RESEARCH ARTICLE

Use of Polyaxial Locking Plate and Rod Reconstruction in the Treatment of Femur Fractures in Dogs: A Clinical Study

Keerthi Vallem[1*], Jagan Mohan Reddy K.[2], Sravanti M.[3], Ranjith Kumar S.[4]

Abstract

Polyaxial Locking Plates (PAX) combines the advantages of conventional locking bone plates along with variable angle screw insertion, with a locking screw angulation range of up to 15° off the central axis. Clinical, orthopaedic examination and survey radiographs revealed the femur fractures in six cases. Polyaxial Locking Plate in conjunction with an Intramedullary pin (IMP) was used to stabilize the femoral fractures in dogs of different breeds and genders. Clinical and haemato-biochemical evaluation was carried out post-operatively at periodic intervals to ascertain the heath and fracture healing. Radiographic examination was conducted on days 0, 30th, 60th and 90th post-operatively. Haemato-biochemical findings did not vary between periods and were within normal range, except serum ALP which showed peak value at 15th post-operative day with gradual reduction thereafter. Minimal contact of PAX plate with the bone resulted in preservation of periosteal blood supply, which promoted early fracture healing, limb ambulation and an earlier return to normal range of motion. A complication of Pin migration was observed in two dogs.

Key words: Dog, Femur fractures, IMP, Pin migration, PAX, Screw angulation.

Ind J Vet Sci and Biotech (2025): 10.48165/ijvsbt.21.1.06

Introduction

One of the most typical fractures in dogs is a fracture of the femur (thigh bone). Usually, severe trauma results in these fractures. Bone plates like the Dynamic Compression Plate (DCP), Locking Compression Plate (LCP), and Limited Contact Dynamic Compression Plate (LC-DCP) were frequently used to treat canine long bone fractures. Two innovative plate designs that have been introduced into small animal practice are the Advanced Locking Plate System (ALPS) and Polyaxial Locking Plate System (PAX plates). These plates have many advantages over traditional plates. The majority of veterinary locking systems are fixed-angle designs that limit the surgeon's ability to angle locking screws within the plate, preventing them from being placed close to joints, fracture lines, and other implants. Variable-angle locking overcomes this restriction (Bassanino *et al.,* 2021). With a locking screw angulation range of up to 15 degrees off the central axis, the polyaxial locking system (PLS) is a variable-angle locking system. This latest innovation enables the elimination of the fixed angle insertion restriction of locking plates while maintaining the benefits of a locked construct (Dona, 2022).

PAX plate was used in conjunction with Intramedullary Pin (IMP). IMP reduces the stress on the plate, extending the fatigue life of the plate in fractures where interfragmentary load sharing cannot be achieved. The plate is well protected from stress by an IM pin that occupies 30-40% of the medullary cavity (Gopinathan *et al.,* 2023). This clinical study was aimed to use polyaxial locking plate and rod reconstruction in the treatment of femur fractures in dogs.

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How to cite this article: Vallem, K., Reddy, J. M. K., Sravanti, M., & Kumar, R. S. (2025). Use of Polyaxial Locking Plate and Rod Reconstruction in the Treatment of Femur Fractures in Dogs: A Clinical Study. Ind J Vet Sci and Biotech. 21(1), 25-29.

Source of support: Nil

Conflict of interest: None

Submitted 15/09/2024 **Accepted** 31/10/2024 **Published** 10/01/2025

Materials and Methods

The present clinical study was conducted on six dogs presented for treatment at the department of Veterinary Surgery and Radiology, College of Veterinary Science, Rajendranagar, Hyderabad (India). Routine clinical, orthopaedic and radiographic evaluations were carried out to diagnose the condition. Complete details regarding the

age, sex, breed of the animal, chief complaint and mode of its onset, and duration of the signs, if any, were recorded. The femoral fractures were temporarily stabilized with Robert Jones bandage without splints until the day of surgery. Pre-operative radiographs were used to select the size of the PAX plate, length of the screws and diameter of intramedullary pin to be used in plate rod construct. The space occupied by intramedullary rod was determined by measuring diameter of intramedullary cavity at the isthmus region of femur. The length of the screw needed for application of PAX plate in each patient was determined directly from the craniocaudal radiographs by measuring the mediolateral thickness of femur at different distances of fractured fragments.

