Chapter 01: Introduction

A fracture is damage to bone tissue that results in the loss of continuity and balance of the bones. A fracture can be caused by external trauma, which is known as a trauma fracture, or by a disease, which is known as a pathological fracture. Fractures have become far more common in veterinary practices (Aithal et al., 1999). The increase in incidence is due to an increase in the number of automotive vehicles on the road, which leads to motor vehicle accidents and road traffic accidents. Falls, battles, and gunshot wounds can all cause it. Fractures of the hindquarters are the most common, accounting for 73% of all fractures affecting the hind limbs, pelvis, or sacrum (Scott, 2005). Pelvic fractures account for 20 to 30% of all trauma-induced fractures (Betts, 1993; DeCamp, 1992).The fracture of a long bone is a common orthopaedic problem in both canine and feline practice. Long bone fractures account for half of all feline fractures, (Scott et Al, 2007) and the femur is one of the most commonly fractured bones in both dogs and cats (Johnson et. al, 1989). It was also shown that 45 percent of all long bone fractures are femoral fractures, and 28 percent of all long bone fractures are femoral diaphysis fractures (Harasen, 2003). According to another study, the femur (42.86 percent) had the most fractures, followed by the humerus (25.40 percent), radius and ulna (20.63 percent), and tibia and fibula (11.11 percent) (Das et. al, 2010). There will be different fracture patterns depending on the loading forces that the bone is subjected to, such as compression, bending, tension, or torsion (Hulse and Hyman 1995). The type of fracture and the degree of soft tissue injury are also affected by the rate of force application (Johonson, 2007). Fractures caused by minor trauma may be related to an underlying pathological disease, the most prevalent of which is neoplasia. Origins, anatomical position, morphology, severity, whether or not the fractured bone is exposed to the external environment, the extent of bone injury, reducibility, and stability are among the different fracture classification systems (3-5, 7, 10). Capital physeal, femoral neck, trochanteric, subtrochanteric, diaphyseal, supracondylar, condylar, or distal physeal fractures are all types of femur fractures. In immature cats and dogs, femur fractures most commonly occur in the proximal or distal physis. In case of Long bones' metaphyseal, diaphyseal, and epiphyseal portions may be affected (Tercanlioglu and Sarierler, 2009; Shiju et al., 2010). The term 'complicated' refers to any fracture that is difficult to heal. However, the word is most usually used to characterize a comminuted (multifragmented) diaphysis fracture in which the predominant proximal and distal fragments do not make contact after reduction (Clayton-2006). High-energy impact produces complex fractures: when a huge amount of force is applied to bone quickly, the bone absorbs a large amount of energy before finally 'blowing' apart and dissipating the energy into the surrounding soft tissues. This causes significant soft tissue devitalization, which makes infection and fracture healing more difficult. Cats are prone to complicated fractures, which are caused in part by their small body size and propensity to stray into the path of vehicles. Furthermore, unless there is a penetrating injury such as a gunshot wound, most femur fractures are closed due to the heavy overlaying muscle. The evaluation of a femur fracture is crucial to the effective treatment planning. Palpation and radiography are both effective tools for identifying fractures in cats. It should be evaluated for fracture position, whether open or closed, kind of fracture, joint involvement, and distal fragment displacement direction. The principles of biological osteosynthesis or anatomic reduction and stabilization can be used to treat femoral fractures. Depending on the technique adopted, the surgical approach will differ. In less severe cases, however, cats can typically be restored to healthy condition utilizing less invasive treatments rather than undergoing extensive reconstructive surgery. The general concept of is to return two fracture fragments to their anatomical positions utilizing closed fixation or open fixation via surgery. Long bone fracture repair can be accomplished with a variety of devices, each with its own set of benefits and drawbacks. These include the lag screw, intramedullary pin, bone plate and screw, interlocking and cross pin, dynamic compression plate, and cerclage wire (Perren, 2002; Horstman et al., 2004). Intramedullary pins, plates, screws, and wires are popular internal fixation devices used in fracture treatment (Mafi et al., 2014; Mwangi and Mande, 2012).

