

Surgical Management of Comminuted Distal Femoral Fracture Using Intramedullary Pin in a Cat

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Abstract

A 3-year-old male domestic short-haired cat, weighing 3.8 kg, was presented with lameness, swelling in the left hind limb groin area, and pain upon palpation. Radiographic examination confirmed a comminuted fracture in the diaphysis of the left femur. This case report aims to document the diagnostic approach and surgical management using an intramedullary pin technique. Surgical intervention was performed to restore the anatomical alignment of the fracture fragments. The procedure involved open reduction and internal fixation using an intramedullary pin. Post-operative medication included tramadol (1 mg/kg BW) for analgesia, ceftriaxone (25 mg/kg BW) as antibiotic therapy, and dexamethasone (2 mg/kg BW) for anti-inflammatory effects. Femoral fractures account for 20-26% of fractures in cats, with various treatment options available including pins and wires, Rush pins, threaded intramedullary pins, interlocking pins, clamp rod internal fixators, and plate-rod systems. The intramedullary pin technique was selected for this case due to its suitability for comminuted diaphyseal fractures. This case highlights the efficacy of intramedullary pin fixation as a viable treatment option for comminuted femoral fractures in cats when appropriate surgical technique and post-operative care are implemented.

Keywords

Cat, Comminuted, Distal Femoral Fracture, Intramedullary Pin, Surgical Management

Introduction

A fracture is a disruption in the structural continuity of the bone cortex, often accompanied by varying degrees of injury to the surrounding soft tissues. Femoral fractures are common in cats and dogs following substantial trauma (Scott *et al.*, 2022a). These fractures can be categorized as capital physeal, femoral neck, trochanteric, subtrochanteric, diaphyseal, supracondylar, condylar, or distal physeal. Most femoral fractures are closed fractures due to the thick musculature surrounding the upper portion of the bone. However, they may become open fractures in cases of penetrating injuries such as gunshot wounds (Sanchez and Perry, 2021).

Secondary bone healing consists of four stages: hematoma formation, fibrocartilaginous callus formation, bone callus formation, and bone remodeling. Delayed healing can affect up to 10% of all fractures and may be caused by various factors, including comminution, infection, tumors, and disruption of vascular supply. The femur, one of the long bones, is most frequently affected by fractures, representing 45% of all long bone fractures. The incidence rate of femoral fractures in cats ranges from 20-26% (Roberts and Meeson, 2022).

The success rate of fracture management depends on the severity of the fracture and the selection of appropriate surgical techniques. Femoral fractures occur at various locations. Diaphyseal fractures with closed presentation are the most common, while young cats typically experience fractures in the proximal or distal epiphyseal regions. In adult cats, fractures generally occur in the diaphyseal and metaphyseal areas (Zurita and Craig, 2022).

The basic principle of fracture management is to restore the anatomical position of the fractured fragments, either through closed fixation or open fixation via surgery (Scott *et al.*, 2022b). Treatment options for femoral fractures in cats include pins and wires, Rush pins, threaded intramedullary pins, interlocking pins, clamp rod internal fixators, and plates or plate-rods. Intramedullary pins are frequently used and often combined with external fixation (Beale, 2004). Factors such as fracture healing, the number of fracture lines, size, and the patient's activity level must be considered when selecting appropriate implants (Scott *et al.*, 2022b).

Important factors in femoral fracture management include the selection of appropriate surgical techniques, minimal dissection, protection of both soft tissue and bone in the affected area, anatomical or indirect reduction, adequate stabilization, the use of suitable materials, and proper post-operative care (Pozzi *et al.*, 2021). Primary bone healing occurs through cortical reconstruction without callus formation when fractures can be repaired through reduction, immobilization, and rehabilitation. Secondary bone healing occurs through callus formation and subsequent remodeling (Roush, 2005). This case report aims to elucidate the diagnostic and therapeutic management of a comminuted diaphyseal femoral fracture in a domestic short-haired cat using intramedullary pin fixation, evaluating its efficacy and post-operative outcomes to advance evidence-based approaches in feline orthopedic surgery.

Materials and Methods

Signalement, History and Physical Examination

A 3-year-old male domestic short-haired cat named Kunting, weighing 3.8 kg, with a solid black coat as a distinguishing characteristic (Figure 1). The cat was presented to WinadiVet on 12 March 2022, with complaints of lameness, swelling in the left hind limb groin area, and pain on palpation. According to the owner, the cat had been experiencing lameness for approximately one week before presentation. Physical examination revealed a body temperature of 38.1°C. Inspection and palpation of the extremities

showed swelling in the left femoral region of the caudal extremity. The cat exhibited pain upon palpation and was unable to bear weight on the left hindlimb.