The owners were advised to withhold food for 12 h and water for 6 h before surgery (Fossum, 2013). The dogs were pre-medicated and anaesthetized with a combination of xylazine and ketamine @ 1 mg /kg and 10 mg/kg body weight given intramuscularly and were intubated with endotracheal tubes of suitable size. Anaesthesia was maintained with intravenous infusion of propofol @ 4 mg/kg body weight. The dogs were positioned in lateral recumbency with the fractured limb up. The distal extremity of the limb was covered with sterile gauze bandage. The prepared site was painted with 5 % povidone-iodine solution followed by application of spirit and a sterile drape (Fig. 1) was applied. Craniolateral skin incision was made from the level of greater trochanter to the level of patella followed by blunt dissection of subcutaneous fat and superficial fascia directly under skin incision (Marwa *et al*., 2022). After the surgical stabilization of femur fractures with plate-rod technique using PAX plates, the tensor fascia lata and subcuticular fascia were closed in two layers with 2-0 polyglactin 910 in simple continuous suture pattern. The skin incision was then closed with a row of cruciate mattress sutures using 2-0 polyamide, and daily dressed with application of 5% povidone iodine. Following surgery, the fractured limb was immobilized with Robert Jones bandage (Johnson, 2013). To prevent post-operative infection and pain, antibiotic ceftriaxone sodium and analgesic medication (meloxicam) were administered for 5 to 7 days post-surgery.

Clinical evaluation was carried out post-operatively at periodic intervals to ascertain the fracture healing. Haemato-biochemical investigations and radiographic examinations were conducted pre-operative and on day 0, 30th, 60th and 90th post-operatively to ascertain the health status and the fracture healing.

Results and Discussion

In the present study, among six cases, five dogs affected were under one year of age and one was of 4 years old, and the duration of fracture varied from 2 to 11 days. This finding was in accordance with Maruf Minar *et al.* (2013), Kallianpur *et al.* (2018), and Keosengthong *et al.* (2019) who reported that fractures were more common in dogs less than one year of age. Out of six dogs, two dogs were German shepherd (33.3%), two Mongrel (33.3%), one each (16.6%) was Labrador and Pomeranian breed. Out of six cases, three cases were females (50%) and three were males (50%). The most leading cause of fracture was found to be automobile accident (83.3%) and fall from height in one case (16.6%).

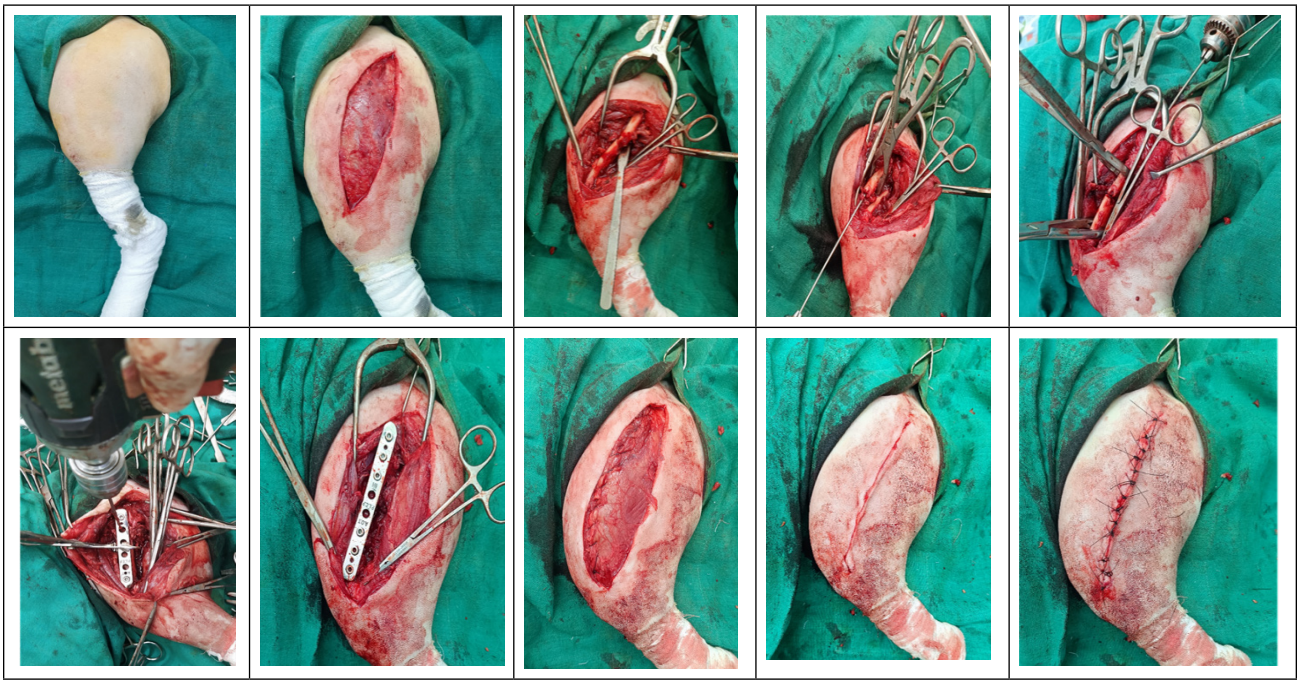

Fig. 1: Steps followed in surgical procedure of femur fracture repair by PAX plates in dogs

