

The treatment of supracondylar and diaphyseal femoral fractures in cats using intramedullary two-way stacked Kirschner wire application

Kemal ALTUNATMAZ¹, Murat KARABAĞLI¹, Didar AYDIN KAYA^{1*}, Özlem GÜZEL¹,
Ebru ERAVCI YALIN¹, Ümit UĞURLU¹, Defne Joan ŞADALAK², Himmet EKİCİ¹

¹Department of Surgery, Faculty of Veterinary Medicine, İstanbul University, İstanbul, Turkey
²32 Sion Hill, Both, BA1, 2UW, United Kingdom

Received: 01.01.2016 • Accepted/Published Online: 01.01.2016 • Final Version: 19.04.2017

Abstract: Femoral fractures in cats are treated using pin and wires, lag screws, Rush pins, intramedullary threaded pins, interlocking pins, clamp rod internal fixators, and plates or plate-rods. In this study, 14 cats brought to the surgery clinic between the years 2010 and 2015 for fracture, due to either a road traffic accident or falling from a height, were evaluated. Following clinical and radiological examination of the cases, the type and location of the fracture, details of the applied fixation method, and postoperative clinical and radiological results were assessed. Localization of the fractures was as follows: 4 comminuted diaphyseal (1 segmental), 6 comminuted distal, and 4 uncomplicated distal transversal fractures. All fractures were closed. Following intramedullary positioning of the pins, rigid stabilization was observed in the fracture line. In the case of the segmental fracture, better stabilization was achieved when the medullary canal was completely filled. The patients were able to use their extremities 3–5 days after surgery and started walking normally from postoperative day 10. Functional healing was seen to improve gradually. Radiographic examination revealed sufficient calli to have formed between days 32 and 44. Complete healing and return to function with no complications was recorded in all the cases.

Key words: Cat, femur, fracture, treatment, intramedullary fixation

1. Introduction

Femoral fractures are common in cats and constitute 20%–26% of total fractures (1). Most of these occur in the femoral shaft and are usually in the form of closed fractures (2,3). While femoral fractures are seen mostly in the proximal or distal physis in young cats, they are mostly metaphyseal or diaphyseal fractures in adults. According to the Salter–Harris classification, distal femoral fractures of cats that have not yet completed their development are called metaphyseal, physeal, or epiphyseal, while fractures of the distal metaphysis are described as supracondylar (4–6). The most common fractures of adult cats are supracondylar fractures. These fractures occur in the distal metaphyseal region of the femur together with condylar fractures, either as an isolated or a comminuted fracture (7). The important factors in the treatment of femoral fractures are appropriate surgical approach, minimal dissection, protection of soft tissue and bones in the area, anatomical or indirect reduction, sufficient stabilization, suitable material selection and application, and appropriate postoperative care (2).

The ultimate aim of fracture treatment is to achieve rapid bone healing, provide fast return to complete

function of the injured leg, and prevent damage to soft tissues and the bone (8,9). If pin application principles are adhered to, intramedullary pin application is a relatively easy method (8).

Distal femoral fractures in cats are successfully treated using pin and wires, Rush pins, intramedullary threaded pins, interlocking pins, clamp rod internal fixators, and plates or plate-rods (2,4,6,7,10–15). In addition to these methods, intramedullary pins are used in combination with external fixators (tie-in) (7,16–18). However, they are not highly advised due to the dense soft tissue mass in the region (2).

The aim of this study is to present to veterinary practice the successful treatment of distal diaphyseal and supracondylar femoral fractures seen commonly in cats, with the easily applicable two-way (normograde and retrograde) intramedullary stacked pin application, which provides good stability and requires minimal dissection.

2. Materials and methods

The study material comprised 14 cats of different breed, age, and sex brought to the İstanbul University Veterinary Faculty Surgery Department between the years 2010

* Correspondence: didaraydin@hotmail.com

and 2015. Physical and radiological examination of the patients (Figures 1–4) led to fracture diagnosis and surgical treatment. The appropriate surgical approach was employed and the fracture site was reached via a lateral femur incision.

