RESEARCH ARTICLE

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A Retrospective Study on The Evaluation of Hind Limb Bone Fractures in Cats

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Abstract

As a result of many traumatic factors such as traffic accidents, falls from height, gunshot wounds and animal fights with each other, orthopedic and soft tissue damage, especially fractures, occur in the musculoskeletal system. Among the fractures within these lesions, the incidence of hind limb long bone fractures is higher than other bones. While the incidence of femur fractures among other fractures in cats is 20-26%, tibia fractures constitute a significant proportion of approximately 20% of other fractures. This study aimed to retrospectively evaluate the distribution, etiology, treatment, and treatment results of fractures in cats with hind limb bone fractures (n=92). In addition to the use of intramedullary nails and plates, external fixators are also used for the treatment of hind limb bone fractures. Despite the advantages and disadvantages of each technique, most of the time no problems are observed during the application of these techniques and in the postoperative period. A functional recovery was observed in all cats at postoperative follow-up. As a result, it can be said that the method to be used in hind limb bone fractures in cats varies according to the surgeon's preference, experience, and existing orthopedic material inventory. However, anatomical locking plates have the advantages of not using postoperative bandages and allowing the limb to be used early.

Keywords: Cats, external fixator, femur, fracture, intramedullary pins, plate, tibia.

INTRODUCTION

Lesions that occur due to disruption of the integrity of bone tissue are defined as fractures. Fractures and their treatment constitute the most important part of veterinary orthopedic practice. Many different fixation techniques have been developed in fracture treatment. The main goal in all of these is to ensure fracture healing in the most accurate way in the shortest time (Şen et al., 2015).

Traumatic situations such as traffic accidents, falls from height, gunshot wounds and other animal attacks are the main cause of fractures in cats, as in many animals (McDonald et al., 2017; Sağlam et al., 2019). Among all fracture cases, femur fractures constitute 20 to 26 percent, while tibia fractures represent 20 percent (Langley-Hobbs et al., 1996; Sancak et al., 2014).

Traumatic fractures vary depending on the intensity of the impacting force and the ability to absorb them. It can vary from a small crack to a fracture in one or more bones to dislocation in the adjacent joints (dislocation with fracture). The force that creates a fracture may not only cause a fracture in the bone, but also injure the skin, muscle, vessel, tendon, ligament, nerve and adjacent tissues and organs around the bone (Sağlam et al., 2019).

The reason for fractures in the hind limbs in cats can be instinctively associated with survival. The risk of mortality is low in cases where the caudal part of the body is exposed to trauma, and cats tend to use their hindquarters to absorb the force of the traumatic factor at the time of trauma (Cardoso et al., 2016).

The basic approach to a patient exposed to trauma should include rapid assessment of respiratory, circulatory and neurological conditions without stressing the patient (Zurita M, 2022).

Clinical, neurological and radiological examinations of hind limb-related cases in cats must be performed carefully and in detail. While a traumatic effect creates a lesion in the area it directly affects, each case should be systematically examined for other possible lesions. The treatment method should be decided by taking into consideration the type of fractures, their localization, displacement status, and the temperament of the patient (Sağlam et al., 2021).

This study aimed to retrospectively evaluate the distribution, etiology, treatment, and treatment results of fractures in cats with hind limb bone fractures (n=92).

MATERIALS AND METHODS

In this study, 92 cats of different ages, breeds and genders with hind limb fractures were evaluated between 2021 and 2023 at Dicle University Faculty of Veterinary Medicine Department of Surgery.

The study was conducted based on clinical examination findings, radiographic findings and treatment results. A clinical follow-up form was created for each

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patient, and these forms included the patient's description, the cause of the fracture, treatment, and outcome information. First, a detailed clinical examination was performed on each patient, and then bilateral (mediolateral or laterolateral and ventrodorsal or craniocaudal) radiographs were taken. Following the identification of the fracture(s) on the radiograms, a surgical treatment was planned. Since fracture patients had a history of trauma, a general trauma protocol (Airways-breathing-circulation (ABC) assessment) was applied and patients who needed oxygen support were supported with an oxygen cage or intensive care cabin.

All operations were performed under general anesthesia. 1 mg/kg IM (intramuscular) xylazine was injected as a premedication and 15 mg/kg IM (intramuscular) ketamine was injected as a general anesthetic. Additionally, maintenance anesthetic (ketamine) was administered at half the initial dose for long operations. For pain management, meloxicam SC (subcutaneous) was administered preemptively as a single dose of 0.3 mg/kg. In addition, 0.9% NaCl solution was given IV at a dose of 10 ml/kg/hour to each anesthetized animal during the operation period. In addition, cats were routinely monitored with VAS and Glasgow (as previously defined Teixeira et al., 2020) pain scale in the first 24 hours postoperatively, and 0.3 mg/kg meloxicam was administered postoperatively to those requiring analgesics. In the postoperative period, antibiotics (35 mg clavulanic acid, 140 mg amoxicillin) were recommended to the patients for 5 days.

