SHORT COMMUNICATION

Use of Polyaxial Locking Plate and Rod Reconstruction in the Treatment of Tibial Diaphyseal Fractures in Dogs

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Abstract

Clinical efficacy of the polyaxial locking plate (PAX) combined with intramedullary (IM) pinning - the plate-rod technique - was assessed in six dogs aged 6-28 months, irrespective of breed and sex, with mid-diaphyseal tibial fractures. Males predominated (83.33%), and road traffic accidents were the leading cause (83.33%) among these cases. Closed oblique fractures accounted for 66.66% of cases, the remainder being spiral. Surgery was performed at a mean of 4.83 ±0.83 days post-injury under a standardized anaesthetic protocol. A cranio-medial approach was used, and the PAX system's ability to angle screws up to 15° from perpendicular appeared to provide stable fixation across fracture configurations. Fixation used 2.7 mm or 3.5 mm PAX plates combined with 1.8-3.0 mm IM pins. Radiographs on days 0, 15, 30, 60 and 90 tracked alignment, implant position, and healing. One case (23 kg, high activity level) showed transient implant bending. Lameness improved progressively, reaching grade I (normal weight-bearing) by day 60 in all six dogs, and radiographic union was achieved in all cases by day 90. The polyaxial plate's limited-contact design supported early weight-bearing and reduced postoperative complications.

Key words: Dog, Plate-rod fixation, Polyaxial locking plate, Tibial diaphyseal fracture.

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Introduction

Fractures often result from external trauma or mechanical forces such as compression, bending, or twisting, with automobile accidents and falls being the most common causes in small animals (Surbhi, 2011). Tibial fractures are among the most common orthopaedic injuries in dogs, second only to femoral fractures (Seaman and Simpson, 2004), and the tibial shaft is the most frequently affected site, representing approximately 57.32% of cases (El-Shafey *et al.,* 2022). Stabilization options include intramedullary pinning, bone plating, interlocking nailing, and external fixation (Nadkarni *et al.,* 2008; Li *et al.,* 2015), of which intramedullary pinning alone, despite its simplicity, is prone to rotational instability, pin migration, and inadequate fixation, predisposing to delayed union, malunion or infection (Li *et al.,* 2015).

The polyaxial locking plate (PAX) system, introduced in 2013, combines the principles of compression and bridging fixation and permits screw insertion at variable angles within a 20° cone, particularly useful near joints or the spine (Arthurs, 2015). This study evaluated the clinical use of the PAX system combined with intramedullary pinning (plate-rod technique) for stabilization of tibial diaphyseal fractures in dogs, assessing clinical outcome and radiographic healing.

Materials and Methods

Six client-owned dogs presented, with diaphyseal tibial fractures, irrespective of breed, sex, age or pre-operative lameness status, at the Department of Veterinary Surgery and Radiology, College of Veterinary Science, Rajendranagar, Hyderabad, were included in the study. Diagnosis was confirmed by clinical, orthopaedic and radiographic examination. Representative pre-operative radiographs are shown in Fig. 1. Signalment, cause and duration of fracture, and any concurrent illness or orthopaedic injury were recorded for each case.

Standard orthogonal (medio-lateral and cranio-caudal) radiographic views of the affected and contralateral limb

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Fig. 1: Pre-operative radiographic views - Lateral and cranio-caudal projections

were used to characterize fracture location and type and to classify fractures according to the AO/ASIF system. Cortical thickness and bone-length measurements on these views guided plate, screw and intramedullary (IM) pin selection based on patient body weight (Fig. 2) (Johnson *et al.,* 2005; Piermattei and Flo, 2006).



Fig. 2: Pre-operative radiographic assessment of tibial cortical diameter and fracture fragment length (medio-lateral and cranio-caudal views), used for implant sizing.

All fractures were stabilized by open reduction and internal fixation via a standard cranio-medial surgical approach to the tibia (Piermattei and Johnson, 2006). After anatomical reduction, a retrograde IM pin was placed, followed by a contoured PAX plate spanning the fracture and secured with locking screws (2.7 mm or 3.5 mm) placed at variable angles as dictated by fracture configuration and bone stock, following standard PAX/AO plating principles (Johnson *et al.,* 2005). The principal surgical steps are illustrated in Fig. 3. Wound closure used absorbable suture for the deep layers and non-absorbable suture for skin. Peri-operative anaesthesia followed a standard protocol (Bednarski *et al.,* 2011).