Following exposure of the fracture fragments, Kirschner pins were first inserted into the medulla of the proximal fragment in a retrograde fashion so that the pin exited the intertrochanteric fossa (Figure 1). The numbers of Kirschner pins used were three 1.5-mm pins in 1 case, two 1.5-mm pins in 4 cases, and two 2-mm pins in 9 cases. An approximately 1-cm incision was made at the pin exit site. The pins were pulled proximally towards the cancellous region in order to vacate the medullary canal (Figure 1).

The stifle joint was then opened and the condyles exposed. Two Kirschner wires each (1.2-mm wires in 5 cases and 1.5-mm wires in 9 cases) were inserted into the medulla in a normograde fashion through the fracture line and these exited the medial and lateral sides of the condyles (Figure 1). Following repositioning of the fracture, the distal pins were advanced until they entered the cancellous bone of the proximal fragment. The pins inserted into the proximal fragment were then advanced until they reached the cancellous bone and the free tips were bent and cut. Metal cerclage wire was used to aid fixation in some oblique, spiral, and comminuted fractures and polydioxanone cerclage was used in other fractures. The tips of the pins inserted distally were bent and left on both sides of the condyles in 9 cats (Figures 1, 2, and

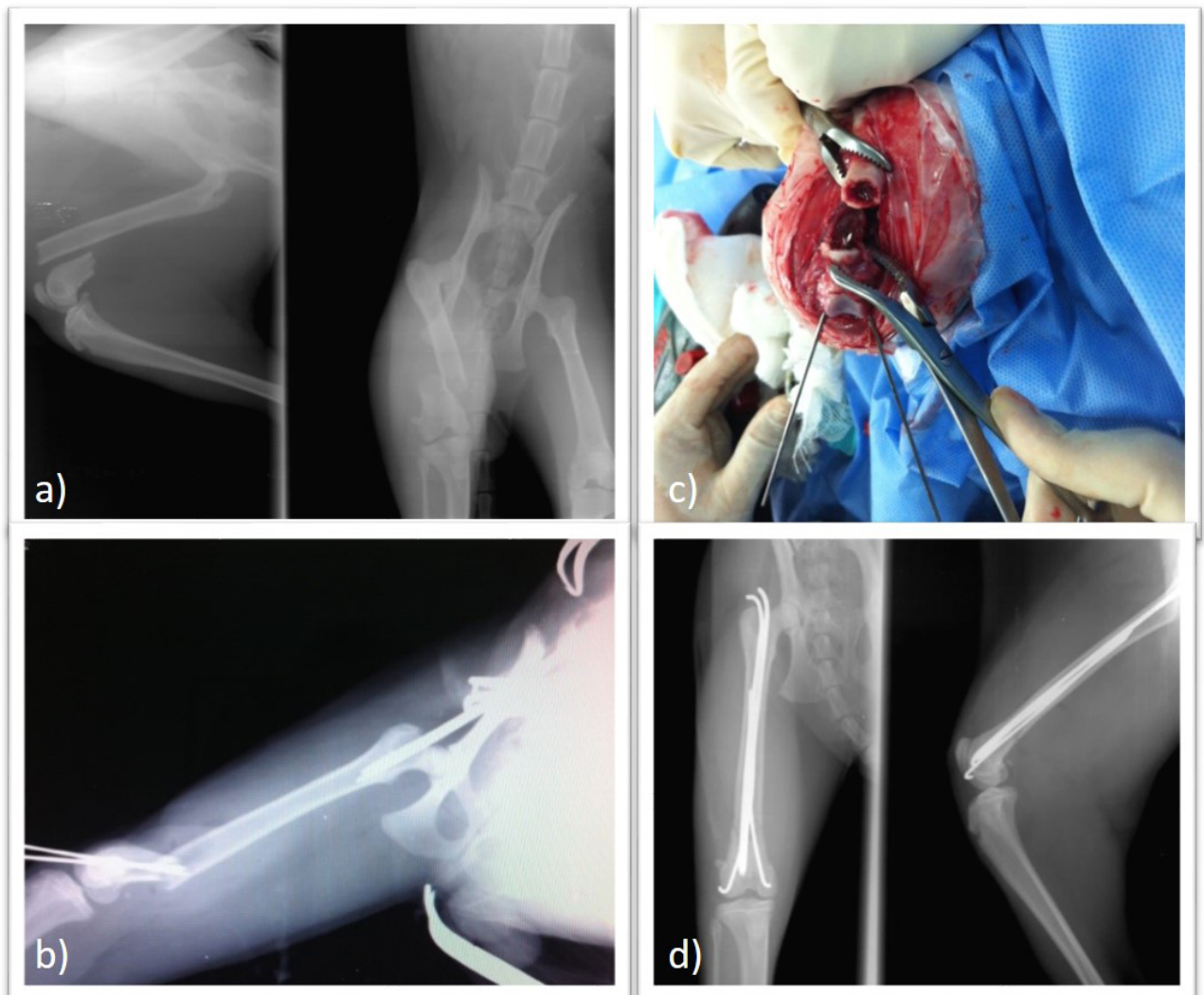


Figure 1. (a) Preoperative mediolateral and ventrodorsal view of distal diaphyseal femur fracture in a 6-month-old mixed breed cat; (b) radiographic view of retracted pins inserted in a retrograde fashion into the proximal fragment before intraoperative repositioning and that of pins inserted lateral to the condyle; (c) intraoperative view of pins inserted in a normograde fashion lateral to the condyle; (d) postoperative mediolateral and ventrodorsal view.