Radiographic Examination

Radiographic examination was performed to confirm the cause of the clinical signs. The radiographs revealed a fracture in the femoral area. Based on the radiographic appearance, the patient was diagnosed with a comminuted fracture in the diaphyseal region of the left femur (Figure 1).

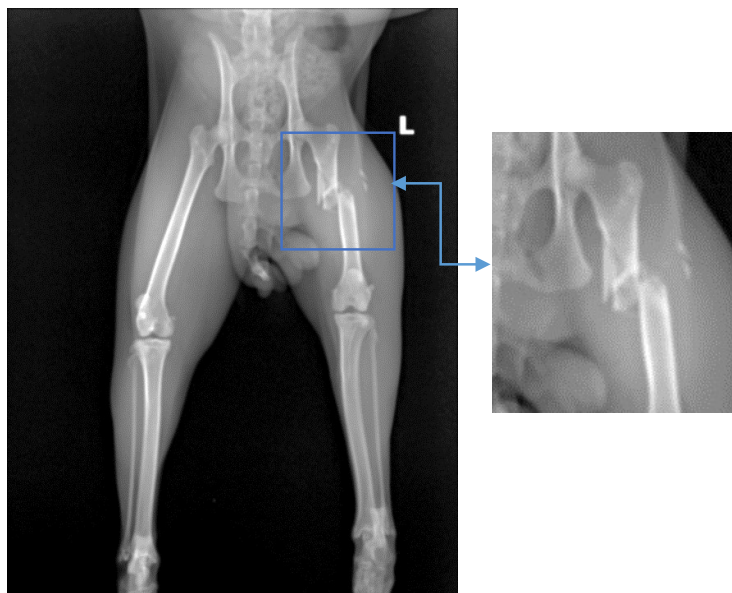


Figure 1. Radiograph Image; Ventrodorsal Position, fracture area (blue arrows).

Blood Hematology Examination

A complete blood count was performed using whole blood collected in purple-topped tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. The blood examination results showed elevated lymphocyte values (lymphocytosis) (Table 1).

Additionally, there were decreased values of granulocytes, hemoglobin, hematocrit (HCT), red cell distribution width coefficient of variation (RDWCV), red cell distribution width standard deviation (RDWSD), and plateletcrit (PCT) compared to normal reference ranges.

Table 1. Blood Hematology Examination Result

Items	Result	Unit	Normal Range	Notes
WBC	16.4	$10^3/L$	5.5– 19.5	
Limfosit	12.8	$10^3/L$	0.8 – 7	H
Monosit	0.9	$10^3/L$	0. – 1.9	
Granulosit	2.7	$10^3/L$	2.1-15	
Limfosit	78.5	$10^9/L$	12-45	H
Monosit	5.3	%	2-9	
Granulosit	16,2	%	35-85	L
RBC	5.01	$10^6/uL$	4.6-10	
Hemoglobin	8.3	g/dL	9.3-15.3	L
MCHC	32.3	g/dL	30-38	
MCH	16.6	Pg	13-21	
RDWCV	12.7	%	14-18	L
RDWSD	30.8	fL	35-56	L
HCT	25.8	%	28-49	L
PLT	29	$10^3/uL$	100-514	
MPV	7.3	fL	5-11.8	
PDW	15.6	fL`	10-18	
PCT	0.021	%	01-05	L
P-LCR	16.3	%	13-43	

A complete blood count (CBC) was performed in this case before surgery for several critical reasons. Preoperative blood screening serves as an essential safety measure to assess the patient's overall health status and identify any underlying conditions that might affect anesthesia administration or surgical outcomes (Ko, 2024). The complete blood count (CBC) revealed several hematological abnormalities, including lymphocytosis, reduced granulocyte count, decreased hemoglobin, hematocrit (HCT), red cell distribution width coefficient of variation

(RDWCV), red cell distribution width standard deviation (RDWSD), and plateletcrit (PCT) compared to established reference ranges. These findings provided critical insights into the patient's physiological status prior to surgical management of a femoral fracture.

The observed lymphocytosis likely reflects an inflammatory or immune response, possibly triggered by the trauma associated with the fracture (Schnelle & Barger, 2012). Elevated lymphocyte counts are commonly associated with tissue injury, as the body mounts an immune response to address tissue damage.

Meanwhile, the decreased hemoglobin and hematocrit levels indicate mild anemia, which is noteworthy in the preoperative setting due to its potential impact on oxygen delivery to tissues (Bliss, 2016). Fortunately, these reductions were not severe enough to preclude surgical intervention, as they did not significantly compromise the patient's oxygen-carrying capacity.