Lameness was graded on postoperative days 0, 15, 30, 60 and 90 using the 5-point scale of Vasseur *et al.* (1995), and radiographic reduction/alignment and fracture healing were scored on the same days following Cook *et al.* (1999).

Results and Discussion

Case profile: The six dogs (one Pomeranian, three Labrador Retrievers, one Golden Retriever, one Mongrel) ranged from 6 to 28 months in age (mean 17.33 ± 3.21 months) and 10 to 25 kg in body weight (mean 18.47 ± 2.73 kg); five were male, one female - a distribution consistent with earlier reports (El-Shafey *et al.,* 2022; Radha *et al.,* 2023; Kostenko *et al.,* 2024).

Aetiology and fracture pattern: Motor vehicle trauma accounted for five of six cases (83.33%) and a fall from height for the remaining case, with a mean interval of 4.83 ± 0.83 days (range 2-8 days) between injury and presentation, in agreement with Harasen (2003) and Ali (2013). Fractures were predominantly mid-diaphyseal (four of six dogs), with one proximal- and one distal-diaphyseal fracture, consistent with Raghunath *et al.* (2007). Closed, simple

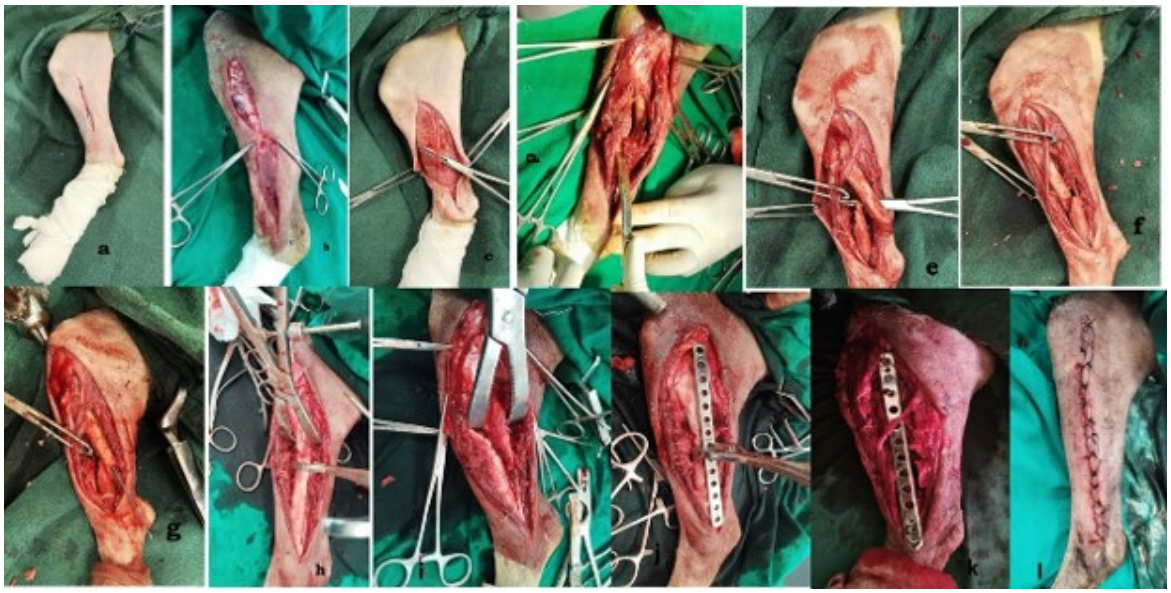


Fig. 3: Pre-operative radiographic assessment of tibial cortical diameter and fracture fragment length (medio-lateral and cranio-caudal views), used for implant sizing.