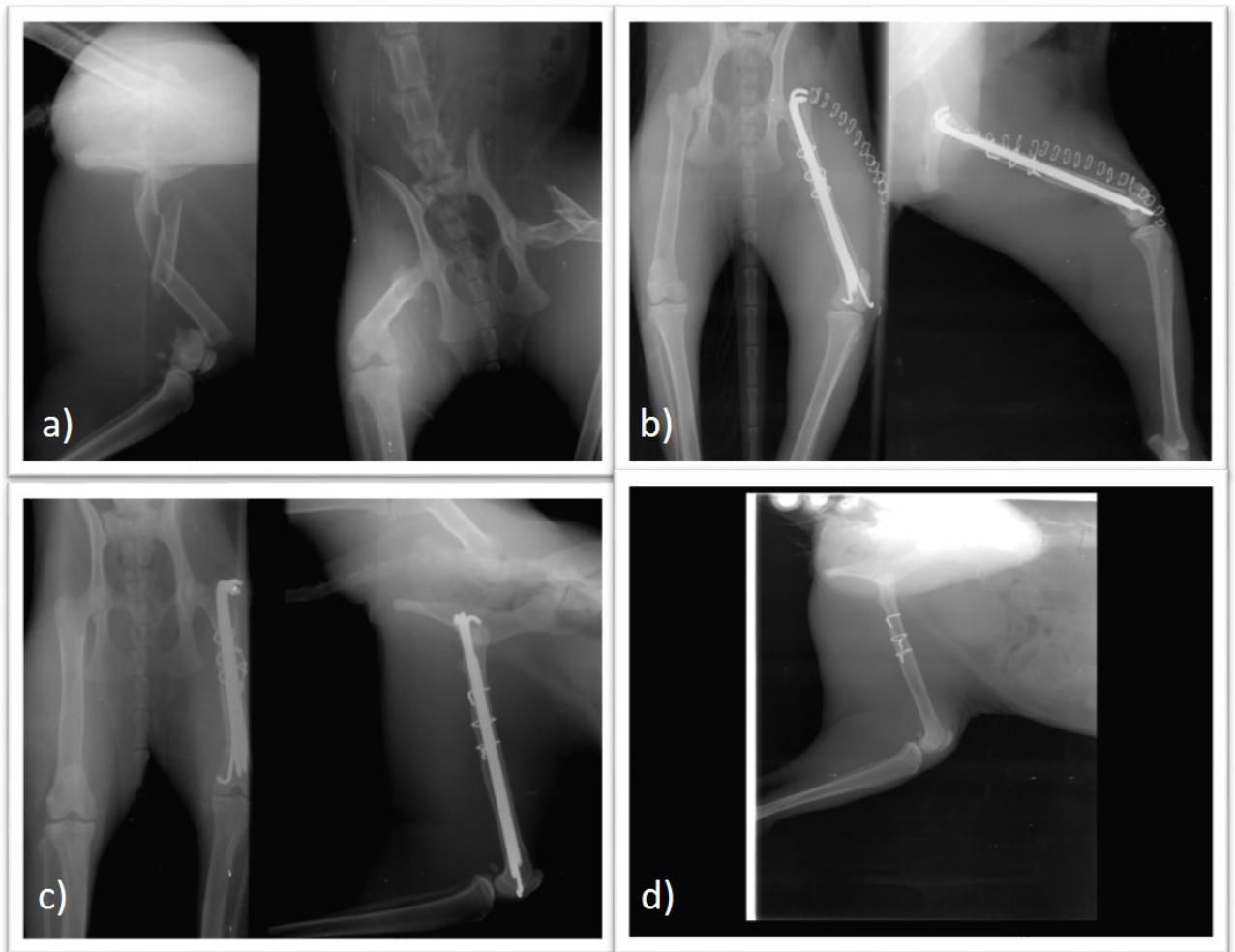


Figure 2. (a) Preoperative mediolateral and ventrodorsal view of segmental comminuted femur fracture in a 7-month-old mixed breed cat; (b) postoperative mediolateral and ventrodorsal view; (c) 2 months after operation, a mediolateral and ventrodorsal view before removal of pins; (d) mediolateral view after removal of pins.

4), while in 5 cats the pins were retracted until the tips disappeared within the joint and then bent over the major trochanter (Figure 3). To prevent soft tissue and ischiatic nerve damage the tips of the bent pins were directed laterally and cranially (Figures 1–4). On completion of the fixation procedure, the operation site was closed routinely.

Postoperative radiographs of the cases were obtained. All cats were administered 30 mg/kg IM ceftriaxone once daily for 5 postoperative days and 0.2 mg/kg IM meloxicam for 3 days for pain relief. When there was sufficient functional healing and radiographic callus formation, the proximally bent pins were removed in all cases and the distally bent pin in one case (Figure 2). No problems were observed with the bent pin tips within the stifle joint in 8 cases; therefore, these were not removed.

3. Results

Intramedullary two-way stacked Kirschner wire application was used to treat femoral fractures in 14 cats. Among these cats, 11 were mixed breed, 2 were Siamese, and 1 was a Sphynx cat. There were 11 male and 3 female cats. Bodyweight ranged between 1.5 and 6 kg and the cats were aged between 5 months and 2 years (7 cats were 11 months old or younger). The fractures had been caused by falling from a height in 5 cases, road traffic accidents in 8 cases, and as a result of being hit in 1 case. The location of the fractures were: diaphyseal comminuted (1 segmental) in 4 cases, distal comminuted in 6 cases, and distal transversal simple fractures in 4 cases. All were closed fractures. Following insertion of intramedullary pins, there was reasonably rigid stability in the fracture line. In the case of the segmental fracture, better stabilization was

