



Evaluation of the Treatment of Feline Metacarpal and Metatarsal Fractures Using Dowel Pinning Technique

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ABSTRACT

This study is aimed to evaluate the postoperative results of the operations performed with the dowel pin technique in metacarpal (Mc) and metatarsal (Mt) fractures of cats, clinically and radiologically. A retrospective evaluation was carried out for 10 cats with Mc and Mt fractures by performing clinical and radiographic examinations for an average of 4.5 months after surgery using the dowel pin technique. In the evaluation, the number of fractures, fracture type and localization, fracture healing, and postoperative complications resulting from clinical and radiographic results, postoperative observations, and the animal owners' observations in the postoperative process were considered. Questionnaires made to animal owners were evaluated. Clinical and radiographic evaluation of the cats included in the study was performed. After the 12th week of the study, there was no information from two cats. Nine of the clients (90%) reported no significant change in their cat's walking after treatment. One client reported that after 4 weeks postoperatively, the cat kept its extremity at rest and suffered from persistent lameness at a minimal level. In conclusion, despite the limited case series of the study, it is seen that the dowel pin technique is a simple, economic, effective, and reliable method for the surgical healing of Mc and Mt bone fractures.

Keywords: Cat, Fracture, Metacarpus, Metatarsus.

ÖZ

Kedi Metakarpal ve Metatarsal Kırıklarının Dowel Pin Tekniği ile Tedavisinin Değerlendirilmesi

Çalışmada kedilerin metakarpal (Mc) ve metatarsal (Mt) kırıklarında dowel pin tekniği ile yapılan operasyonların postoperatif sonuçlarının klinik ve radyolojik değerlendirilmesi amaçlandı. Mc ve mt kırıkları olan 10 kedinin dowel pin tekniği kullanılarak yapılan ameliyatları sonrası ortalama 4.5 ay süreyle klinik ve radyografik muayeneleri yapılarak geriye dönük değerlendirmesi yapıldı. Değerlendirmede, kırık sayısı, kırık tipi ve lokalizasyonu, klinik ve radyografik sonuçlar neticesinde kırık iyileşmesi ve postoperatif komplikasyonlar ile hayvan sahiplerinin postoperatif süreçteki gözlemleri dikkate alındı. Hayvan sahiplerine yapılan anketler değerlendirildi. Çalışmaya alınan kedilerin klinik ve radyografik değerlendirilmesi yapıldı. Çalışmadaki 10 kedinin 2 tanesinden 12. haftadan sonra haber alınamadı. 10 hayvan sahibinden 9'u (%90), tedaviden sonra kedilerinin yürüyüşünde belirgin bir değişiklik olmadığını bildirdi. Bir kedi sahibi, postoperatif 4. haftadan sonra kedinin dinlenme esnasında ekstremitesini askıda tuttuğunu ve minimum seviyede kalıcı topallık olduğunu bildirdi. Sonuç olarak, bu çalışmadaki az sayıda hayvan bulunmasına rağmen, dowel pin tekniğinin mc ve mt kemik kırıklarının cerrahi onarımı için basit, ucuz, etkili ve güvenilir bir yöntem olduğu görülmüştür.

Anahtar Kelimeler: Kedi, Kırık, Metakarpus, Metatarsus.

INTRODUCTION

Metacarpal and metatarsal fractures are common injuries in small animals, forming 8.1% of all fractures in dogs and 3.3% in cats. These fractures usually occur due to trauma resulting from traffic accidents, falling from a height, or stepping on the extremity. It has been reported that lower extremity fractures are seen at a rate of 10% due to cat fall syndrome (Fitzpatrick 2017; McBrain Jr 2020). The fracture location (base, trunk, head of bone) and the

number of bones affected are essential criteria for deciding on appropriate treatment. Surgical operation is required to treat open fractures, dislocated and comminuted fractures, when Mc and Mt 3 and 4 fractures bear the burden of the extremity, more than 2 Mc or Mt fractures in one extremity (Muir and Norris 1997; Kapatkin et al. 2000). Since cats have minor Mc and Mt bones, many surgeons prefer external coaptation rather than open reduction and internal fixation (Rasmussen 2018). Internal fixation techniques in cats are limited to intramedullary pins, mini-



plates, and screws due to their small bone structures. Kirschner wires (K-wire) are used as intramedullary pins because of their small bone structure. K-wire is sent to the distal fragment in retrograde fashion; after reducing the bone fragments, the proximal fragment is sent retrogradely to the medulla for fixation. The operation is completed by bending the distal pin end. However, damage in the metacarpophalangeal diarthrosis is a common complication of this technique (Manley 1981; Benedetti et al. 1986) Dowel pinning is a technique that involves inserting a K-wire into the intramedullary canal in Mc or Mt fractures of small animals. This technique is performed by embedding the K-wire into the intramedullary canal by distracting the fracture fragments (Degaspero et al. 2007; Kornmayer and Matis 2017)

This study aimed to evaluate the clinical and radiological postoperative results of operations performed using the dowel pinning technique in metacarpus and metatarsus fractures of cats.

