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Case Study

Successful Management of a Femur Fracture with Double Plating in an 8-Month-Old Domestic Short Hair Cat: Enhancing Stability and Rigidity in Implant Constructs

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Abstract

Femur fractures in young cats are particularly challenging due to the complexity of the acting forces necessitating for a stable and rigid fixation to ensure proper healing and functionality. Double plating, a technique involving the application of two plates on a fractured bone, has demonstrated promising results in providing superior mechanical stability and early return to function. This case report highlights the use of double plating in an 8-month-old cat with an oblique femur fracture, emphasizing its advantages over traditional plating and plate rod combination techniques. This article compares other implant combinations and discusses existing literature on double plating in Veterinary Orthopedic Surgery.

Keywords: Double Plating; Cat; Fracture; Femur; Orthopedic

Abbreviation

ORIF: Open Reduction and Internal Fixation; FPAS: Fracture Patient Assessment Score; PAX: Polyaxial; IM: Intrmedullary; VCP: Veterinary Cuttables Plates; DCPs: Dynamic Compression Plates; LCPs: Locking Compression Plates

Introduction

Femur fractures are reported to be the most common skeletal condition affecting growing cats accounting for 20% of all fractures and 45-47% of all long bone fractures [5]. These fractures are most prevalent in cats under 2 years old and typically result from severe trauma such as vehicular accidents, gunshot injuries, falls, or occasionally pathologic diseases. Femur bones connect to major muscle such as lateral fascia lata, biceps femoris muscle, vastus laterals muscle and semitendinosus muscle. Fracture is the one of the most common problems with femur bones in veterinary field [2].

Open reduction and internal fixation (ORIF) with bone plates involves surgically approaching the bone, manipulating fracture fragments and aligning the bone in anatomically stable apposition along with placing appropriate implant. While ORIF provides rigid fixation and promotes weight-bearing on the affected limb at the earliest, its invasive nature may delay fracture healing. Fractures suitable for open anatomical reconstruction include transverse, short oblique, long oblique, segmental, minimally comminuted (butterfly fragments), and articular fractures [3]. Achieving anatomical reconstruction of joint surfaces is particularly extremely crucial. The goal of fracture correction is to restore anatomical alignment and reduction of the fractured bone while applying stable fixation to allow early patient mobilization.

Femur fractures are recommended to be treated surgically with an appropriate fixation technique based on the type of fracture, preservation of regional soft tissues, and their attachments to the

bone fragments. Plating is a widely used internal fixation technique for transverse and short oblique fractures of long bones but the technique counters only bending forces. Traditional single plating methods may not provide adequate stability, potentially leading to complications such as non-union or malunion. Double plating, which involves applying two orthogonal plates to the femur, offers enhanced mechanical rigidity and stability, making it effective for complex fractures and counteracting all forces that impact the femur.

Materials and Method

Case Presentation

A 8 month old male intact domestic short hair cat was presented for non-weight bearing lameness after a fall from a height. During the clinical examination, the cat exhibited reduced appetite, non-weight bearing, pain on palpation, swelling, and crepitation of the left hind limb. Neurological examination was performed to ascertain neurological deficits, however the patient showed positive deep pain and proprioception reflex. Radiographic examination confirmed a long comminuted mid to distal third femur fracture (Figure 1(a) and figURE 1(b)) using Skanmobile-230 (Skanray Technologies Pvt Ltd) a high frequency diagnostic X-Ray system. After assessing the fracture's complexity, double plating was selected as the preferred fixation method.

Fracture Patient Assessment Score (FPAS) includes biological, clinical and mechanical factors in case. FPAS involves assigning a score of 1 to 10 for a number of different mechanicals, biological and clinical factors. Mechanical factors affecting the fracture site determine the strength and repair technique. Biological factors involve the duration that the fixation method would need to be in place and clinical factors includes like level of owner compliance or consequences of the surgery failing to achieve its objectives [7,8]. The case under study for this article had a FPAS score of 18 out of 30.

Procedure

Pre-operative preparation

Pre-operative blood tests revealed elevated white blood cell count and elevated ALT levels. The cat was premedicated with tiletamine and zolazepam (ZoletilTM 50; Virbac) at 4 mg/kg and dexmedetomidine (Dexthesia; Vivaldis Health & Foods Pvt Ltd) at 1 mcg/kg intramuscularly. For induction, midazolam (Mezolam; Neon Laboratories Limited) was administered at 0.05 mg/kg intravenously, followed by Propofol (Neorof; Neon Laboratories Limited) at 2 mg/kg intravenously. General anesthesia was maintained with isoflurane (Sosrane; Neon Laboratories Limited). Antibiotics ceftriaxone and tazobactam (Intacef tazopet; Intas Pharmaceuticals LTD) were given at 30 mg/kg once daily intravenously.