The reduced granulocyte count warrants consideration, as it may suggest a diminished capacity to combat infection (Schnelle and Barger, 2012). However, the degree of reduction was likely insufficient to justify delaying surgery, indicating that the patient's immune function remained adequate for the procedure. Additionally, the alterations in RDWCV and RDWSD provided insight into the heterogeneity of red blood cell size, aiding in the characterization of the anemia (Salvagno *et al.*, 2015). These parameters suggest variability in erythrocyte morphology, which may be associated with the underlying pathophysiology of the trauma or anemia.

The decreased plateletcrit, indicative of reduced platelet mass, could theoretically influence hemostasis (Salvagno *et al.*, 2015). Nevertheless, since the surgical procedure proceeded, this parameter was likely within a range deemed safe for surgery, posing minimal risk of excessive bleeding. Collectively, these hematological deviations, while notable, did not constitute contraindications severe enough to delay surgical correction of the femoral fracture.

The surgical team concluded that the urgency of addressing the fracture outweighed the risks posed by these mild hematological abnormalities. The observed changes were consistent with the expected physiological

response to acute trauma and did not suggest underlying systemic conditions that would substantially elevate anesthetic or surgical risks. These findings underscore the importance of comprehensive hematological evaluation in trauma patients to guide clinical decision-making while balancing the benefits and risks of timely surgical intervention.

Diagnosis and Prognosis

Based on the signalment, clinical history, physical examination, radiographic findings, and hematological evaluation, the cat was diagnosed with a comminuted fracture in the diaphyseal region of the left femur. The prognosis for this case is favorable, contingent upon the implementation of an appropriate surgical intervention, meticulous surgical technique, and effective post-operative care to ensure optimal recovery and restoration of function.

Results and Discussion

Premedication and Anesthesia

Before surgery, the cat received premedication with atropine sulfate. Premedication serves several purposes in surgical preparation: it calms the animal, facilitates handling during pre-surgical procedures such as induction and fluid administration, reduces basal metabolism to ease anesthesia maintenance, and requires lower doses of anesthetic agents, allowing for faster recovery (Grubb *et al.*, 2020). Surgical trauma often causes reflex movements, which can be suppressed with appropriate analgesics. Atropine sulfate was administered as an anticholinergic agent to reduce salivary and bronchial secretions and prevent bradycardia before anesthesia induction (Maryatmo *et al.*, 2022). For this case, atropine was administered

subcutaneously at a dose of 0.02 mg/kg body weight. This was particularly important considering that bronchial secretions can increase during anesthesia and tracheal intubation.

The surgical procedure was performed using a combination of ketamine-xylazine anesthesia with doses of ketamine 10 mg/kg and xylazine 2 mg/kg administered intramuscularly. The anesthesia protocol was selected based on the specific requirements of the orthopedic procedure. Anesthesia renders the patient insensitive to pain, keeping the animal calm and manageable while eliminating sensibility to pain and suppressing reflexes related to locomotion and the neurovegetative system (Maryatmo *et al.*, 2022). Ketamine HCl, a colorless and stable solution at room temperature, is valued for its wide safety margin and potent analgesic effects, which do not induce drowsiness. In combination with xylazine, an alpha-2 adrenergic receptor agonist, ketamine facilitates sedation, analgesia, and muscle relaxation, establishing optimal conditions for orthopedic procedures. This anesthetic regimen ensured sufficient depth and duration of anesthesia, enabling the successful execution of intramedullary pin fixation while preserving stable physiological parameters throughout the surgical procedure (Grub *et al.*, 2020).

Surgical Procedure

The patient underwent surgical management of the comminuted diaphyseal femoral fracture using the intramedullary pin

technique. The surgical procedure was performed after the cat reached an appropriate plane of anesthesia. The cat was positioned in the left lateral recumbency following hair removal from the entire thigh region, extending from the dorsal aspect to the ventral patella and slightly into the caudal abdominal area. The surgical site was aseptically prepared using 70% alcohol and povidone-iodine, applied in a circular motion from the center outward across both medial and lateral femoral regions. Sterile drapes were positioned to isolate the surgical field.

A 10 cm skin incision was made over the gluteal region using a surgical blade. The incision progressed through the cutaneous layer and continued through the muscular layers, following muscle fiber orientation to avoid severing any tendons (Figure 2A). The skin, subcutaneous fat, and superficial fascia were retracted until the superficial layer of the fascia lata became visible.