In the current study, two cases were presented with comminuted (33.3%) type of fracture, three with oblique (50%) type of fracture and one with transverse (16.6%) fracture. Five out of six dogs (83.3%) were fractured with left hindlimb. Similar were the findings of Singh *et al*. (2017). Among the six dogs, three dogs had distal third diaphyseal fractures (50%) and two dogs had mid diaphyseal fractures (33.3%) and one dog had proximal diaphyseal fracture (16.6%). This finding differed from Hansda *et al.* (2012) who reported that midshaft fractures accounted for the greatest number of femur fractures (50%), followed by distal third (33.33%), proximal third of diaphysis (11.11%), and least number of supracondylar fractures (5.56%).

Lameness grading in all the cases under this study was done according to the protocol developed by Vasseur *et al.* (1995). All the six cases showed grade V lameness pre-operatively. At 60th post-operative day all the cases showed grade I (normal weight bearing on all limbs at rest and while walking) lameness. The mean lameness scores in the animals were found to be 5.00±0.00, 3.5±0.22, 2.16±0.16, 1.16±0.16, 1± 0.00 and 1± 0.00 on the pre-operative day, 1st, 15th, 30th, 60th and 90th post-operative day, respectively. There was gradual reduction in lameness grading score. These observations concurred with Basiri *et al.* (2021).

In the current investigation, all the six cases were stabilized with 3.5 mm Polyaxial Locking Plate (PAX) with 3.5 mm polyaxial locking cortical screws. Drill bit of size 2.7 mm was used to create holes in the bone, to fix screws into the plate. There was no incidence of screw loosening throughout the period of study in any of the six cases. This finding was similar to Bufkin *et al.* (2013), who stated that the screw head could be flush with the plate or slightly countersunk within the hole in the plate obtaining an appropriate level of depth of engagement while keeping a high level of push out strength. None of the case under study showed abnormalities related with plate such as plate bending. This could be due to the use of appropriate size of the plate in consideration with the bone measurements and the body weight of the animal. Other possible reason for plate stability might be due to the fact that intramedullary rod minimizes the stress on the plate increasing the strength of the plate. This finding was similar to the observation of Haaland *et al.* (2009). One case each showed pin migration at 60th post-operative day and 30th post-operative day, respectively. This could be due to improper lodgement of