Table 1. The types of fractures and the treatments applied.

Broken bone	**Fracture type**		**U/B, M**	**Applied treatment**	**Treatment result**			
					+++	++	+	-
Femur	Proximal n=7	3 caput	3 U	Resection	3	-	-	-
		1 collum	1 U	Resection	1	-	-	-
		1 trochanteric	1 U	K wire tension band	1	-	-	-
		2 subtrahonteric	2 U	2 Pin	1	-	1	-
	Diaphyseal n=14	7 spiral	7 U, 3 M	7 Pin	3	2	1	1
		2 transversal	2 U, 1 M	1 Pin	-	1	-	-
				1 plate	1	-	-	-
		3 oblique	3 U	1 Pin	-	1	-	-
				1 plate	-	1	-	-
				1 external	-	1	-	-
		2 multiple	2 B	2 Pin+ cerclage	-	2	-	-
	Distal n=33	19 supracondylar	4 B, 15 U, 3 M	5 Pin (rush or cross)	-	3	2	-
				14 Plate	7	4	3	-
		14 condylar (Salter Harris I-IV)	14 U	6 Pin (rush or cross)	1	2	3	-
				8 L plate	3	5	-	-
Patella	-	-	-	-	-	-	-	-
Tibia/fibula	Proximal n=3	3	3 U	2 cross pin	2	-	-	-
				1 Plate	1	-	-	-
	Diaphyseal n=27	3 spiral	1 B, 2U	3 plate	2	1	-	-
		7 oblique	7U	4 plate	2	2	-	-
				3 External	2	1	-	-
		8 transversal	8U	8 plate	3	4	1	-
		9 multiple	7 U, 2B	6 pin	3	2	1	-
				3 plate	1	2	-	-
	Distal n=14	14	13U, 1B	6 cross pin	1	4	1	-
				7 T-L plate	6	1	-	-
				1 pantarsal arthrodesis	-	1	-	-
Tarsus		1 calcaneus	1 U	1 K wire tension band	-	1	-	-
		6 talus	5U, 1B	6 pantarsal arthrodesis	4	2	-	-
Metatarsus		3	3U	3 Pin	-	3	-	-
Phalanx		4	4U, 2M	4 Pin	-	3	1	-
Total	112 fractures (92 cats)		23 bilateral, 69 unilateral	Pin: 45, Plate: 50, External: 4, Tension band:2	+++: 48, ++: 49, +: 14, -: 1			

U: Unilateral, B: bilateral, M: Multiple, +++: very good recovery, ++: good recovery, +: poor recovery, -: fair recovery
**Multiple unilateral or bilateral fractures may occur in an animal at the same time.*

After the preparation for the operation was completed, the patients included in the study were placed in an appropriate position according to the location and condition of the fracture. Asepsis-antisepsis of the area was ensured and the area was limited with sterile drapes. Then, a suitable technique among intramedullary pin application (Figure 1A), plate osteosynthesis (Figure 1B) and external fixation techniques (Figure 1C) was performed and records were taken. In intramedullary pin applications, the extremity was kept in a protective bandage for 10 days.

Figure 1. Image of some of the cases; A-intramedullary pin application, B-plate osteosynthesis and C- external fixation techniques.

Postoperative outcomes were followed and results were very good (+++: no lameness and normal gait), good recovery (++: mild lameness after intense exercise), poor recovery (+: stepping on but moderate or mild lameness), and fair recovery (-: non-bearing lameness). Additionally, postoperative complications were categorized as complications related to the applied technique, complications related to the implant, and complications related to the patient.

RESULTS

The average age of the cats evaluated within the scope of the study was determined to be 1.89 ± 1.66 (min: 035, max 11) years old. Their breeds were 67 tabby cats, 1 Persian cat, 5 Van cats, 2 Angora cats, 6 British Shorthairs and 9 Scottish Folds. Additionally, 48 of these cats were female and 44 were male (castrated or not). The weight of the cats was calculated as 3.46±1.50. According to the information in the study records, the etiologies were observed as falling from height in 62 cases, traffic or vehicle accidents in 21 cases, other animal attacks in 3 cases, and unknown causes in the remaining 6 cases.

The depth and duration of anesthesia during the operation were sufficient to complete the operations.