An incision was made at the cranial border of the biceps femoris muscles. To access the fractured bone, the vastus lateralis and rectus femoris muscles were carefully retracted from the cranial femur (Figure 2B). Open reduction was performed to accurately reposition the fracture fragments.

Following muscle retraction, the fractured bone surface was fully exposed, allowing clear visualization of the fracture site (Figure 2C). The fracture fragments were then meticulously reduced and aligned to ensure proper anatomical restoration (Figure 2D).

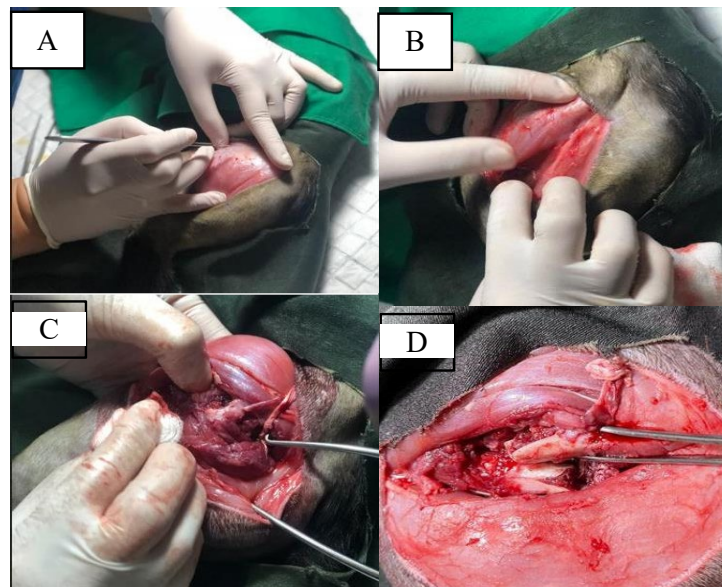


Figure 2. Surgical procedure: (A) incision of skin and subcutaneous tissues, (B) muscular

A 2.5 mm diameter intramedullary pin was inserted through the femoral fragments to achieve alignment and stabilization (Figure 3A). The pin was measured to the appropriate femoral length and trimmed

accordingly. Throughout the procedure, the surgical site was periodically irrigated with 0.9% physiological saline solution to prevent tissue desiccation (Figure 3B).

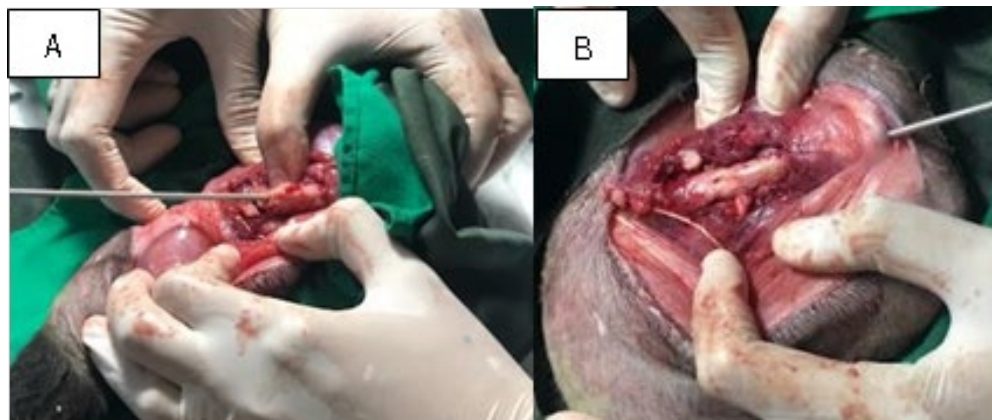


Figure 3. Surgical procedure: (A) insertion of 2.5 mm intramedullary pin, (B) result of intramedullary pin placement

Before closure, the surgical site was flushed with penicillin-streptomycin sulfate antibiotic solution (Figure 4A). The fascia lata was closed using simple interrupted sutures with 3-0 polyglactin (Vicryl®) suture material (Figure 4B). The subcutaneous layer was

similarly closed using simple interrupted sutures with 3-0 polyglactin. The skin was apposed using simple interrupted sutures with 3-0 silk (Figure 4C). Finally, a protective bandage was applied over the surgical site (Figure 4D).