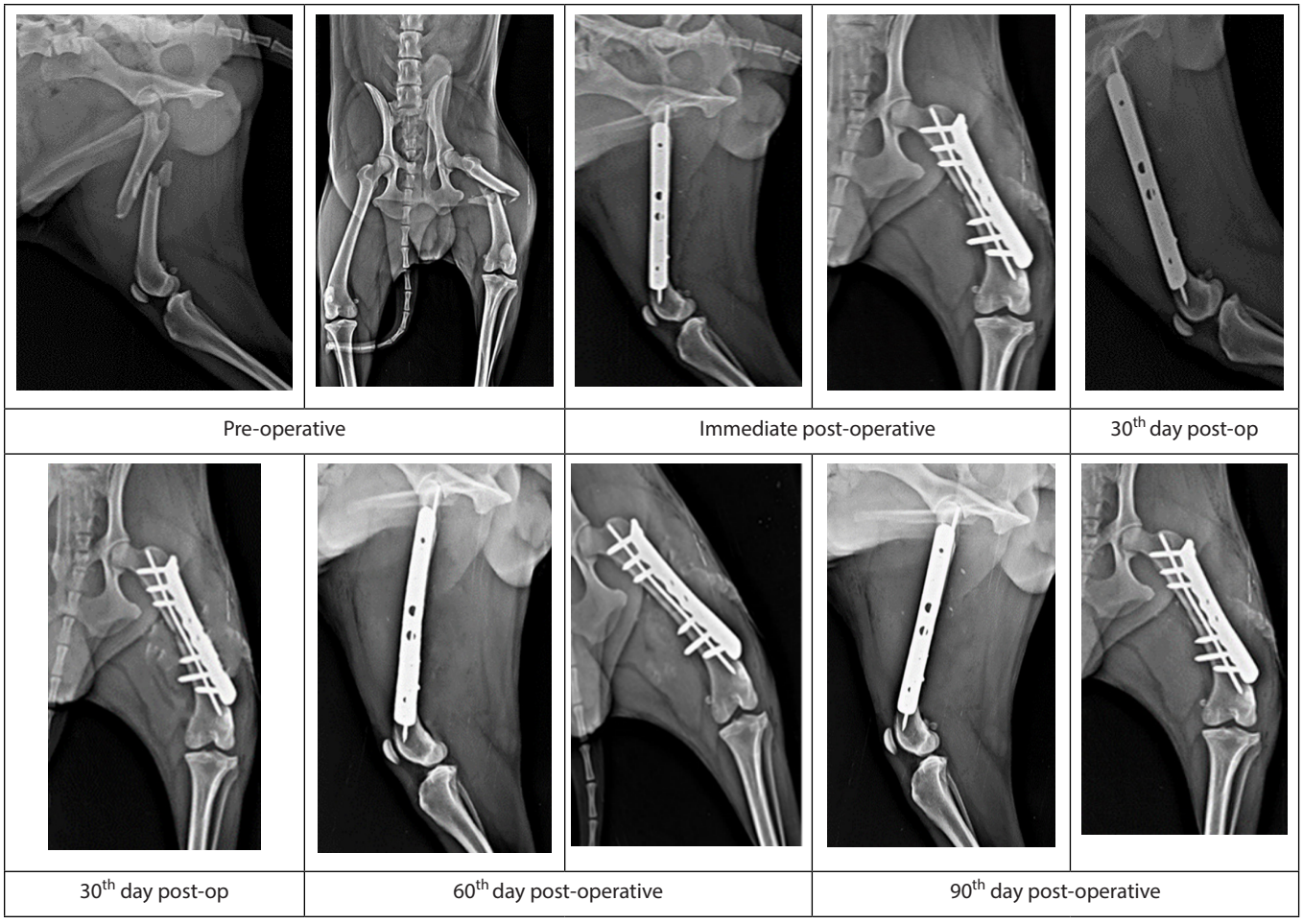

Fig. 2: Skiagrams showing progressive radiographic changes

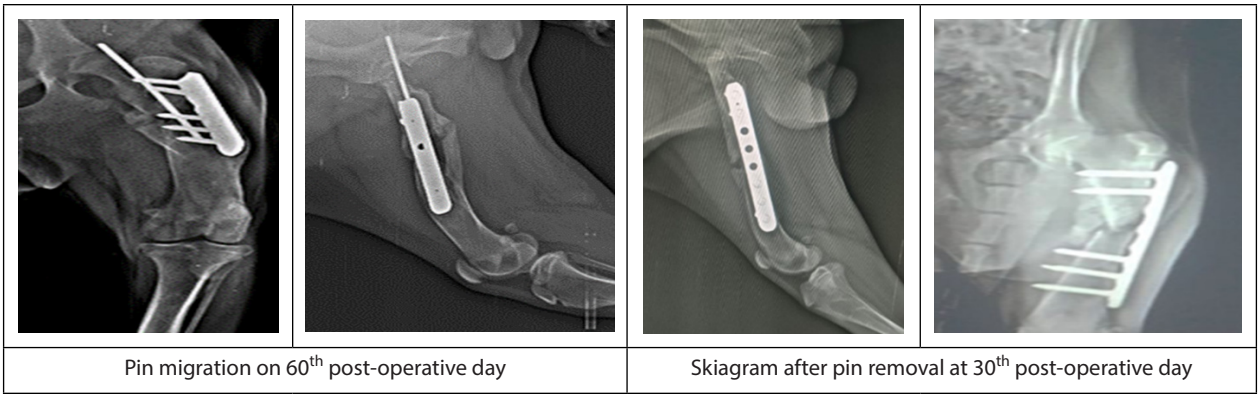

Fig. 3: Complication of pin migration observed in two dogs on 60th and 30th day post-operative

intramedullary rod in the distal condyle or due to vigorous activity of the animal. Similar complication of pin migration in plate-rod constructs was noticed by Sarangom *et al.* (2018) and Basiri *et al.* (2021).

Haemogram did not vary significantly ($p>0.05$) at different time intervals, pre- and post-operatively, and was within normal physiologic range. Serum alkaline phosphatase differed significantly ($p<0.05$) at different post-operative intervals. Peak levels of serum ALP were observed on 15th post-operative day and then gradually decreased till 60th post-operative day to reach normal physiologic limit indicating bone union. Least levels of serum ALP was observed on 0th day. However, serum calcium, phosphorus did not differ significantly ($p>0.05$) at different intervals and fluctuated within normal physiologic range.

Conclusion

Based on the results of present study, it was concluded that the repair of femoral fractures using Polyaxial Locking Plate (PAX) in combination with Intramedullary Rod (IMR) had successful outcome in functional usage of the repaired limb and stable fracture fixation till complete union. The advantage of multidirectional screw placement upto 15° from perpendicular axis allowed the surgeon for successful repair of oblique, spiral, comminuted and distal third diaphyseal fractures, fractures close to joints, fracture line and intramedullary rod.

Acknowledgement

Authors thank the University authorities and the Head of Department of Veterinary Surgery and Radiology, College of Veterinary Science, Rajendranagar, Hyderabad for the facilities and cooperation extended.

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