According to the information obtained from the study data, the types of fractures and the treatments applied are given in Table 1.

Postoperative follow-up showed poor recovery in 11 cats, and 3 of them had bilateral fractures. Additionally, only unilateral pin migration was observed in 1 cat whose bilateral condylar fracture was treated with rush pin application, and a functional recovery was observed after re-fixation with an L plate. Nonunion was observed in 1 cat with diaphyseal femur fracture, and clinical recovery was poor. No complications such as fracture or bending of the implant were observed in all cats, and no complications related to infection or wound area were observed. However, there were 8 cats that had regional atrophy and mild circulatory impairment due to the bandage. Additionally, pin base infection was observed in 2 of 4 cats that received external fixator.

DISCUSSION AND CONCLUSION

Recently, especially after the pandemic, there has been a significant increase in the number of animals being cared for at home. Parallel to this increase, there is a significant increase in the number of animals exposed to trauma. Although bone fractures are one of the lesions seen in animals exposed to trauma, it is also a frequently encountered condition in domestic animals (Sağlam et al., 2021; Özden, 2022). Long bone fractures in cats occur most often in the hind limbs. In cases where the caudal part of the body is exposed to trauma, immediate trauma management is required, even if the risk of mortality is low. In addition, cats tend to use their hindquarters to absorb the force of the traumatic agent at the time of trauma (Scott, H., 2005; Cardoso et al., 2016, Gülaydın and Alkan, 2023). The incidence of fractures is especially high in the femur and tibia bones that form the hind extremity. The distribution of observed femur fractures constitutes 20-26% of all fracture cases. Tibia and fibula fractures are encountered in 20% of general fracture cases. This is due to the fact that the area is surrounded by anatomically weak soft tissue and the body weight is given to the rear extremity at a higher rate (Yardımcı and Çetinkaya, 2007). In this study, it was aimed to retrospectively evaluate the fracture cases occurring in the hind limb bones in cats using different osteosynthesis techniques such as intramedullary pin, plate osteosynthesis, external fixator and tension band, and evaluating the clinical and radiographic findings in the postoperative period, the degree of healing and the complications that occurred.

Many factors that directly affect cats are known to cause trauma, especially traffic accidents and falls from height. It has also been reported that animal fights with each other and traumas of unknown origin are also effective in the formation of fractures (Sağlam et al., 2021). In this study, the cause of hind limb fracture was determined as 67.39% falling from height, 22.83% traffic accident, 3.26% other animal attack and 6.52% trauma of unknown cause. It is thought that traffic accidents, high-rise buildings and hot climate in a big city like Diyarbakır are effective on this situation.

Fractures occurring in the femur can be classified as proximal, diaphyseal and distal fractures. Caput femoris, collum femoris, trochanteric and subtrochanteric fractures can be considered as proximal fractures. It is possible to classify diaphyseal fractures as spiral, transversal, oblique, simple and comminuted fractures. Supracondylar and condylar fractures are included in the classification of distal fractures and can be classified in their own way (T, Y or Salter Harris I-V) (Robetson and Meeson, 2022). In a study on the subject (Piermattei et al., 2006), it was reported that femur fractures were more common than other bone fractures in the whole body. However, the classification of fractures in the tibia is simpler and is generally classified as proximal, diaphyseal and distal (Sancak et al., 2014). In the study, a total of 112 fractures, unilateral or bilateral, were observed in 92 cats. These fractures were 48.21% in the femur, 39.29% in the tibia, 6.25% in the tarsus, 2.68% in the metatarsus, and 3.57% in the phalanx. Of the 54 femur fractures, 12.96% occurred in the proximal femur, 25.93% occurred in the diaphysis of the femur, and 61.11% occurred in the distal femur. It was observed that 6.82% of the tibia fractures occurred in the proximal tibia, 61.36% in the diaphysis of the tibia, and 31.81% in the distal tibia.