MATERIAL AND METHODS

This study has been approved by the Local Ethics Committee of Kirikkale University (decision date 08.07.2020 and numbered 31).

The study material consists of 10 cats of different races, ages, and sexes brought to Kirikkale University, Faculty of Veterinary Medicine, Department of Surgery between 2019-2021 with complaints of Mc and Mt fracture. Animal owners were informed about the operation and postoperative process to be performed on the animal. Moreover, informed consent forms were obtained from the animal owners. Animals with systemic diseases and osteoarthritis, which might adversely affect walking in the relevant extremity, were excluded from the study.

Operation Technique

Osteosynthesis was performed in closed fractures involving only one severely displaced bone and fractures involving two or more Mc or Mt bones of the same extremity. A longitudinal incision was made on the dorsal surface of the metacarpus or metatarsus over the fracture location. The soft tissue was preserved by minimal dissection near the fracture location. In this way, care was taken not to damage the tendons while exposing the broken bone. The bone fragments, which were carefully handled with Mosquito forceps, were exposed without damaging the tendon and the bone periosteum. A retrograde K-wire (08 to 1.0 mm diameter, 316l stainless steel) filling the longitudinal canal was inserted into the medullary canal of the long bone fragment and cut to protrude approximately 8-16 mm from the tip of the fracture. A K-wire in the same thickness was sent and removed again to open the medullary canal of the short fragment. The bone fragments held with Mosquito forceps were mutually distracted. The free K-wire end was placed at the medullary canal entrance, and light pressure was applied on the bones from the dorsal, and the free K-wire end was placed into the medullary canal of the short fragment. The free end of the K-wire was shortened as necessary when it was challenging to insert the free K-wire end into the medullary canal of the short fragment. After the K-wire was placed, the broken ends were gently pushed towards each other and aligned anatomically (Zahn et al. 2007). This procedure was repeated for all Mc and Mt fractures. After the fracture reduction procedure was completed, the subcutaneous tissue and skin were closed. The supported bandage was applied to the palmar

or plantar part of the relevant extremity for 4 weeks postoperatively, and the clients were advised to bring the animal for regular control while in the bandage.

The balanced electrolyte solution was administered intravenously at a dose of 10 ml/kg to all cats included in the study during the operation. Against the risk of infection, preoperative cefazolin sodium (Eqizolin: Tüm Ekip İlaç A.Ş., Turkey) was administered at a dose of 25 mg/kg preoperatively, and amoxicillin-clavulanate (Synulox; Pfizer, Germany) at a dose of 20 mg/kg for 5 days postoperatively by SC route. For analgesia, perioperative butorphanol (Butomidol; Richterpharma, Austria) was administered at IM at a dose of 0.2 mg/kg, and meloxicam (Maxicam; Sanovel, Turkey) was administered at SC at a dose of 0.2 mg/kg for 3 days postoperatively.

Evaluation of the Results

Clinical examination and radiological evaluations were performed during the follow-up period, ranging from 3 to 7 months. All animal owners were given the same questionnaire (Appendix A) (Degaspero et al. 2007) evaluating lameness, pain, and problems associated with the supported bandage or implants used after bandage removal. Follow-up radiographs of fractures were evaluated to assess fracture healing and detect complications, particularly synostosis, malunion, nonunion, and implant failures such as twisting or fracture.

RESULTS

10 cats were included in the study. 7 of them were male, while 3 of them were female. Their ages ranged from 5 to 54 months (mean±SD: 21.40±15.05), and their mean body weight was 4.02±0.77 (mean±SD) kg. In total, 33 of 36 fractures were operated; it included 12 forelimbs and 1 hindlimb. Bilateral Mc fractures were found in 3 out of 10 cats in the study. Mc III and IV bones were most frequently affected, and Mc I was never fractured. Eight cats were brought for a final clinical and radiological examination. Two cats could not be reached at the 12th week controls since they were cats fed in the garden. In total, 21 of 36 fractures healed without any complications.

