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Treatment of Diaphyseal Tibial Fractures of Cats with Using Minimal Invasive Plate Osteosynthesis and Evaluation of Outcomes Postoperatively

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Abstract

In the present study, it was aimed to apply minimally invasive plate osteosynthesis (MIPO) in the treatment of diaphyseal tibia fractures in cats and to evaluate recovery and complications postoperatively. Minimally invasive fracture repair preserves the blood supply of fragments and periosteal tissues which help to result faster healing, less morbidity, and rapid recovery of limb function. The study was conducted on 12 cats with diaphyseal tibia fracture. After closed reduction of the fractures of the cats included in the study, two small incisions were made from the proximal and distal tibia to expose the bone tissue. Plate placement was performed percutaneously through these insicion areas. The plate was fixed with two screws from the proximal and distal incision line and the fixation of the fracture line was ensured. Soft bandage was applied for 5 days postoperatively and animals caged to restrict movements for 3 weeks. X-rays were taken at regular intervals postoperatively and fracture healing was evaluated. In the controls, it was seen that the animals started to use their legs after the bandage was removed. There were no complications related to the very small operation wound and bone tissue. Healing times were determined as 35 days on average. As a result, it was determined that earlier healing was performed and less complication rate compared to open operational techniques.

Keywords: Cat, fracture, plate osteosynthesis, tibia.

INTRODUCTION

AO principles recommend complete anatomical reduction of fracture fragments prior to the application of internal fixation methods (Schutz and Sudkamp, 2003). Complete exposure and manipulation of the fracture site are required for complete anatomical reduction (Schatzker, 1995). The rigid fixation and interfragmental compression created support for primary fracture healing with minimal callus formation (Palmer, 1999). Although open reduction techniques allow reduction of fragments by direct manipulation, fracture hematoma in the region and disruption of regional extraosseous blood supply may pose problems in fracture healing (Farouk et al., 1998; Field and Tornkvist, 2001; Borrelli et al., 2002). The iatrogenic trauma created can slow the rate of new bone formation and cause devitalization of the fracture fragments (Mizuno et al., 1990).

In order to maximize the biological healing potential in fracture treatment, indirect stabilization techniques that cause minimal damage to soft tissue and biological osteosynthesis principles that provide adequate reduction have been developed (Schatzker, 1995; Palmer, 1999; Field and Tornkvist, 2001). Minimally invasive fracture repair preserves the blood supply of fragments and periosteal tissues, resulting in faster healing, less morbidity, and rapid recovery of limb function. (Johnson et al., 1998; Schmokel et al., 2003; Hudson et al., 2009) Minimally invasive surgical procedures can be performed using an external fixator, interlocking screw, plate-rod combination, clamp-rod internal fixation, and plate-screw (Johnson et al., 1998; Schwarz, 2005; Piermattei et al., 2006; Tong and Bavonratanavech, 2007; Guiot and Dejardin, 2011). Minimally invasive plate osteosynthesis (MIPO) is the procedure of applying a bone plate without an open approach to the fracture site. In MIPO, only the intact bone cortices of proximal and distal fracture fragments are exposed to position the plaque and fix the screws. Thus, the osteogenic tissues surrounding the fracture are preserved. MIPO decreases the duration of the surgery, therefore reducing the risk of infection (Eugster et al., 2004; Hudson et al., 2009). In noninfectious fracture healing; the incidence of complications such as loss of fixation or delayed union is reduced (Krettek et al., 1997).

Tibia-fibula and radius-ulna fractures are common fractures in cats and dogs (Harasen, 2003; Nolte et al., 2005). Especially in distal tibia fractures, the risk of open fractures or vascular damage increases due to the weak amount of muscle on the medial surface of the tibia. It has been reported that 11/18 of cat diaphyseal tibia fractures turn into non-union fractures (Nolte et al., 2005). The cause of delayed / non-union fractures is due to insufficient biological compensation (insufficient blood supply due to limited extraosseous soft tissue) and mechanical compliance (insufficient stabilization of the fracture line, large space between fragments and soft tissues entering between the fracture fragments) (DeAngelis, 1975). Therefore, the rate of complications such as osteomyelitis, non-union or implant failure in the tibia is high in open reduction techniques (Boone et al., 1986; Dudley et al., 1997; Nolte et al., 2005).