Fractures that may occur in bones will lead to structural and functional changes in the musculoskeletal structure and may lead to permanent defects if appropriate treatment is not applied. A number of factors, such as the condition of the fracture, the surgeon's experience, the structure of the broken bone, the patient's age, weight, and soft tissue damage accompanying trauma in the area, have an impact on the choice of fixation technique for treatment. The selected technique should provide adequate stabilization of the fracture fragments throughout the healing process and cause minimal adverse effects during the healing period, and the extremity should return to normal or near-normal function after the fracture has healed (Scott H, 2005; Yayla et al., 2022; El-shafey et al., 2022). Both conservative and surgical methods have been developed to treat hind limb fractures in cats. Surgical methods include external and internal operation techniques using different materials. In general, in patients with intramedullary pin application, the pin cannot resist rotational forces and a supported bandage is needed to prevent pin migration (Yayla et al., 2022). On the other hand, external fixators are easy to apply, durable and easily available, and the operation time is shorter than internal fixation methods, but since they are applied percutaneously, the incidence of pin base infection and osteomyelitis in the area where the pins are located is high (Sağlam et al., 2019). In this study, the external fixation method was applied in 4 cases (%13.39), while the internal fixation method (50 plates, 45 pins, 2 tension bands, 7 arthrodesis) was applied in a much larger number of cases. For internal fixation, plate osteosynthesis was applied in 44.64%, intramedullar pin in 40.18%, tension band in 1.29% and pantarsal arthrodesis in 5.36%. Apart from these procedures, caput resection was deemed appropriate for 4 patients (3.57%) with unilateral caput or collum fractures located on the proximal femur. While planning the method, the type and location of the fracture in the bone, the experience of the surgeon, the age of the patient, the preference of the patient owner and the economic situation were taken into consideration. In addition, PVC-supported bandage was applied to 45 patients who received intramedullary pins for 10 days in order to prevent pin migration and to provide the stability of the bone ends. During clinical examination, bandage complications such as muscle atrophy and edema due to mild circulatory disorders were detected in 8 of 45 patients (17.78%). For this reason, in cases where bandage application is required, necessary precautions should be taken considering the possible complications that may be encountered after the bandage.

While the craniolateral approach is preferred in the treatment of femur fractures, the medial approach is frequently used in the treatment of tibia and tarsus fractures. Although approaching the femur from the craniolateral side is beneficial in reducing the risk of complications by providing easier access to the region and minimal tissue damage, if a medial approach is preferred for the tibia, it is especially for the protection of vessels and nerves and to minimize the destruction of thin muscle tissues. In addition, in case of fractures of the distal bones, it is very important not to cause vascular damage during transportation to the region in terms of local blood supply and nutrition of the region in the postoperative period (Piermattei et al., 2006). We also preferred a craniolateral incision for the femur in our surgeries. The tibia and talus were approached through a medial incision. For other distal bones of the extremity, they were approached from the cranial side. It was extremely easy to reach the fracture line during the operations. In the operations performed in our study, no abnormal bleeding, anesthesia complications, or any complications related to technical equipment were observed during the intraoperative period. In the 50 patients to whom the plate was applied, it was observed that the patients used the relevant extremity and started walking within the first 2 postoperative days. No complications related to screws, plates or gait were encountered in these patients, who were called for control examinations at regular intervals. Bandage-related complications were observed in 8 of 45 patients to whom PVC-supported bandage was applied to prevent pin migration during pin applications. Although these complications have been eliminated, the need to support postoperative period with a bandage can be considered a significant disadvantage compared to plate. In addition, pin base infection developed in 2 of 4 cases in which external fixation was used, and as noted in the literature, this situation should be taken into consideration in external fixator applications. For this purpose, the patient owner should be informed about complications such as pin root infection and osteomyelitis in the postoperative period and asepsis of the area should be ensured. Additionally, in one of our cases with bilateral distal femur fractures, both fractures were intervened with a rush pin, but it was determined that nonunion developed as a result of pin migration in one of the fractures. In this fracture, the migrating pin was removed and a locking L plate was placed in its place, and healing was achieved without any problems.

In some studies (Gorse et al., 1991; Johnson et al., 2005), arthrodesis is defined as 'irreversible surgical fusion of two or more bones in a joint'; Indications for pantarsal arthrodesis include irreparable joint fractures of the distal tibia or talus, unstabilizable tarsocrural luxations, severe instability of the tarsus, and end-stage degenerative joint disease. In this study, for the pantarsal arthrodesis applied to the tarsus, the angle of the tarsus was adjusted to 100-125 degrees and the tarsus was immobilized with a locked 'V' plate, which is an internal fixation method. During the examination of the patients who were called for control, their gait was evaluated and no complications were found.

As a result, many different methods are used in hind extremity fractures depending on the location of the fracture, the patient's condition and the surgeon's preference. Among these, it is possible to use external and internal osteosynthesis techniques or their combinations. However, it can be said that plate osteosynthesis provides a significant advantage in terms of fewer complications and earlier recovery compared to bandage applications applied with external fixators and pins.

Conflict of Interest

The authors declare that they have no competing interests.

Authorship contributions

Concept: R.C., S.Y., Design: S.Y., E.C., B.E.K., N.S., S.A., Data Collection or Processing: R.C., S.Y., N.S., Analyses or interpretation: R.C., S.Y., Literature Search: R.C., Writing: R.C., S.Y.

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