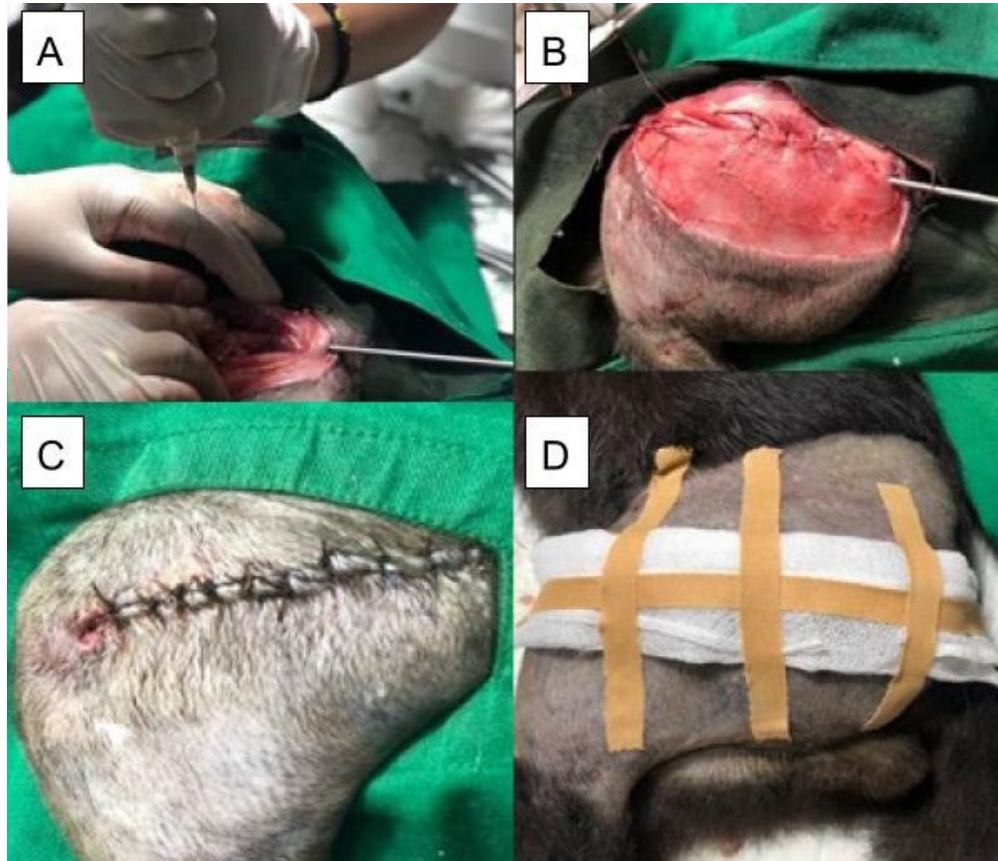


Figure 4. Surgical procedure: (A) application of topical antibiotic, (B) simple interrupted suture pattern on fascia lata using 3-0 polyglactin (Vicryl®), (C) simple interrupted suture pattern on skin using 3-0 silk, (D) bandage application

Fractures represent injuries to bone tissue that cause loss of continuity and balance. They can result from external trauma (traumatic fractures) or various diseases (pathological fractures) (Gaddam, 2024). Femoral fractures in cats typically occur due to various traumatic

events and can affect the metaphyseal, diaphyseal, or epiphyseal regions of long bones (Sanchez and Perry, 2021). During palpation of femoral fractures, instability, swelling, and pain response are typically observed. Intramedullary pins should occupy 70-80% of the bone's

medullary cavity, and pin selection must consider the diameter of the medullary canal and femoral isthmus (Zurita and Craig, 2022).

The basic principle of fracture management is to restore the anatomical position of the fracture fragments using either closed or open fixation through surgery (Pozzi *et al.*, 2021). Internal fixation devices commonly used in fracture treatment include intramedullary pins, plates, screws, and wires. Most femoral fractures present as closed fractures due to the thickness of surrounding muscles (Beale, 2004).

Fracture management follows the principles of recognition, reduction, repositioning, and rehabilitation. Recognition involves identifying the fracture type, location, and general condition, including wound severity and the presence of crepitation. Reduction is the process of returning bone fragments to their normal anatomical position, thereby preventing soft tissue from losing elasticity due to edema and hemorrhage (Steagall *et al.*, 2022). In this case, open reduction was selected with internal fixation to maintain stability.

The success of fracture management depends on accurate diagnosis and proper planning. Variables such as the cat's size, age, fracture type, and associated soft tissue damage significantly influence the selection of the repair method. Other factors include the cat's disease status, owner compliance with post-operative care, and the cat's temperament and environment (Langley-Hobbs, 2021).

Intramedullary pins inserted into fractured femurs create good stability between broken fragments. Femoral fracture fixation with intramedullary pinning is an economical and efficient method that provides good stability with minimal complications (Scott *et al.*, 2022a).