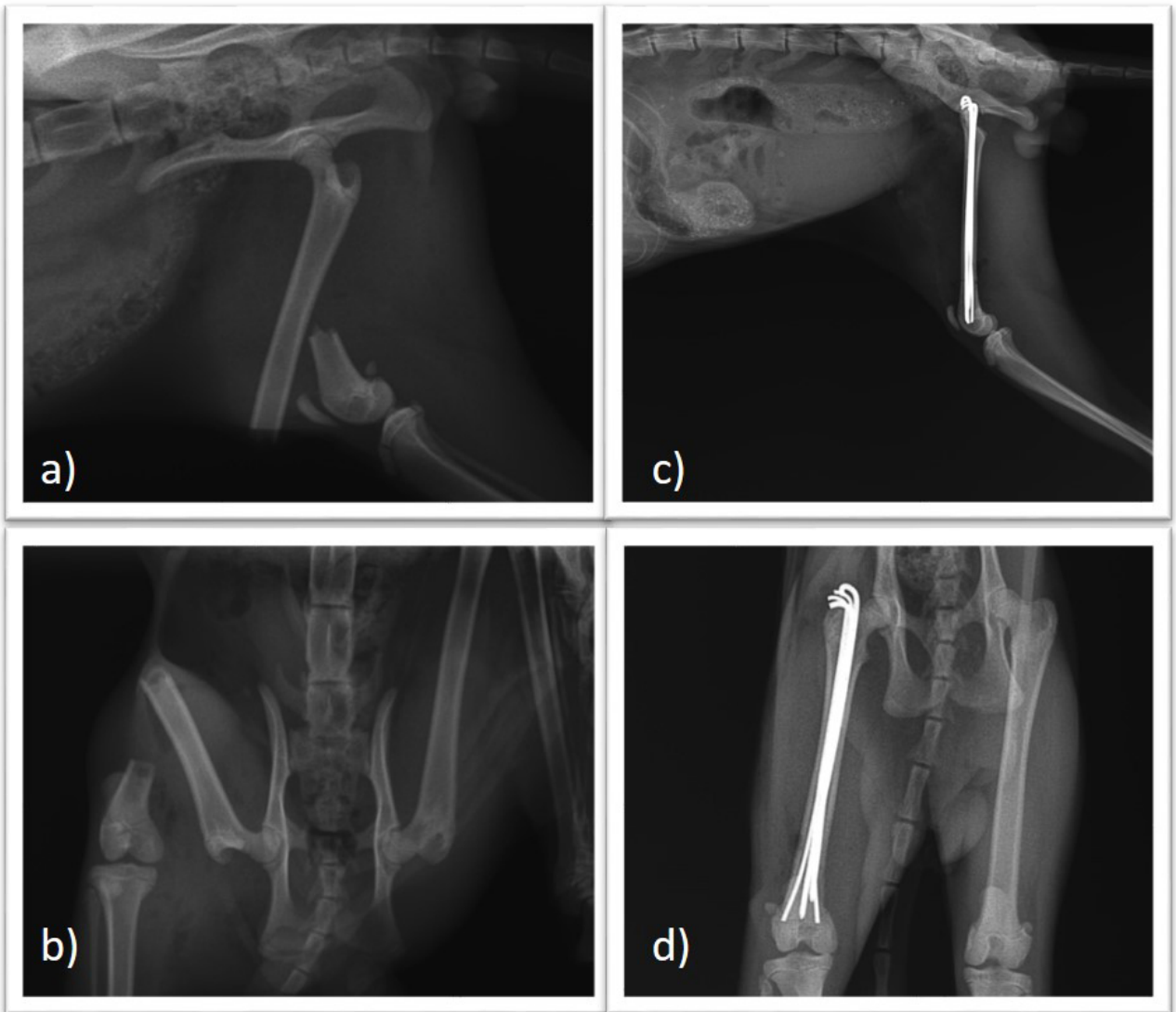


Figure 3. Preoperative (a) mediolateral and (b) ventrodorsal view of distal diaphyseal femur fracture in a 9-month-old Sphynx cat; postoperative (c) mediolateral (d) and ventrodorsal view.

achieved when the medullary canal was completely filled. The patients were seen to begin using their extremities 3–5 days after surgery and were walking normally from postoperative day 10. Functional healing was determined to improve gradually. In radiographic controls, total healing (sufficient callus) was seen to occur between days 32 and 44. Full recovery and return to function with no complications was observed in all cases.