The Results Reported by the Clients

During the study, all clients were contacted, and information about their postoperative status was obtained. The 7 operated cats accepted the bandage, and cats wore the bandage for 1 to 4 weeks (mean±SD: 2.56±1.13 weeks). Although 3 cats were bandaged, the bandages could not be kept in place because the cats constantly played with and removed the bandage. On the other hand, in the examinations performed, there were no signs of abnormal walking and pain on palpation in all the cats that were bandaged or not. Nine cats owners reported that their cat's walking was similar to its preoperative appearance from six weeks postoperatively. The owner of one of the cats, who did not accept the bandage, reported that the cat used its extremity comfortably after the postoperative 6th week, kept the relevant extremity upwards during rest, and there was minimal permanent lameness. A control X-ray of this animal showed that there is a malunion in one of the Mc bones. Five cats owners reported sensitivity in palpation after removing the bandage, but they reported that this situation disappeared in the following weeks.

Results of Clinical Examination

Eight cats could clinically be examined again. No abnormality was detected in the cats' dorsal Mc and Mt areas in the operation area in the examinations. There was no observable pain on palpation in the fracture areas; there was no abnormality in the cats' walking and movements.

Results of Radiological Examination

Postoperative radiographic images were obtained from all animals immediately after surgery. There were not any

complications encountered such as pin migration or bending in the radiological examinations performed in the postoperative period. During the postoperative controls about fracture healing; cats were evaluated in terms of synostosis, malunion, nonunion, implant failure, and malunion was detected in 4 fractures (11.1%), synostosis in 10 fractures (27.8%) postoperatively (Figure 1). Apart from these, there was no radiographic abnormality observed in any of the cases. In total, 22 (61.1%) fractures healed without any complication (Table 1).

Table 1. Details and clinical and radiological outcomes of 10 cats with metacarpal and metatarsal fractures treated with dowel pinning.

Ca	Age at injury (month)	Weight (kg)	Cause of injury	Bone	Fracture type	Complication	Outcome
1	5	1.2	Unknown	Mc II-III-IV-V	Proximal 1/3, midshaft, Transverse, oblique, Nondisplaced, Displaced	Synostosis between Mc II-III-IV-V, Malunion in Mc III	1
2	16	3.1	High rise syndrome	Mc II-III	Proximal 1/3, midshaft, Transverse, Displaced	None	0
3	13	2.8	High rise syndrome	Mc III-IV-V	Midshaft, Transverse, Nondisplaced, Displaced	None	1
4	16	3.6	High rise syndrome	Mt II-III-IV-V	Midshaft, Proximal 1/3, Transverse, Displaced	Synostosis between Mt IV-V	1
5	40	4.8	High rise syndrome	R Mc II-III, L Mc III-V	L Midshaft, R distal 1/3, displaced, transverse	Synostosis between L Mc III-IV, Malunion in R Mc III	1
6	27	4.3	Fall	Mc III-IV	Midshaft, Distal 1/3, Transverse, displaced	Synostosis between R Mc III-IV, malunion in R Mc IV	1
7	54	5.4	Unknown	Mc II-IV	Midshaft, Transverse, displaced	None	1
8	19	4.8	Unknown	Mc III-IV-V	Midshaft, transverse, nondisplaced, displaced	None	1
9	15	2.8	High rise syndrom	Mc III-IV-V	Midshaft, distal 1/3, displaced, transverse	None	1
10	9	1.8	High rise syndrom	R Mc III-IV, L Mc II-III-IV-V	R midshaft, L proximal 1/3, midshaft, transverse	Malunion L Mc V	1

Mc: Metacarpus, Mt: Metacarpus, L: Left, R: Right, 0: good functional outcome with mild lameness, 1: excellent functional outcome.



Figure 1. Dorsoplantar and laterolateral radiographic views of metatarsal bones before (A), postoperatively (B) and 7 months after dowel pinning of metatarsal II, III, IV and V fractures (C). Synostoses between metatarsal IV and V (C).