The diameter of the intramedullary pin must correspond to the animal's weight to support it adequately. Larger diameter pins minimize complications and have lower deflection potential. Pins that occupy 70-80% of the femoral medullary canal demonstrate better recovery compared to pins occupying only 30-40% (Erwin *et al.*, 2018).

Intramedullary pins provide good balance for long bones like the femur, resulting in better fracture healing. They accelerate callus strength and inhibit muscle atrophy and joint ankylosis while providing flexibility for femoral movement. However, this technique has limitations in preventing rotation and may shift if the animal's mobility is not temporarily restricted (Worth, 2007).

The surgical incision was made along the cranial border of the caudofemoralis and biceps femoris muscles to access the fracture segments. The vastus lateralis and medialis muscles were retracted from the cranial femur to access the fractured bone. It is important to avoid the adductor magnus muscle during incision as it supplies blood to the femur. Pin placement began by measuring the appropriate pin diameter to ensure adequate filling of the femoral medullary cavity. The pin was inserted starting from the femoral trochanter using a drill. Two pins were used—one serving as a guide while the other was inserted into the femoral medulla. The pin was placed using a normograde approach, starting from one end of the bone.

After inserting the intramedullary pin, the muscular layer was closed with simple interrupted sutures using 3-0 polyglactin. Polyglactin is an absorbable suture that takes sufficient time to be absorbed, allowing the muscles to unite completely before the suture is

fully absorbed. Polyglactin sutures are synthetic and can be absorbed within 56-70 days. They are coated with antibacterial agents, which cause minimal tissue irritation and enhance wound healing to some extent (D'Cunha *et al.*, 2022).

The skin layer was sutured with simple interrupted sutures using 3-0 silk. Silk suture was chosen to create strong knots, particularly important for extremity areas. Silk is a non-absorbable suture commonly used in wound ligation due to its excellent knot strength, easy handling characteristics, and minimal suture tearing (Kladakis, 2014). Following pin placement, topical antibiotics were applied to the surgical site to prevent bacterial contamination and possible infection. Beta-lactam antibiotics are particularly effective as perioperative antibiotics in such cases.

Post Surgery

Following the successful completion of intramedullary pin fixation for a femoral fracture, a comprehensive post-operative care plan was implemented to promote the cat's recovery. Immediately post-surgery, tramadol was administered intravenously at a dosage of 1-2 mg/kg to manage acute pain. Selected for its centrally acting opioid agonist properties, tramadol effectively alleviated post-operative discomfort during the critical initial recovery phase (Passavanti *et al.*, 2020). Concurrently, ceftriaxone, a third-generation cephalosporin, was administered intramuscularly at a dose of 25-50 mg/kg. Its broad-spectrum activity against gram-positive and gram-negative bacteria made it a suitable choice for preventing surgical site infections, despite its less frequent use in veterinary practice (Sudharsan *et al.*, 2024).

To mitigate the inflammatory response associated with surgical trauma, dexamethasone was administered intramuscularly at 2 mg/kg. This potent corticosteroid, approximately 30 times more effective than cortisol, suppressed inflammatory mediators and reduced tissue swelling (Lowe *et al.*, 2008). The cat's vital signs, including body temperature, respiration, and heart rate, were closely monitored in a clean, dry enclosure with a heat pad to prevent hypothermia, a common risk following anesthesia.

Over the subsequent week, the surgical wound and suture integrity were regularly evaluated. The treatment regimen shifted to oral cephalexin at 15 mg/kg twice daily to continue infection prevention during home care, ensuring sustained recovery. Cephalexin is a first-generation cephalosporin that provides continued antibacterial coverage, particularly effective against most Gram-positive cocci and certain Gram-negative bacteria, such as *E. coli*, *Proteus mirabilis*, and *Klebsiella pneumoniae*. Cephalexin works by inhibiting bacterial cell wall synthesis through its beta-lactam ring structure, thereby preventing the formation of peptidoglycan, which is necessary for bacterial cell wall stability (Hardefeldt and Prescott, 2024).

Alongside the antibiotic therapy, prednisolone was administered orally at a dose of 0.5 mg/kg twice daily. This glucocorticoid provided ongoing anti-inflammatory effects and contributed to pain management during the recovery period. Though less potent than dexamethasone (approximately one-seventh the potency), prednisolone is well-suited for maintenance anti-inflammatory therapy. It is particularly appropriate for cats despite their

sometimes reduced ability to convert prednisone to prednisolone (Khelik *et al.*, 2019).

This multimodal approach to post-operative care addressed both pain management and infection prevention. The transition from injectable medications in the immediate post-surgical period to oral medications for continued care follows standard veterinary protocols, providing comprehensive support throughout the recovery process as the patient adapts to the changing needs of healing.