Intramedullary pinning is a popular form of long bone fracture repair in cats (Scott, 2005), and it can be used to treat practically any type of fracture, even severely comminuted diaphysis fractures (Denny and Butterworth, 2000). Pin insertion is technically simple, and the necessary equipment and implants are inexpensive and widely available. Feline femur is a tubular bone that is straight and has a big medullary canal. The pin should occupy around 70% of the diameter of the medullary canal, there is a substantial extra osseous blood supply, which aids in quick recovery. The diaphysis and distal shaft are involved in the majority of fractures. On the tension side of the bone, implants are placed laterally.

There is a prevalent misunderstanding that feline long bone restoration is straightforward and does not have the same issues as dog long bone repair. It has been suggested that if two cat bone fragments are brought together in the same room, they will heal. Unfortunately, clinical experience and studies have revealed that cats are susceptible to the same range of issues as dogs. The cat's capacity to compensate for reduced function may have given rise to the assumption that feline fracture recovery is simple. The objective of this case report is to discuss the clinical and radiological assessment of a femoral fracture in a cat, as well as effective fracture stabilization with C-arm guided intramedullary pinning.

Chapter 02: Methods, Materials and Results

2.1 Case History and observation

The study was performed at Surgery Unit, Teaching and Training Pet Hospital and pet hospital and research centre (TTPHRC) of Chittagong Veterinary and Animal Sciences University (CVASU), Chittagong in June 2021. An approximate 3-month-old female of a 2.2 kg body weight cat was carried to Pet hospital (TTPHRC) with a history of falling from the 5th floor of a building. Before going to the hospital, no conservative or supportive treatment was given. The cat was active, awake, and had normal defecation, urination, and no external injury in the affected limb was revealed after clinical examination. Orthopaedic examination on involved bone by inspection and palpation showed non-weight bearing pain, swelling and crepitation.

2.2 Radiographic examination

Radiological investigation was performed on lateral view by using a digital x-ray machine which confirmed that the cat was suffered from a complete transverse distal diaphyseal fracture of the Right femur. (Fig.1).

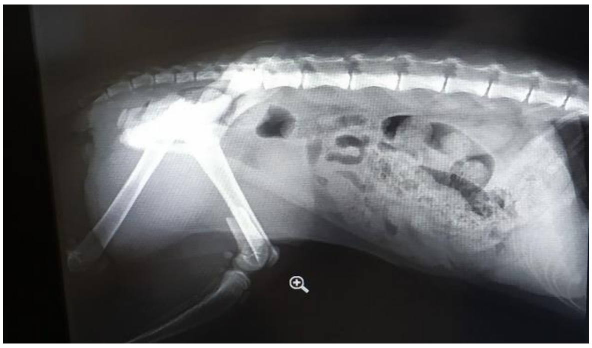


Fig 1: X-ray view of affected limb

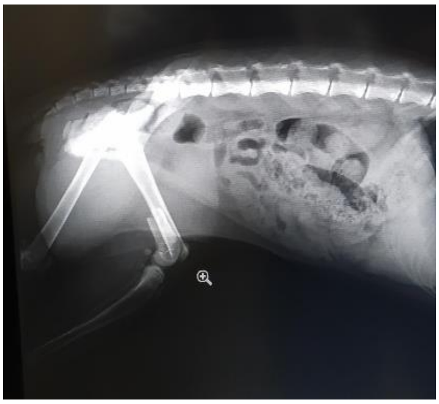
Neurological examination found positive conscious proprioception. It was performed while the cat was standing with the limbs in a normal position, the toes were turned over and released, in positive reflex, and the cat showed immediate return the toe in normal position. The cat also shows a deep pain reflex that is performed by applying pressure on the toe web by artery forceps. Based on the clinical condition of the cat and fracture patient assessment score (FPAS), the surgeon decided to open reduction internal fixation (ORIF) by intramedullary pinning to correct the fracture.