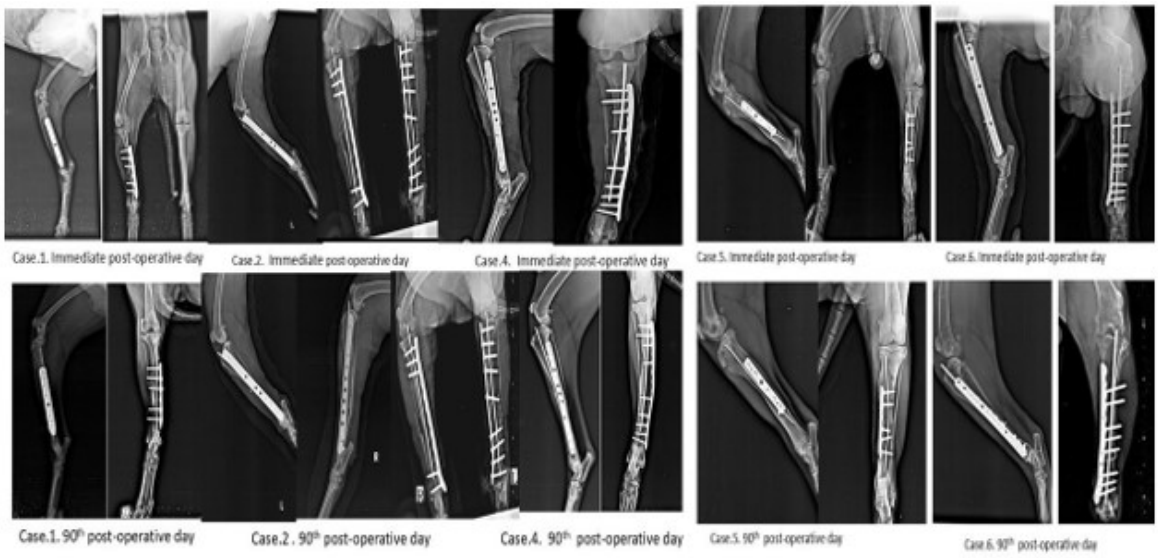


Fig. 4: Radiographic evaluation of fracture healing over the follow-up period

oblique fractures (AO/ASIF type A2) were seen in four dogs, while the remaining two dogs had spiral fractures; one dog presented with a unilateral type B1 fracture and the other with bilateral tibial fractures classified as types B1 and C1.

Implant selection and surgery: Following the weight- and radiograph-based selection approach of Johnson *et al.* (2005), the two dogs weighing ≤15 kg were stabilized with 6-hole 2.7 mm PAX plates and 1.8 mm IM pins, while the four dogs >15 kg received 12- to 14-hole 3.5 mm PAX plates with 2.5-3.0 mm IM pins, in line with the screw-diameter safety margin (≤40% of bone diameter at the fracture site) recommended by Rüedi and Murphy (2000). Surgical time (40-90 min) varied largely with the degree of soft-tissue swelling and fragment overriding, which ranged from mild to marked. The polyaxial mechanism, which permits screw angulation within a 20° cone, allowed screw placement to be adapted to periarticular constraints without compromising rigid fixation, corroborating the observations of Wilkens *et al.* (2008) and Barnhart *et al.* (2013).

Complications: Transient plate bending occurred in one case (23 kg, high activity level) on postoperative day 15, but did not progress further and did not affect eventual healing,

consistent with the findings of Robinson (2014) and Reddy *et al.* (2021).

Functional outcome: All dogs presented with grade V (non-weight-bearing) lameness pre-operatively. Lameness improved progressively through days 15 and 30, and all six dogs had reached grade I (normal weight-bearing) by day 60, sustained through day 90, consistent with the observations of Vasseur *et al.* (1995) and Vallem *et al.* (2025).

Radiographic union: Reduction/alignment scores (0 = anatomical) ranged from 1 to 2/3. The three dogs with minimal malreduction (score 1) achieved radiographic union (healing score 0) by day 30, while the remaining dogs, which had moderate-to-severe malreduction, achieved union by day 60-90; no case progressed to delayed union or non-union. Representative radiographic progression of fracture healing is shown in Fig. 4. These findings support the principle, also reported by Cook *et al.* (1999) and Robinson (2014), that rigid internal fixation may compensate for imperfect anatomical reduction.

In short, in this case series, polyaxial locking plate combined with intramedullary pin (plate-rod) fixation appeared to provide reliable stabilization of canine tibial diaphyseal fractures across varied fracture configurations and patient sizes. The system's angular flexibility may reduce the risk to adjacent joints and physes, appeared to support return to normal weight-bearing by day 60, and was associated with complete radiographic union in all cases by day 90 without major implant-related complications.

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