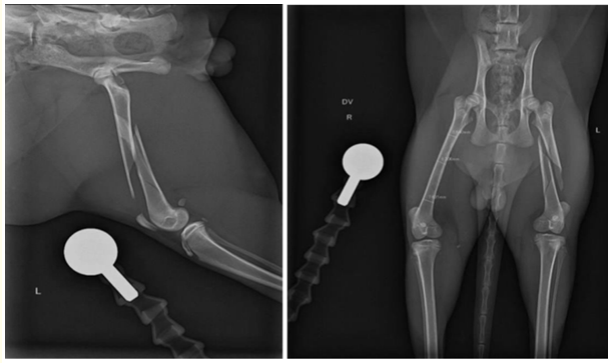

Figure 1: a: Left lateral view, b: Ventro-dorsal view.

Surgical procedure

The surgical site was prepared following standard aseptic procedures. The affected limb was clipped, and the surgical area was prepared using 7% povidone iodine scrub solution and followed by 5% povidone iodine solution. An incision was made along the cranio-lateral border of the left thigh and extended from greater trochanter to stifle joint. After carefully dissection through the skin and subcutaneous along the cranial border of the biceps femoris muscle, the fascia lata was incised. The biceps femoris muscle was retracted caudally, and the vastus lateralis muscle was reflected from the femur to expose the femoral diaphysis [12]. The fracture fragments were reduced using pointed reduction forceps to achieve proper anatomical alignment. The fracture hematoma was left intact due to its beneficial effects on healing [5]. After the fracture fragments were aligned, stabilization was achieved using appropriately sized Veterinary Cuttable Plates (VCP).

A 2.0 mm cuttable plate was applied to the lateral aspect of the femur and secured with screws. A second 2.0 mm cuttable plate was placed on the cranial aspect of the femur to enhance rigidity, also secured with bicortical screws to ensure proper alignment

and stability. Order of placing the screws were as follows; first distal most then secondly proximal most then remaining holes to accommodate the growth plates. A strip of plate with the required number of holes was cut to the desired length (between 8 to 13 cm) from a 300 mm VCP using a standard pin cutter [13].

After the implants were secured in position the lateral fascia lata muscles were sutured with Polydioxanone (PDS; Jhonson and Jhonson Pvt Ltd) round body (size 3-0) in a simple continuous suture pattern. Local infiltration inj bupivacaine (Anawin; Neon Laboratories Limited) was administered intramuscularly into the sutured fascia lata muscle. The subcutaneous tissues were opposed with Poliglecaprone (Monocryl; Jhonson and Jhonson Pvt Ltd) reverse cutting (size 4-0) in a simple continuous pattern, and then intradermal sutures were placed using the same suture material.

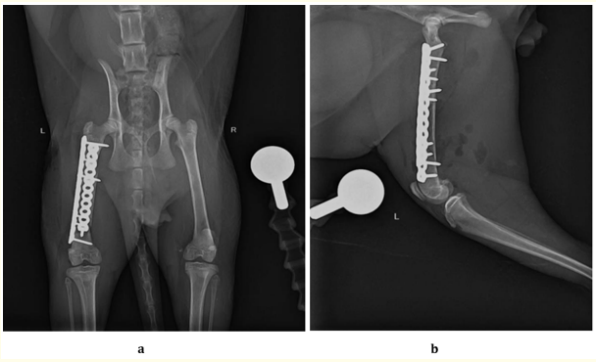

Figure 2: a: Ventro-dorsal view, b: Left lateral view.

Post-operative sedation radiographs

Radiographs postoperatively were taken consideration for the following points Alignment, Apposition, Apparatus and Activity [8].

- **Alignment:** Both Coxo - Femoral and stifle joint anatomically positioned to indicating good alignment.
- **Apposition:** Since correct fracture emphasis was made on correct limits length and anatomical alignment.
- **Apparatus:** Appears contoured correctly to femur diaphysis screws are bicortical.
- **Activity:** Started weight bearing on all four limb.

Post-operative care

Patient was adviced cage rest along with oral medications which included analgesias and antibiotics Tab Cefpodoxime (Intas Cefpet Proxetil; Intas Pharmaceuticals Ltd) (@10 mg/ kg od P/O for 7 days), Tab Gabapentin (Vetina Gabapentin; Vetina Healthcare LLP)(@10 mg/kg bid P/O for 10 days), Tab Carprofen (Carodyl; Savavet) (@2.2 mg/kg bid P/O for 5 days), Tab Buprenorphine (Addnok; Rusan Pharma Ltd) (@0.02 mg/kg bid P/O for 3 days), Tab Chymoral Forte (Torrent Pharmaceutical Ltd) (1 tab bid P/O for 10 days). Additionally cold compresses for 10 minutes twice in a day to the affected area for three days, restricting movement for two weeks and keeping the surgical area dry, clean, and protected until the incision site healed. Cat was weight bearing within 24 hours after surgery. Regular follow-up was advised, with a focus on return to normal funtion to assess bone healing. The surgical outcome was evaluated based on lameness grade and functional limb outcome. Follow-up radiographs were taken at 4 weeks post-surgery to monitor the healing process.