2.3. Control and Anaesthetic Protocol

Pre-surgery clinical examination indicated that the cat was in stable condition. Physiological parameters (temperature, heart rate, respiratory rate, and mucosal membrane) and blood and other biochemical profile was within the normal value. The patient was off feed 12 hours before surgery. Both physical and chemical methods were used to restrain the cat. At first, the cat was positioned in lateral recumbency. It was given Atropine sulphate (0.04 mg/kg body weight intramuscularly) as a form of premedication. Then the cat was sedated with Xylazine hydrochloride (1mg/kg body weight intramuscularly), which was given 5 minutes after premedication. General anaesthesia was performed by Ketamine hydrochloride (10mg/kg body weight intravenously). Clipping and shaving did and the patient prepared aseptically by using Chlorhexidine, 10% povidone-iodine and 70% alcohol. Fluid was administered as 10ml/kg/hour during surgery.

2.4.Surgical Procedure

In Operation Theatre, the cat was positioned on the table. A draper was wrapped over the surgical site. The incision line was mopped with povidone-iodine before incision, and an incision was made along the skin of the afflicted area and separated from the subcutaneous layer. After that, the muscle was incised, taking care not to cut any major blood vessels. Following muscle separation by blunt dissection, the muscle layer was incised and a cut guided by a finger placed under the bone fracture was made. The fractured bone's portions were then removed using a bone curette and bone cutting forceps. The Hohmann retractor was used to return the bone to its original position. After that, a bone drilling machine was used to drill the bone. Retrograde intramedullary pinning with a 3.0mm Steinmann pin was used fixation of the fracture. The muscle was then sutured with a simple continuous catgut suture. The skin was positioned using silk by cross mattress stitch, and the subcutaneous tissue was positioned using catgut in a simple continuous pattern. Povidone iodine was used to clean the suture line. During operation, 200 mL of 5 percent dextrose in normal saline was given intravenously. The leg was then covered in a soft cotton bandage to immobilize the damaged area.

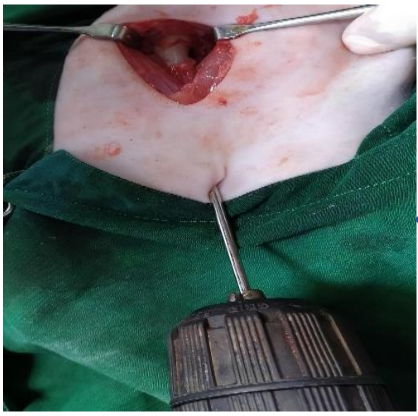


Radiological Examination

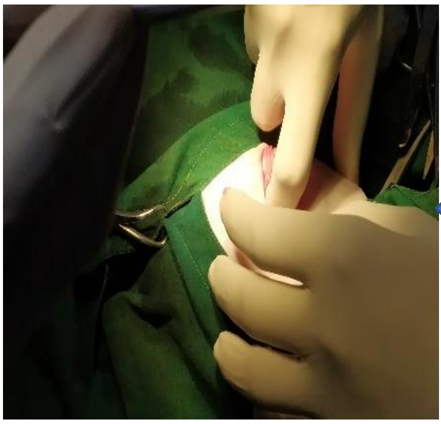
Shaving

Preparing for surgery

Make Incision



Muscle separation



Locating fracture of the bone

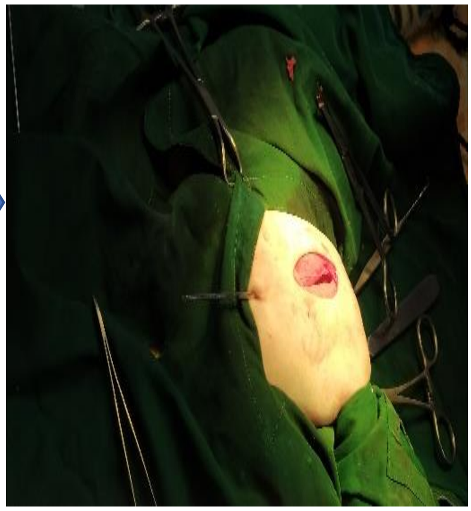
Fractured bone

Positioning of the pin

Set up pin in the drill

Removing bone fragments

Drilling Intramedullary Pin



After inserting pin

Suture in the muscle

Suture in the skin

Complete suturing

X-ray after surgery

Radiograph

Cutting the extra pin

Disinfecting after surgery

Bandaging the suture

After complete surgery

Fig: 2 Demonstration of the technique of surgical management of the femur fracture in cat