DISCUSSION AND CONCLUSION

Intramedullary pins are frequently used for the fixation of Mc and Mt fractures of cats and dogs. In the previous studies, some techniques using intramedullary pins to treat Mc and Mt fractures of cats and dogs have been described. One of them is to make a hole in the distal dorsal part of the Mc or Mt bone and send the K-wire intramedullary retrograde or normograde (Wind 1976; Benedetti et al. 1986). In these described techniques, the K-wire must be lightly bent to enter the intramedullary canal from the distal, and it is reported that this will create difficulty in the improvement of the pin in the cat metacarpus or metatarsus, where the bone medulla is very narrow. When the techniques described in the studies were applied, iatrogenic fracture in the bone, arthrosis damage, and permanent lameness due to these, and as a result, degenerative arthrosis disease was revealed as the most common complication if an extra hole was drilled in the dorsal bone (Degaspero et al. 2007). In another study, a different technique was introduced in the fixation of Mc or Mt bone fractures, in the form of pin placement in the bone medulla with the distraction of fragments method to prevent arthrosis damage. According to this technique, it is reported that intramedullary pin application is easier and faster, and there is no risk of iatrogenic bone fracture since there is no need to drill an extra hole in the bone (Rudy 1975). Zahn et al. (2007) used the distraction method in Mc and Mt fractures of cats and defined this technique as dowel pinning. Apart from these techniques, it has been reported that plate osteosynthesis is performed in Mc and Mt fractures, but since plate application covers a more extensive region, it will cause tendon and periosteal soft tissue damage on the bone (Degaspero et al. 2007). In this study, the distraction and pin placement technique, one of the intramedullary pins applied techniques, is applied. In the results of the study, it has been seen that while there are differences between some studies mentioned above (Wind 1976); on the other hand, it has been determined that there are similarities with some studies (Rudy 1975; Zahn et al. 2007). In the presented study results, arthrosis-related complications such as arthrosis damage or degenerative arthrosis disease were not formed. The results of the radiological examination and the information obtained from the animal owners revealed that there was no problem with walking. It is thought that this situation is related to the absence of any contact towards arthrosis while placing the intramedullary pin in the osteosynthesis technique applied.

Since the Mc and Mt bones are small bones, the wideness of the medulla is accordingly slight. Therefore, it is reported that the pins used for fixation should be thin enough to fill 70% of the bone medulla. Pins of this thickness are generally weak implants and are weak against forces acting on the bone from various directions and can bend. As a result, some complications such as rotation and movement might occur in the fragment line. For these reasons, it has been reported that immobilization should be supported since complete rigid fixation cannot be achieved in the fracture line with intramedullary pins (Roe 2005; Piermattei et al. 2006). Degaspero et al. (2007) applied intramedullary K-wire with the dowel pinning technique in Mc and Mt fractures of cats in their study and then applied a supported bandage placing support on the palmar/plantar surface of the relevant extremity for 4-6 weeks. They reported that some cats immediately removed the bandage, some cats did not react to the bandage, there was no negative situation

related to the bandage, and some fractures had malunion. Zahn et al. (2007) applied the dowel pin technique and postoperative supported bandage together in Mc and Mt fractures of cats and determined the average bandage time to be 3-9 weeks. As a result of their studies, they found that 21% malunion and 71% synostosis were formed in fracture healing. This study applied dowel pinning technique in Mc and Mt fractures of cats and supported bandage and area restriction were applied for 4 weeks postoperatively. Like previous studies, some cats removed the supported bandage quickly; the bandage was renewed or followed without bandage in the narrow area. The controls determined that the fracture healing was delayed, and malunion was formed in animals with incomplete bandage application. Especially in the healing of proximal fractures, the formation of synostosis was noted despite the support bandage. It is thought that the Mc and Mt bones are closer to each other through proximal localization. When the results compared with Zahn et al. (2007) study, it has been seen that the rate of malunion and synostosis was less. It is thought that this situation may be related to the small number of causes used in the study.

Zahn et al. (2007) reported in their study that Mc and Mt bone healing with dowel pinning and supported bandage is more effective than fracture healing with only external rupture. They deduced that this technique is non-damaging compared to other intramedullary pin techniques that may damage the arthrosis. On the other hand, Degaspero et al. (2007) reported that the results of the dowel pinning technique were positive, and the recovery rate in the Mc and Mt bones in animals was 86%. In this study, lameness was not observed in any cats, except for one who removed the postoperatively supported bandage. It is determined that the success rate of the dowel pinning technique in Mc and Mt fractures is 90%.

In conclusion, it was determined that the surgery of metacarpus and metatarsus fractures using the dowel pinning technique is a simple, economic, and reliable technique. Moreover, it is thought to be preferable over other techniques because it does not cause arthrosis damage and possible iatrogenic fracture by opening an extra hole in the bone.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

Idea / Concept: BK
 Supervision / Consultancy: BK
 Data Collection and / or Processing: BK
 Analysis and / or Interpretation: BK
 Writing the Article: BK
 Critical Review: BK

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