4. Discussion

Due to the variable medullary canal diameters of the bones, the application of just one intramedullary pin usually does not provide sufficient fixation. Insertion of multiple pins increases pin and bone contact and gives

better stabilization (9,14,19). Traditional intramedullary pin or stacked pin application is used mostly for the fixation of simple diaphyseal fractures of the femur and humerus (14,19). The majority of the cases in this study had distal diaphyseal or supracondylar fractures. The diaphyseal fractures were comminuted. Since two-way stacked pins provide sufficient stabilization, in the authors' opinion, this method can be used without any problems in all femoral fractures in cats.

Retrograde application of the interlocking pin is used successfully in supracondylar or diaphyseal femoral fractures in cats (6). Retrograde and normograde two-way pin application causes less trauma and removal of the material is easier. Also, it may not be possible in every

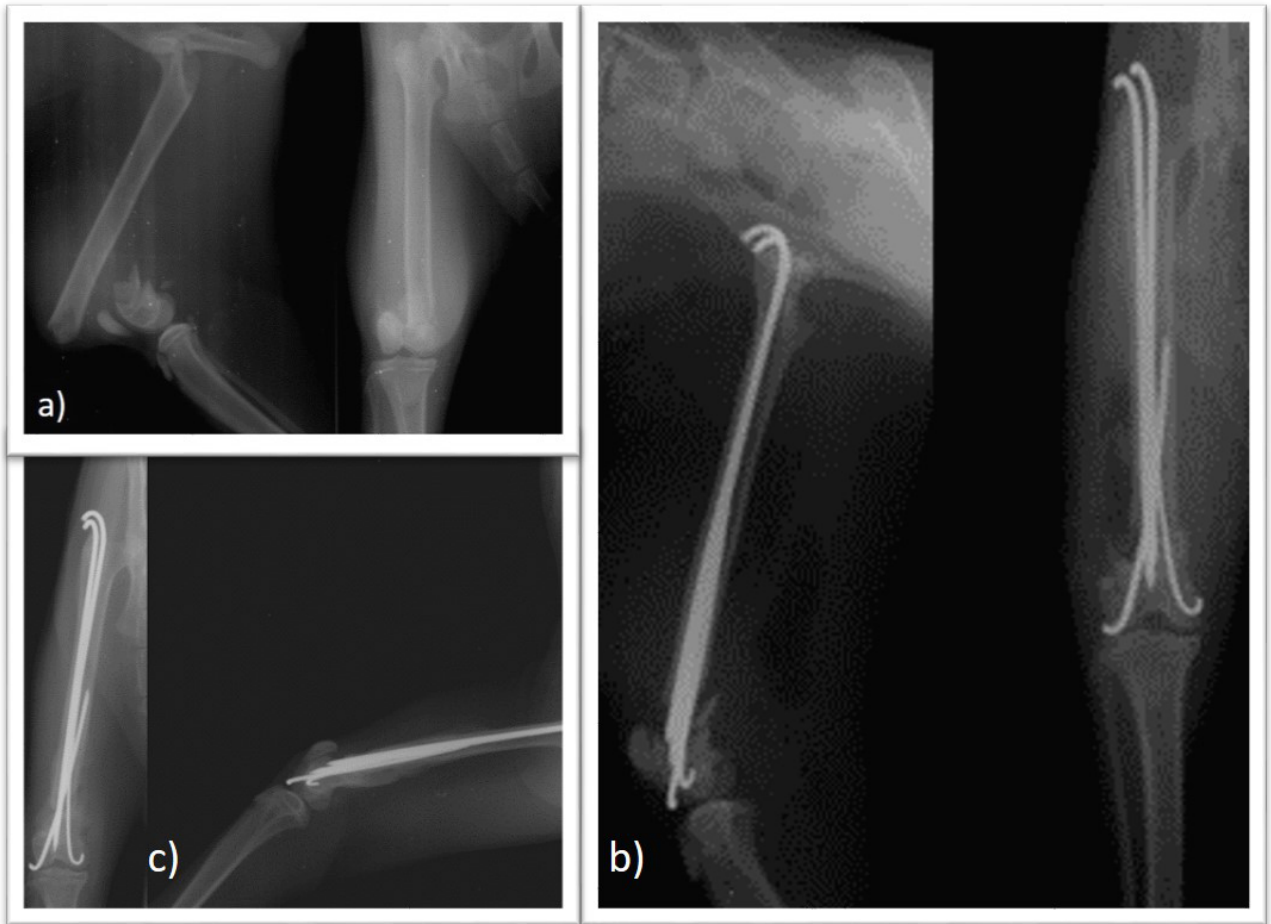


Figure 4. (a) Preoperative mediolateral and ventrodorsal view, (b) postoperative mediolateral and ventrodorsal view, and (c) mediolateral and ventrodorsal view 40 days after operation of supracondylar femur fracture in a 6-month old mix breed cat.

veterinary practice to acquire an interlocking pin and set for cats. However, Kirschner wires are easy to obtain and this method is easily applicable.

Distal femoral fractures can also be treated using plate-rod constructs and adjunctive external fixators (2,20). The authors reached the conclusion that, compared to the methods mentioned above, the two-way intramedullary pin application is quicker and more easily applicable, removal of the osteosynthesis material following healing is easy, and it is a more cost-effective technique.

In fracture treatment using plate-rod constructs, Reems et al. (21) reported that they encountered complications such as pin migration, soft tissue irritation, and serum production. None of these complications were observed in the present study.