2.5 Blood Test

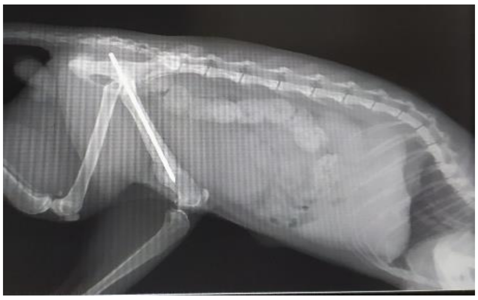
Blood samples were collected before and after surgery and examined different blood parameter levels. Some blood parameters were firstly normal, after surgery it increased or decreased that followed the 14th and 28th day after surgery. The following blood laboratory parameters were determined;

Table 01: Different Laboratory Parameters before and after surgery

Name of the test	Normal Range	Result		
		Before Surgery	15th days after surgery	30th days after surgery
Hemoglobin	9.8-15.4g/dl	8.8	9.1	9.3
Albumin	2.8-3.9g/dl	5.57	9.27	11.67
Alkaline Phosphatase	0-45U/L	70.2	191.7	186.7
Calcium	8.7-11.7 mg/dl	11.9	8.7	11.6
Phosphorus	3.0-6.1 mg/dl	6.6	7.7	9.2
Total Protein	6.0-7.9g/dl	5.8	5.4	6.1
PCV	30-45%	27.8	28.5	28.9
Total count of RBC	5.0-10.0 (*10^6/µl)	5.4	4.7	5.0
Total count of WBC	5.5-19.5 (*10^3/µl)	12.5	13.1	11.7

2.6. Post-operative Care

The cat was kept under observation for five days to see whether there were any complications. Fluid replacements were given to the cat after surgery. Antibiotics (ceftriaxone) were given intramuscularly for five days, anti-inflammatory medications (Meloxicam) were given subcutaneously for three days, and antihistaminic (Pheniramine maleate) were given intramuscularly for five days. For 15 days, a calcium supplement (Calbo-D) and vitamin B2 (Neuro-B) were given orally. The recommendation was to apply a cold compress to the affected area for three days and limit activity for two weeks. The owner was advised to maintain the surgery area dry, neat, and clean, and to bring the patient in for follow-up exams at regular intervals. The following parameters were assessed at regular intervals to determine the patient's surgical efficacy: lameness grade, functional limb outcome, and fracture healing. After 14 days, the sutures were removed. The radiographic evaluation was continued until the fracture had healed completely.



14th day after surgery

28th day after surgery

Fig 3: Post-operative care

Chapter 3: Discussion

Femoral fractures are rather common in cats, accounting for 20 to 26% of all fractures (Whitehair & Vasseur 1992). This could be due to survival ability, as wounds to the caudal half of the body are less likely to be fatal, or self-defense, as the animal uses its hindquarters to absorb the main impact force when trauma is imminent (Harasen, 2003). Trauma, car accidents, and jumping from high heights are all common causes of damage. Our study expressed that falling from the 5th floor was the cause of fracture in the femur of the cat. Because of the underlying musculature, most femoral fractures are closed (Beale 2004). According to Phillips (1979), the majority of occurrences occur in healthy animals under the age of three, which is similar to our findings. They will gradually recover with conservative management (Denny, 1978). Different fracture patterns are produced when supraphysiologic forces (compression, tension, bending, and rotation) are applied to bone columns. (Hulse and colleagues, 1997). Internal bone pressures and strains can also cause comminuted, oblique, or transverse fractures to collapse and displace further. The ability of the fixation to successfully neutralize distractive pressures at the fracture site and promote bone union is thus a factor in the choice of an implant or external splintage.