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This study aimed to treat diaphyseal tibia fracture of cats using minimal invasive plate osteosynthesis and evaluate outcomes postoperatively.

MATERIALS AND METHODS

Ethics committee approval was received from the Kırıkkale University Clinical Practices Ethics Committee. The study was conducted on 12 cats with different breeds, ages, and sexes brought to Kırıkkale University Animal Hospital with complaints of diaphyseal tibia fracture. Owners were informed about the operation and postoperative process to be performed on the animal.

Food restrictions started 12 hours prior to operation, and no water restrictions were applied. In preparation for the operation, an intravenous (IV) cannula was placed into the cephalic vein. For pre-anesthesia, animals were premedicated with IV 20 mcg/kg medetomidine (Domitor, Zoetis, USA) and 0.2 mg/kg butorphanol (Butomidor, Richter Pharma, Austria) and anesthesia induced with 5-7.5 mg/kg dose of ketamine (Ketasol, Interhas, Turkey). After the induction, animals were intubated and anesthesia was maintained with 1-2% isoflurane (Isoflurane, Piramal, USA) using a semicircular inhalation device (SMS Company, Turkey). The extremity was prepared for aseptic surgery from the tarsal joint to the lumbosacral region. Intravenous 22 mg/kg Cefazolin sodium (Eqizolin, Tüm Ekip Ilac AS, Turkey) was administered at induction and every 90 minutes intraoperatively. In the postoperative period, amoxicillin clavulanic acid (Synulox, Phizer, USA) subcutan at a dose of 12.5 mg/kg for a week and meloxicam (Maxicam, Sanovel, Turkey) sc at a dose of 0.2 ml/kg for 3 days.

A medial approach was used for the surgery. The cats were positioned in lateral recumbency to expose the medial surface of the affected tibia. Proximal and distal tibia palpated and 1 cm incision was made to approach to tibia. The proximal tibia is exposed after incising the tendons of insertion of the semitendinosus, gracilis, and sartorius muscles. Care is taken to preserve the medial saphenous artery and vein for the distal approach of tibia. The epiperiosteal tunnel is created by protecting the subcutaneous tissues and muscles by entering through the proximal and distal incision lines, and the plate was inserted through this tunnel. The plate is fixed to the bone with a minimum of two screws from the proximal and distal incision lines (Figure 1). The incision lines that were opened are ligated and closed. Postoperative radiographs were taken, and bandage is applied for 5 days and activities were restricted for 3 weeks (Figure 2).

Figure 1. Mediolateral and craniocaudal radiographic views of tibia fracture preoperatively.

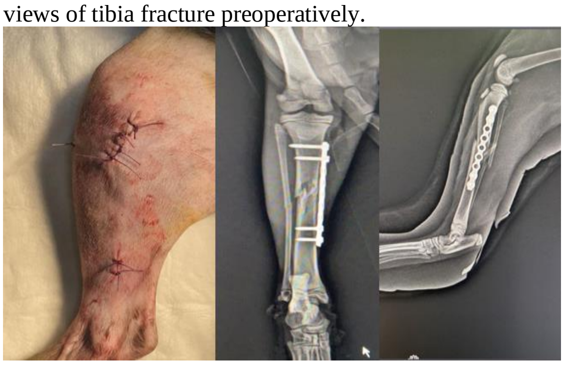

Figure 2. Imadiately after postoperative views of incision area and radiographic views of tibia fracture fixation.

RESULTS

Animal ages and body weight were determined as 26±15.30 (ranged from 5 to 52 months) and 3.7±0.87 (mean±SD), respectively (Table 1). All fractures were treated with 1.5/2.0 mm plates. Nine cats could be vetted again. Wound dehiscence was detected in 3 cats in postoperative period. These were treated with local wound care and parenteral antibiotic administration. There was no pain in the fracture area's palpation; there was no abnormality in the cat's walking and movements. Healing occurred without further complications 35 days after the initial surgery. Clinical examinations and radiological evaluations were performed during the follow-up period, ranging from 1 to 6 months. Follow-up x-rays were examined to assess the healing progress of fractures and to identify issues such as malunion, nonunion, and implant failures including as bending or breakage (Figure 3-4). There was no radiographic abnormality observed.