In patients that have not yet completed their physical development, plate application in metaphyseal fractures has a negative effect on growth (22). Among the cases of this study, neither premature growth plate closure nor problems associated with this were encountered.

In a study carried out by Stigen (23), supracondylar femoral fractures were treated using fixation with normograde pin application via the stifle joint. However, it was reported that removal of the pins following fracture repair was difficult and therefore this method was not advised (23). In the present study, pin removal was seen to be reasonably easy and uncomplicated in the two-way pin application, particularly in cases where the pin tip was bent over the major trochanter.

Iatrogenic sciatic nerve damage may occur following intramedullary pin application in femoral fractures (24). This may be particularly because during the bending of the intramedullary pins, the bent tips can also cause damage to the nerve. During retrograde application, holding the hip joint in slight extension and adducting the leg minimizes soft tissue penetration and prevents the exposed pin from damaging the sciatic nerve (9). It has been reported that an appropriate tie-in technique in external fixation and intramedullary pin combinations may prevent sciatic nerve damage and soft tissue irritation that may be caused

by intramedullary pin application (20). In this study, no nerve damage or soft tissue irritation was encountered either during two-way stacked pin application or removal. In the authors' opinion, this damage can be avoided by cranial and lateral bending of the pin tips over the major trochanter. In the tie-in technique, since the intramedullary pin was bent laterally, this problem did not occur. Also in patients where all the pins were bent upwards, the fact that pin removal could be performed under sedation and local analgesia was considered to be an advantage.