Results and Discussion

The postoperative recovery was smooth, with radiographs showing progressive fracture healing and excellent alignment. By 8 weeks, the cat had regained full use of the limb with no signs of discomfort or lameness.

Clinical studies have demonstrated successful stabilization of fractures using double plate fixation [3]. Double plating is advantageous when prolonged healing or inadequate postoperative restraint is expected, as it provides greater strength against destructive testing. Bone plates are typically applied to the tension surface of the bone and can be used in various configurations: compression, neutralization, buttress, or bridging. There are numerous methods available for fixing the various types of fractures that can occur in a feline's femur, and having a solid grasp of the forces affecting the fracture is essential for choosing the right implant. In recent years, the availability of appropriate implants for the feline femur has greatly improved, with the introduction of 2.4 mm plating sets and interlocking nails specifically designed for cats [15].

Comminuted fractures present particular challenges because of the complexity of the fracture fragments and the associated soft tissue damage. It is crucial to carefully consider the approach

to repair before beginning the fracture treatment [1]. Orthogonal plating offers greater rigidity during mediolateral bending and can withstand a higher failure load under axial compression. However, a drawback in small bones is the need to purchase additional screws [4]. Although the pin-plate combination has mostly replaced the use of ESFs for stabilizing femoral fractures in cats. ESFs are still used, particularly for comminuted femoral fractures. However, the substantial muscle mass around the femoral diaphysis restricts the placement of external fixator pins to the proximal and distal insertion sites, which limits the ability to enhance the stiffness of the construct [19]. Bone plates are typically applied to the lateral (tension) surface of the femur, with DCPs (Dynamic Compression Plates), VCPs, and LCPs (Locking compression plates) being commonly utilized. In cases of comminuted femoral fractures, DCPs and VCPs can be applied in a bridging manner [14].

Locking plates and locking screws are often used together with an intramedullary (IM) pin. In some cases, placing cortical screws can help avoid interference with the pin. A polyaxial (PAX) locking plate is another valuable option, as it allows screws to be inserted at various angles, helping to avoid joint spaces, anatomical structures, and any additional devices. Plate-rod constructs are effective for stabilizing various types of femoral fractures, ranging from simple transverse to highly comminuted fractures. The placement of an intramedullary (IM) pin can be done either normograde or retrograde for the femur. However, normograde insertion, from proximal to distal, is highly recommended because it allows for more precise positioning of the rod within the trochanteric fossa and medullary canal. This approach also minimizes manipulation of the fracture site, thereby better preserving the fracture haematoma. On the other hand, retrograde insertion carries a higher risk of sciatic nerve injury, especially in cats [14].

Dual plating offers enhanced axial and rotational stiffness in high-strain conditions, making it particularly effective for initial repairs and revisions of failed plate osteosynthesis [4]. Double plating offers superior mechanical stability compared to single plating methods. The use of two plates distributes the mechanical load more evenly, reducing risk of implant failure and enhancing fracture healing. This technique is especially beneficial for young, active animals, allowing for a quicker return to normal function. Double plating offers increased resistance to bending and torsion compared to single plating, though improper dissection and implant techniques may lead to soft tissue damage and delayed bone healing [9]. The orthogonal double plating technique is frequently used for long bone fractures [6], providing strong stabilization. In feline surgeries, orthogonal double plating is advantageous due to its stiffness, effectiveness in high-strain environments, and stability. It also reduces the risk of implant bending, a common issue with tibial plating [4]. Potential complications include arthrofibrosis and heterotopic ossification [16]. This technique has also been successfully implemented in wild animals using two locking plates orthogonally to treat a femoral fracture in a polar bear [18] and giant anteaters [10].

Common complications include implant migration, which can lead to soft tissue irritation, malunion, delayed union, and pin loosening [17]. Plate bending is also a significant issue in some cases [11]. Double plating is a dependable approach for managing these complications or when there is a high risk of recurrence. Potential complications associated with bone plating include delayed union, nonunion, malunion, reoperation due to implant failure osteomyelitis, sequestration, and mechanical failure [15]. Studies in conventional plate osteosynthesis in humans over three decades have been conducted and factors contributing to complications have been identified; such as extensive soft tissue dissection, disruption of the fracture hematoma, and multifocal periosteal necrosis from plate compression. Complications were classified as either fixation failures as in this case no implant failure, screw pullout, and iatrogenic fissures and other is fractures [3].

Conclusion

Double plating in femur fractures offers a promising alternative to traditional single plating methods, providing enhanced stability and rigidity essential for successful healing. This case report demonstrates the effectiveness of double plating in a young cat, highlighting its potential for broader application in veterinary orthopedic surgery. Further research and clinical trials are recommended to establish standardized guidelines for this technique.

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Conflict of Interest

The author declare that they do not have any conflict of interest.

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