Table 1. Details and clinical outcomes of 12 cats postoperatively.

Age at injury (month)	Breed	Weight(kg)	Fracture type	Complication
5	Crossbreed	2.0	Transverse	---
18	British short hair	3.4	Transverse	Wound dehiscence
48	British short hair	3.9	Comminuted	---
37	Crossbreed	3.9	Oblique	---
52	Crossbreed	4.8	Transverse	Wound dehiscence
32	Siyam	3.0	Oblique	---
36	Crossbreed	4.5	Comminuted	---
11	British short hair	4.1	Comminuted	Wound dehiscence
17	Persian	5.0	Oblique	---
8	Crossbreed	2.6	Transverse	---
21	Crossbreed	3.4	Transverse	---
25	Crossbreed	3.6	Comminuted	---

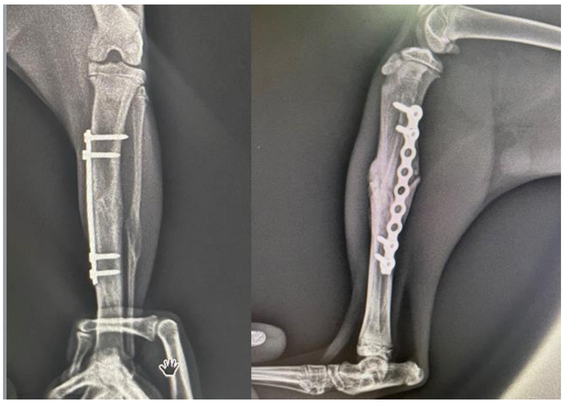

Figure 3. Radiographic image of tibia fracture repair with MIPO on postoperative 33. day.

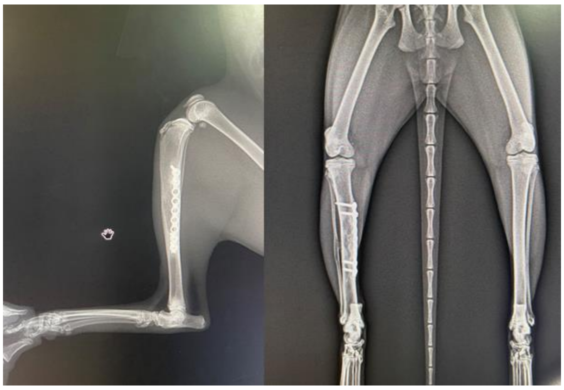

Figure 4. Radiographic image of tibia fracture repair with MIPO on postoperative views of tibia fracture postoperative 6th month.

DISCUSSION AND CONCLUSION

It is stated that there is no need for full anatomical reduction of the fracture line in MIPO application. The aim of this application is to bring the fracture fragments together in the correct alignment and restore bone function. Fracture reduction is performed with an indirect technique; thus, this technique causes minimal discomfort to the fracture hematoma and preserves periosteal blood flow to the bone. In recent years, it has been reported that leaving the fracture hematoma and soft tissues around the fracture untouched helps fracture healing and in this way, it is stated that fracture healing is rapid and the risk of contamination is minimal (Farouk et al., 1997; Nikalou et al., 2008; Baroncelli 2012; Peirone, 2020). Anatomically reducing comminuted fractures is not a primary goal in fracture treatment with minimally invasive plate osteosynthesis, a kind of biological internal fixing. The purpose of biological fixation is to fix the bone at its original length and prevent the movement of the fragments by resisting the resulting axial and torsional forces (Gautier and Ganz, 1994; Wenda et al., 1997). It is reported in previous studies (Wenda et al., 1997; Conzemius and Swainson, 1999) that the minimally invasive plate osteosynthesis procedure has an advantage over the traditional plate application technique, as the procedure is shorter (36-45 days) and bone healing is faster on radiological examination. On the other hand, it is stated that there is no significant difference in the degree of healing between MIPO and the open reduction internal fixation method (Baroncelli et al., 2012). It is stated in a previous study that healing time was 87-121 days using open reduction internal fixation technique with a bone plate. In the presented study, MIPO was applied to diaphyseal tibia fractures of cats and biological healing was aimed, as stated in the literature. It is aimed to bring the fracture lines on the same alignment and the plate is placed in this way for biological healing. Since the tissue around the fracture line was not damaged when applying mipo after bone reduction, circulatory damage was kept to a minimum and recovery was short (35 days) and infection-free. Due to the absence of a control group in the study, it was not suitable to conclusively mention on the recovery duration.