References

- Whitehair JG, Vasseur PB. Fractures of the femur. *Vet Clin North Am Small Anim Pract* 1992; 2: 149-159.
- Beale B. Orthopedic clinical techniques femur fracture repair. *Clin Tech Small Anim Pract* 2004; 19: 134-150.
- Braden TD, Eicker SW, Abdinoor D, Prieur WD. Characteristics of 1000 femoral fractures in the dog and cat. *Vet Comp Orthop Traumatol* 1995; 8: 38-44.
- Piermattei DL, Flo GL. Correction of abnormal bone growth and healing. In: Piermattei DL, Flo GL, DeCamp CE, editors. Brinker, Piermattei and Flo's Handbook of Small Animal Orthopedics and Fracture Repair. 3rd ed. Philadelphia, PA, USA: WB Saunders Company; 1997. pp. 503-511.
- Simpson DJ, Lewis DD. Fracture of the femur. In: Slatter D, editor. Textbook of Small Animal Surgery. 3rd ed. Philadelphia, PA, USA: WB Saunders Company; 2003. pp. 2059-2089.
- Scotti S, Klein A, Pink J, Hidalgo A, Moissonnier P, Fayolle P. Retrograde placement of a novel 3.5 mm titanium interlocking nail for supracondylar and diaphyseal femoral fractures in cats. *Vet Comp Orthop Traumatol* 2007; 20: 211-218.
- Chandler JC, Beale BS. Feline orthopedics. *Clin Tech Small Anim Pract* 2002; 17: 190-203.
- Coetzee GL. Long bone fracture fixation with an intramedullary pin and C-clamp-on plate in dogs: 21 cases (1992-1997). *Vet Comp Orthop Traumatol* 1999; 12: 31-37.
- Deyoung DJ, Probst CW. Methods of internal fracture fixation. In: Slatter DH, editor. Textbook of Small Animal Surgery. 2nd ed. Philadelphia, PA, USA: WB Saunders Company; 1993. pp. 1610-1627.
- Zahn K, Matis U. The clamp rod internal fixator - application and results in 120 small animal fracture patients. *Vet Comp Orthop Traumatol* 2004; 17: 110-120.
- Altunatmaz K, Ozsoy S, Mutlu Z, Devencioglu Y, Guzel O. Use of intramedullary fully-threaded pins in the fixation of feline and canine humeral, femoral and tibial fractures. *Vet Comp Orthop Traumatol* 2012; 25: 321-325.
- Könning T, Maarschalkerweerd RJ, Endenburg N, Theyse LFH. A comparison between fixation methods of femoral diaphyseal fractures in cats - a retrospective study. *J Small Anim Pract* 2013; 54: 248-252.
- Ozsoy S. Fixation of femur, humerus and tibia in cats using intramedullary threaded Steinmann pins. *Vet Rec* 2004; 155: 152-153.
- Denny HR, Butterworth SJ. A Guide to Canine and Feline Orthopaedic Surgery. 4th ed. Oxford, UK: Blackwell Science; 2000.
- Johnson AL, Smith C, Schaeffer DJ. Fragment reconstruction and bone plate fixation versus bridging plate fixation for treating highly comminuted femoral fractures in dogs: 35 cases (1987-1997). *J Am Vet Med Assoc* 1998; 213: 1157-1161.
- Langley-Hobbs SJ, Carmichael S, McCartney W. Use of external fixators in the repair of femoral fractures in cats. *J Small Anim Pract* 1996; 37: 95-101.
- Aron DN, Foutz TL, Keller WG. Experimental and clinical experience with an IM pin external skeletal fixator tie-in configuration. *Vet Comp Orthop Traumatol* 1991; 4: 86-94.
- Worth AJ. 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* 2007; 55: 191-197.
- Hach V. Initial experience with a newly developed medullary stabilization nail (Trilam nail). *Vet Comp Orthop Traumatol* 2000; 13: 109-114.
- Harari J. Treatments for feline long bone fractures. *Vet Clin North Am Small Anim Pract* 2002; 32: 927-947.
- Reems MR, Beale BS, Hulse DA. Use of a plate-rod construct and principles of biological osteosynthesis for repair of diaphyseal fractures in dogs and cats: 47 cases (1994-2001). *J Am Vet Med Assoc* 2003; 223: 330-335.
- Hulse D, Hyman W, Nori M, Slater M. Reduction in plate strain by addition of an intramedullary pin. *Vet Surg* 1997; 26: 451-459.
- Stigen O. Supracondylar femoral fractures in 159 dogs and cats treated using a normograde intramedullary pinning technique. *J Small Anim Pract* 1999; 40: 519-523.
- Fortere F, Tomek A, Rytz U, Brunberg L, Jaggy A, Spreng D. Iatrogenic sciatic nerve injury in eighteen dogs and nine cats (1997-2006). *Vet Surg* 2007; 36: 464-471.

It was concluded that intramedullary two-way (normograde and retrograde) pin fixation provides good stabilization under a limited approach, it is an easily applicable method, it qualifies for absence of traumatic material removal, and it is a cost-effective method.

Acknowledgments

The authors would like to thank Dr Klaus Zahn for his idea during this study. This study was supported by the İstanbul University Research Fund, Project Number UDP-31128.