According to Mwangi and Mande (2012), a correct surgical approach, limiting tissue injury, proper stabilization, selecting implant material and its implementation (fixation), and post-surgery care are all things to keep in mind during fracture rehabilitation, according to Mwangi and Mande (2012). Femur fractures are rarely susceptible to conservative treatment, involving the use of an internal fixator. Closed reduction and stabilization can help some femoral fractures heal faster and with less patient morbidity if done correctly. The most common procedure is open reduction and stabilization, which is usually successful if basic repair principles are followed. Appropriate surgical approach, preservation of regional soft tissues and their attachments to bone fragments, either anatomic or indirect reduction, adequate stabilization, appropriate choice and application of implant system, and proper postoperative care are all important factors in femur fracture repair. The femur is the most suited long bone for the insertion of intramedullary devices due to its structure. Intramedullary pins are recommended, however, whether these implants are inserted normograde or retrograde, great care should be given to minimize iatrogenic damage to the sciatic nerve around the greater trochanter. Most fractures involve the femoral diaphysis, according to a study (Schrader et al, 1994), which is comparable to ours. Distal fractures involving the supracondylar or condylar (physeal) regions can be approached laterally, with the patella deflected medially to allow retrograde pinning of the fragments proximally into the shaft (Harari et. al, 1996). Pin diameters of 1.6 mm to 4.8 mm are adequate for use in most cats, and the pin should fill roughly 70% of the diameter of the medullary canal, although the larger the pin, the greater the rigidity of the repair and implant strength in general. Pins with a smooth shaft and a trocar point on each end are perfect. An intramedullary pin rarely provides adequate fracture stability when used alone; however, when used in conjunction with cerclage wiring procedures, it can be used successfully for certain reconstructable comminuted, long oblique, or spiral fractures.

The feline femur is a long, straight tubular bone protected on all sides by muscle. Rapid healing is aided by a large medullary cavity and sufficient perosseous vascular supply. Fracture site stability and vascularization are essential for bone repair (Remedios, 1999). Because of variables such as patient age, kind of damage, and technique of fixation, including cancellous grafting; determining feline fracture healing rates and criteria for radiographic assessment is difficult (Johnson, 2010; Langley-Hobbs et al, 1996; Ross et al, 1993). Young animals' bones heal faster than older animals' bones (Stubbe et al. 2008), and this was also observed in our investigation, with the patient recovering faster. Numerous arteries perforate newly formed appositional bone in immature animals, running longitudinally over the periosteal surface (Johnson et al. 1998). Immature (less than a year old) cats should be checked every 2 to 4 weeks, whereas young (1–5 years old) and middle-aged (6–10 years old) cats should be checked every 4 to 6 weeks. Aged patients should be re-examined every 6 to 8 weeks. Femoral fractures in heavier cats heal at a slower rate. This could be owing to the additional stresses placed on the fracture throughout the recovery period. It takes longer for more complicated fractures to heal. This was to be predicted, as comminuted fractures are more likely to have high-energy fractures with vascular and soft-tissue damage, all of which have a deleterious impact on fracture healing (McCartney & MacDonald 2006). When callus production stops, serum ALP activity, as well as calcium and phosphorus levels, revert to normal. Komnenou et al. (2005) discovered a link between total serum alkaline phosphatase levels and the healing of long bone fractures in dogs, which is also consistent with our initial follow-up investigation. Further follow-up results will show whether the fracture union occurred properly.

Limitations

This discussion is based on a patient follow-up about 28 days following surgery in which the owner was not interested in thoroughly inspecting the cat. Furthermore, because the cat was not properly rested, the pin shifted significantly away from the bone's predicted position. However, after a few days, the cat returned to normal, and after 25 days, it was able to fully carry its weight.

Conclusion

Fracture repair is not without complications and Surgeons, on the other hand, can reduce the likelihood of these problems. Appropriate surgical procedures and right diameter/size pins, preservation of regional soft tissues, adequate stabilization, and proper postoperative care are all important variables in femur fracture repair. If basic principles of repair are followed, open reduction and stabilization of femur fractures using intramedullary pins is a safe, affordable, and effective therapeutic option.

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Biography

I am Ifteqar Hassan, son of Ahasanul Hoque and Kamrun Nahar. I passed Secondary School Certificate examination from Chattogram Government High School, Chattogram in 2012 (G.P.A-5.00) followed by Higher Secondary Certificate examination from Chattogram College, Chattogram in 2014 (G.P.A-5.00). Now I am an intern veterinarian under the Faculty of Veterinary Medicine in Chattogram Veterinary and Animal Sciences University, Bangladesh.

Bangladesh is a developing country in South Asia where livestock plays a very important role in our economy as well as the food chain. I expect to be a future researcher of life science to address the present challenges we have in this field.