In MIPO application, the entire bone line may not be visible when the plate is placed, which can lead to shifts in the fracture line reduction after screwing due to incorrect plate positioning and misalignment of screw holes. It is reported that caution should be exercised during the screw tightening process, as tightening the screw too much or too little will have negative effects. To avoid problems, radiological imaging modalities should be used and fixation should be checked with palpation during MIPO administration (Baroncelli et al., 2012; Peirone, 2020). Although the use of long plates and a limited number of screws is useful in comminuted fractures, should be avoided in transverse or short oblique fractures as it will increase the interfragmentary stress. In such fractures, it is recommended to place plate screws close to the fracture lines to increase local stability and create sufficient durability (Stoffel et al., 2003). In the study, intraoperative radiological imaging was used for both fracture reduction and fracture fixation. Images were obtained prior to the plate being positioned on the fracture line, and the final condition of the fracture line was examined following its placement.

Conflict of Interest

The authors declare that they have no competing interests.

Authorship contributions

Concept: B.K., M.B., Design: B.K., M.B., Data Collection or Processing: B.K., M.B., Analysis or Interpretation: B.K, M.B., Literature Search: B.K., M.B., Writing: B.K., M.B.

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Ethical Approval

Ethics committee approval was received from the Kırıkkale University Clinical Practices Ethics Committee.

REFERENCES

Baroncelli AB, Peirone B, Winter MD, Reese DJ, Pozzi A. 2012. Retrospective comparison between minimally invasive plate osteosynthesis and open plating for tibial fractures in dogs. Veterinary and Comparative Orthopaedics and Traumatology, 25(5): 410-417.

Boone EG, Johnson AL, Montavon P, Hohn RB. 1986. Fractures of the tibial diaphysis in dogs and cats. Journal of the American Veterinary Medical Association, 188(1): 41-45.

Borrelli J, Prickett W, Song E, Becker D, Ricci W. 2002. Extraosseous blood supply of the tibia and the effects of different plating techniques: a human cadaveric study. Journal of Orthopaedic Trauma, 16(10): 691-695.

Conzemius M, Swainson S. 1999. Fracture fixation with screws and bone plates. Veterinary Clinics of North America Small Animal Practice, 29(5): 1117-1133.

DeAngelis MP. 1975. Causes of delayed and non-union of fractures. Veterinary Clinics of North America, 5(2): 251-258.

Dudley M, Johnson AL, Olmstead M, Smith CW, Schaeffer DJ, Abbuehl U. 1997. Open reduction and bone plate stabilization, compared with closed reduction and external fixation, for treatment of comminuted tibial fractures: 47 cases (1980-1995) in dogs. Journal of the American Veterinary Medical Association, 211(8): 1008-1012.

Eugster S, Schawalder P, Gaschen F, Boerlin P. 2004. A prospective study of postoperative surgical site infections in dogs and cats. Veterinary Surgery, 33(5): 542-550.

Farouk O, Krettek C, Miclau T, Schandelmaier P, Tscherne H. 1998. Effects of percutaneous and conventional plating techniques on the blood supply to the femur. Archives of Orthopaedic and Trauma Surgery, 117(8): 438-441.

Farouk O, Krettek T, Miclau T, Schandelmaier P, Guy P, Tseherne H. 1997. Minimally invasive plate osteosynthesis and vascularity: preliminary results or u cadaver injection study. Injury, 28(1): 7-12.

Field JR, Tornkvist H. 2001. Biological fracture fixation: a perspective. Veterinary and Comparative Orthopaedics and Traumatology, 14(4): 169-178.