Conclusion

This case report describes the successful treatment of a closed comminuted diaphyseal fracture of the left femur in a 3-year-old male domestic short-haired cat using intramedullary pin fixation. Radiographic evaluation confirmed the fracture, while preoperative blood analysis indicated minor trauma-related hematological changes that did not preclude surgery. The procedure, performed under ketamine-xylazine anesthesia with atropine sulfate premedication, utilized an intramedullary pin occupying 70–80% of the medullary canal diameter to achieve optimal stability and promote healing. Post-operative management involved analgesics, antibiotics, and anti-inflammatory drugs, with vigilant monitoring of vital signs and wound condition for one week. This demonstrates that intramedullary pin fixation, when paired with meticulous surgical and post-operative care, is an effective and cost-efficient approach for managing feline femoral fractures.

Approval of Ethical Commission

This case report did not require ethical clearance, as it was based on the medical

records of a patient treated at WinadiVet Animal Clinic for medical intervention and condition amelioration. The owner's consent was obtained, and all procedures, including data collection, physical examinations, radiographic assessments, and treatments, were conducted by certified veterinarians or under their supervision, adhering strictly to ethical guidelines throughout the case management and reporting process.

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Author's Contribution

CEAP and AAR: Conceptualization, Methodology, Validation, Investigation, Resources, Data Curation, Writing - Original Draft. CEAP, AAR, MAA, and MAAH: Writing - Review & Editing.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

Beale, B., 2004. Orthopedic clinical techniques femur fracture repair. *Clin.Tech.Small Anim.Pract.*, 19(3), pp.134-150. DOI: <https://doi.org/10.1053/j.ctsap.2004.09.006>

- Bliss, S., 2016. Anemia and Oxygen. *Vet.Clin.North Am.Small Anim.Pract.*, 45(5), pp.917-930. DOI: <https://doi.org/10.1016/j.cvsm.2015.04.006>
- D'Cunha, P., Pande, B., Kathalagiri, M.S., Moharana, A.K., Deepak, T.S., and Pinto, C.S., 2022. Absorbable sutures: chronicles and applications. *Int.Surg.J.*, 9(7), pp.1383-1394. DOI: <https://doi.org/10.18203/2349-2902.isj20221733>
- Erwin, E., Noviana, D., Umbu, D., and Dewi, T.I.T., 2018. Management femoral fracture in cats using intramedullary pin and wires fixation. *Int.J.Trop.Vet.Biomed.Res.*, 3(2), pp.32-35. DOI: <http://dx.doi.org/10.21157/ijtvbr.v3i2.12333>
- Gaddam, D.V., 2024. The Possible Risk Factors for Bone Fractures in Animals and Management of Pre and Post-operative Pain. *J.Skelet.Syst.*, 3(1): pp.2836-2284. DOI: <https://doi.org/10.58489/2836-2284/009>
- Grubb, T., Sager, J., Gaynor, J.S., Montgomery, E., Parker, J.A., Shafford, H., and Tearney, C., 2020. 2020 AAHA anesthesia and monitoring guidelines for dogs and cats. *J.Am.Anim.Hosp.Assoc.*, 56(2), pp.59-82. DOI: <https://doi.org/10.5326/jaaha-ms-7055>
- Hardefeldt, L.Y. and Prescott, J.F., 2024. Beta-lactam Antibiotics: Cephalosporins. *Antimicrob.Ther.Vet.Med.*, Chapter 8, pp.143-167. DOI: <http://dx.doi.org/10.1002/9781119654629.ch8>
- Khelik, I.A., Berger, D.J., Mochel, J.P., Seo, Y.J., Palerme, J.S., Ware, W.A., and Ward, J.L., 2019. Clinicopathologic, hemodynamic, and echocardiographic effects of short-term oral administration of anti-inflammatory doses of prednisolone to systemically normal cats. *Am.J.Vet.Res.*, 80(8): pp.743-755. DOI: <https://doi.org/10.2460/ajvr.80.8.743>
- Kladakis, S., 2014. Choosing sutures in small animal surgery. *J.Dairy Vet.Anim.Res.*, 1(3), pp.68-71. DOI: <http://dx.doi.org/10.15406/jdvar.2014.01.00015>
- Ko, J.C., 2024. Necessity of preoperative blood work and urine analysis for anesthesia. *Small Animal Anesthesia and Pain Management: A Color Handbook* (2nd ed.). CRC Press, pp.41-50. DOI: <https://doi.org/10.1201/9781315265643>
- Langley-Hobbs, S.J., 2021. Patellar fractures in cats: repair techniques and treatment decision-making. *J.Feline Med.Surg.*, 23(7), pp.649-661. DOI: <https://doi.org/10.1177/1098612X211021539>
- Lowe, A.D., Campbell, K.L., and Graves, T., 2008. Glucocorticoids in the cat. *Vet.Dermatol.*, 19(6), pp.340-347. DOI: <https://doi.org/10.1111/j.1365-3164.2008.00717.x>
- Maryatmo, M.A., Syahwa, D., Rosetyadewi, A.W., Septana, A.I., and Wijayanti, A.D., 2022. The Comparison of some General Anesthetics Preparation in Cat Orchiectomy Based on the Onset and Duration of Anesthesia. *Indones.J.Vet.Sci.*, 3(1), pp.33-37. DOI: <https://doi.org/10.22146/ijvs.v3i1.75092>
- Passavanti, M.B., G. Piccinno, A. Alfieri, S. Di Franco, P. Sansone, G. Mangoni and M. Fiore., 2020. Local infiltration of tramadol as an effective strategy to reduce post-

