tissue complications such as quadriceps contracture, resulting in stiff hyperextension of the affected leg and reduced flexion of the knee joint. In one study, the dynamic intramedullary cross pin technique was used in distal femur fractures of dogs, and it was reported that it provides good stability and recovery without any complications in the postoperative follow-up (Dn et al., 2014). Robinson (2000), as for that, applied rush pin in distal femur fractures of cats and reported complications such as postoperative pin migration and caudal metaphyseal proliferation. In the present study, a dynamic intramedullary crosspinning technique was used for distal femur fractures and Salter-Harris type 2 and 4 fractures of cats. In parallel with the studies conducted, postoperative Robert Jones bandages and area restrictions were applied to the animals. Pin migration complications reported in previous studies (Robinson, 2000; Stigen, 1999), occurred in one animal in our study. The reason for pin migration in this animal is thought to be related to the animal is a tough-tempered animal and does

not accept the postoperative bandage; animal owners do not narrow the area and release the animal in the postoperative period. Apart from this, no complications were encountered.

In one study conducted, it was reported that supracondylar femur fractures are mostly seen in animals aged 3-9 months (Gill et al., 2018). Robinson (2000) reported that cats with supracondylar femur fractures are adult cats in his study. It is seen that the animals included in the study are mostly between 3-10 months old, and this situation is compatible with the study of Gill et al. (2018). Considering that cats' growth plates close later than dogs (Smith, 1969), this is thought to be related to the fact that young or young adult animals are more mobile, and their growth plates are not yet closed.

Palmer et al. (1988), reported that normograde im pin application in femur fractures might be less likely to cause sciatic nerve injury, especially in midshaft and distal fractures, compared to retrograde application. During retrograde application, keeping the hip joint slightly extended and adduction of the leg minimizes soft tissue penetration and prevents the exposed pin from damaging the sciatic nerve (Deyoung and Probst, 1993). It is reported that there is no problem such as sciatic nerve damage in the dynamic intramedullary pin technique, and it gives good results in distal diaphysis fractures (Beale, 2004). In the present study, no neurological problems such as sciatic nerve damage were encountered in consequence of the dynamic intramedullary cross-pinning technique applied to distal femur fractures. Consequently, the dynamic intramedullary cross-pinning application is an easy, inexpensive, and reliable technique for feline supracondylar and distal diaphyseal femur fractures, and it is recommended to be used in the treatment of this type of fracture.

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References

Aithal HP, Singh GR, Sharma AK, Amarpal, 1998: Modified technique of single pin fixation and cross intramedullary pin fixation technique for supracondylar femoral fracture in dogs: A comparative study. *Indian J. Vet. Surg,* 19(2): 84-89.

Altunatmaz K, Karabagli M, Aydın Kaya D, et al., 2017: The treatment of supracondylar and diaphyseal femoral fractures in cats using intramedullary two-way stacked Kirschner wire application. *Turk J Vet Anim Sci,* 41: 282-287.

Beale B, 2004: Orthopedic Clinical Techniques Femur Fracture Repair. *Clin Tech Small Anim Pract*, 19:134-150.

Chandler JC, Beale BS, 2002: Feline orthopedics. *Clin Tech Small AnimPract*,17:(4), 190-203.

Deyoung DJ, Probst CW, 1993: Methods of internal fracture fixation. (Ed.) Slatter D H. *Textbook of Small Animal Surgery*. 2nd edn, pp. 1610–27. W.B. Saunders Company, Philadelphia.

Dn M, Ahmad RA, Aithal HP, et al., 2014: Surgical management of supracondylar femur fracture in dog. *Indian J of Canine Pract*, 6 (2), 158-160.

Fossum TW, 2013: Small Animal Surgery. 4th ed. Elsevier. Philadelphia, USA. pp: 1181-1185.

Gill KK, Kumar A, Sangwan V, Anand A, Mahajan SK, Mohindroo J 2018: Comparative functional out come of supracondylar femora lfracture stabilized with cross and end threaded intramedullary pinning in dogs. *Indian J Anim Sci,* 88(2): 161–169.

Langley-Hobbs SJ, Carmichael S, McCartney W, 1996: Use of external fixators in the repair of femoral fractures in cats. *J Small Anim Pract*, 37; 95-101.

Lidbetter DA, Glyde MR, 2000: Supracondylar femoral fractures in adult animals. *Comp. Cont Edu Pract Vet*, 22:1041-1045.

Newton CD, 1985: Fractures of the femur. *Textbook of Small Animal Orthopaedics.* pp. 428–30. (Eds.) Newton C D and Nunamaker D M. Lippincott, Philadelphia.

Palmer RH, Aron DN, Purinton PT, 1988. Relation ship off emoral intramedullary pin stothe sciatic nerve and gluteal muscles after retrograde and normogradeinsertion. *Veterinary Surgery,* 17: 65–70.

Ramesh N, Anil M, Raghavender KBP, Gireesh Kumar V, Chandra Sekhar EL, Latha C, 2018: A clinical study on the use of single 'Arrow-pin' technique for management of supracondylar femoral fractures in young dogs. *J Entomol Zool Stud,* 6: 1047-1050

Rathnadiwakara RWMH, De Silva DDN, Suranji Wijekoon HM, 2020: Treatment of supracondylar femoral fractures in young cats and dogs using "Arrow Pin" technique. *J Vet Med Animal Sci*, 3: 1017-1022.

Robinson A, 2000: Use of a Rush pin to repair fractures of the distal femur in cats. *Veterinary Record*, 146, 429-432.

Scotti S, Klein A, Pink J, Hidalgo A, Moissonnier P, Fayolle P, 2007: Retrograde placement of a novel 3.5 mm titanium interlocking nail for supracondylar and diaphyseal femoral fractures in cats. *Vet Comp Orthop Traumatol*, 20; 211-218.

Simpson DJ, Lewis DD, 2003: Fracture of the femur. In: Slatter D, editor. Textbook of Small Animal Surgery. 3rd ed. Philadelphia, PA, USA: WB Saunders Company; pp. 2059-2089.

Smith RN, 1969: Fusion of ossification centres in thecat. *J Small Anim Pract,* 10, 523-530.

Stigen O, 1999: Supracondylar femoral fractures in 159 dogs and cats treated using a normograde intramedullary pinning technique. *J Small Anim Pract,* 40: 519-523.

Sukhiani HR, Holmberg DL, 1997: Ex Vivo Biomechanical Comparison of Pin Fixation Techniques for Canine Distal Femoral Physeal Fractures. *Veterinary Surgery*, 26: 398-407.

Syam KV, Venkateswaralu B, SaradaAmma T, Raji TA, Ranjith M, 2012: External skeletal fixation in combination with intramedullary pinning and cerclage wiring for the management of comminuted fracture of humerus in dog. *Indian J Canine Pract,*4: 54-55.

Worth AJ, 2007: Management of fractures of the long bones of eight cats using external skeletal fixation and a tied-in intramedullary pin with a resin-acrylic bar. *NZ Vet J*, 55; 191- 197.

Zahn K, Matis U, 2004: The clamp rod internal fixator - application and results in 120 small animal fracture patients. *Vet Comp Orthop Traumatol*, 17; 110-120.

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