Gautier E, Ganz R. 1994. The biological plate osteosynthesis. Zentralblatt fur Chirurgie, 119(8): 564-572

Guiot LP, Dejardin LM. 2011. Prospective evaluation of minimally invasive plate osteosynthesis in 36 nonarticular tibial fractures in dogs and cats. Veterinary Surgery, 40(2): 171-182.

Harasen G. 2003. Common long bone fractures in small animal practice–part 1. The Canadian Veterinary Journal, 44(4): 333-334.

Hudson CC, Pozzi A, Lewis DD. 2009. Minimally invasive plate osteosynthesis: applications and techniques in dogs and cats. Veterinary and Comparative Orthopaedics and Traumatology, 22(3): 175-182.

Johnson AL, Egger EL, Eurell JC, Losonsky JM, Egger EL. 1998. Biomechanics and biology of fracture healing with external skeletal fixation. The Compendium on Continuing Education for the Small Animal Practitioner, 20(4): 487-501.

Johnson AL, Smith CW, Scheffer DJ. 1998. Fragment reconstruction and bone plate fixation versus bridging plate fixation for treating highly comminuted femoral fractures in dogs: 35 cases (1987-1997). Journal of the American Veterinary Medical Association, 213(8): 1157-1161.

Krettek C, Schandelmaier P, Miclau T, Tscherne H. 1997. Minimally invasive percutaneous plate osteosynthesis (MIPO) using the DCS in proximal and distal femoral fractures. Injury, 28(11): 20-30.

Mizuno K, Mineo K, Tachibana T, Sumi M, Matsubara T, Hirohata K. 1990. The osteogenetic potential of fracture haematoma. Subperiosteal and intramuscular transplantation of the haematoma. Journal of Bone and Joint Surgery, 72(5): 822-829.

Nikolaou VS, Efstathopoulos N, Papakostidis C, Kanakaris NK, Kontakis G, Giannoudis PV. 2008. Minimally invasive plate osteosynthesis-an update. Current Orthapedic, 22(3): 2002-2007.

Nolte DM, Fusco JV, Peterson ME. 2005. Incidence of and predisposing factors for non-union of fractures involving the appendicular skeleton in cats: 18 cases (1998-2002). Journal of the American Veterinary Medical Association, 226(1): 77-82.

Palmer RH. 1999. Biological osteosynthesis. Veterinary Clinics of North America Small Animal Practice, 29(5): 1171–1185.

Peirone B, Rovesti GL, Baroncelli AB, Piras LA. 2020. Minimally invasive plate osteosynthesis fracture reduction techniques in small animals. Veterinary Clinics of North America Small Animal Practice, 50(1): 23-47.

Piermattei DL, Flo GL, DeCamp CE. 2006. Handbook of small animal orthopedics and fracture repair, fourth ed. St Louis (MO): Saunders Elsevier, USA.

Schatzker J. 1995. Changes in the AO/ASIF principles and methods. Injury, 26(2): 51-56.

Schmokel HG, Hurter K, Schawalder P. 2003. Percutaneous plating of tibial fractures in two dogs. Veterinary and Comparative Orthopaedics and Traumatology, 16(3): 191-195.

Schutz M, Sudkamp NP. 2003. Revolution in plate osteosynthesis: new internal fixator systems. Journal of Orthopaedic Science, 8(2): 252-258.

Schwarz G. 2005. Fractures of the tibial diaphysis, İn: Johnson AL, Houlton JEF, Vannini R. (Eds.), AO principles of fracture management in the dog and cat. AO Publishing, Davos (Switzerland), pp. 319-331.

Stoffel K, Dieter U, Stachowiak G, Gächter A, Kuster MS. 2003. Biomechanical testing of the LCP—how can stability in locked internal fixators be controlled?. Injury, 3(2): 11-19.

Tong G, Bavonratanavech S. 2007. AO manual of fracture management minimally invasive plate osteosynth esis (MIPO), first ed. AO Publishing, Clavadelerstrasse (Switzerland).

Wenda K, RunkeI M, Degreif l, Rudig L. 1997. Minimally invasive plate fixation in femoral shaft fractures. Injury, 28(1): 13-19.