- operative pain: a systematic review protocol and meta-analysis. *Syst.Rev.*, 9(157), pp.1-6. DOI: <https://doi.org/10.1186/s13643-020-01419-1>
- Pozzi, A., Lewis, D.D., Scheuermann, L.M., Castelli, E., and Longo, F., 2021. A review of minimally invasive fracture stabilization in dogs and cats. *Vet.Surg*, 50(S1): pp.5-16. DOI: <https://doi.org/10.1111/vsu.13685>
- Roberts, V.J, and Meeson., R.L., 2022. Feline femoral fracture fixation: what are the options?. *J.Feline Med.Surg.*, 24(5), pp.442-463. DOI: <https://doi.org/10.1177/1098612x221090391>
- Roush, J.K., 2005. Management of fractures in small animals. *Vet.Clin.North Am.Small Anim.Pract.*, 35(5), pp.1137-1154. DOI: <https://doi.org/10.1016/j.cvsm.2005.06.001>
- Salvagno, G.L., Sanchis-Gomar, F., Picanza, A., and Lippi, G., 2015. Red blood cell distribution width: a simple parameter with multiple clinical applications. *Crit.Rev.Clin.Lab.Sci.*, 52(2), pp.86-105. DOI: <https://doi.org/10.3109/10408363.2014.992064>
- Sanchez, M.D.P., and Perry, K.L., 2021. CPD article: Fractures of the femur. *Companion Anim.*, 26(5), pp.1-15. DOI: <https://doi.org/10.12968/coan.2020.0096>
- Schnelle, A.N., and Barger, A.M., 2012. Neutropenia in dogs and cats: causes and consequences. *Vet.Clin.North Am.Small Anim.Pract.*, 42(1), pp.111-122. DOI: <https://doi.org/10.1016/j.cvsm.2011.09.008>
- Scott, H., Marti, J. M, and Witte, P., 2022a. Fracture Classification, Decision-Making and Bone Healing. *Feline Orthopaedics* (2nd ed.). CRC Press, pp.43-52. DOI: <https://doi.org/10.1201/9780429091537>
- Scott, H., Marti, J. M, and Witte, P., 2022b. Fracture fixation methods: principles and techniques. *Feline Orthopaedics* (2nd ed.). CRC Press, pp.61-87. DOI: <https://doi.org/10.1201/9780429091537>
- Steagall, P.V., Robertson, S., Simon, B., Warne, L.N., Shilo-Benjamini, Y., and Taylor, S., 2022. 2022 ISFM consensus guidelines on the management of acute pain in cats. *J.Feline Med.Surg.*, 24(1), pp.4-30. DOI: <https://doi.org/10.1177/1098612x211066268>
- Sudharsan, H.A., TA, K., and Ali, M.A., 2024. A review on the Use of Third-Generation cephalosporins on Gram-positive and Gram-negative Bacteria based on its spectrum of activity. *Recent Trends Pharm.Sci.Res.*, 6(1), pp.1-7. DOI: <http://dx.doi.org/10.46610/RTPSR.2024.v06i01.001>
- Worth, A., 2007. Management of fractures of the long bones of eight cats using external skeletal fixation and a tied-in intra-medullary pin with a resin-acrylic bar. *N.Z.Vet.J.*, 55(4), pp.191-197. DOI: <https://doi.org/10.1080/00480169.2007.36767>
- Zurita, M. and Craig. A., 2022. Feline diaphyseal fractures: management and treatment options. *J.Feline Med.Surg.*, 24(7), pp.662-674. DOI: <https://doi.org/10.1177/1098612x221106354>