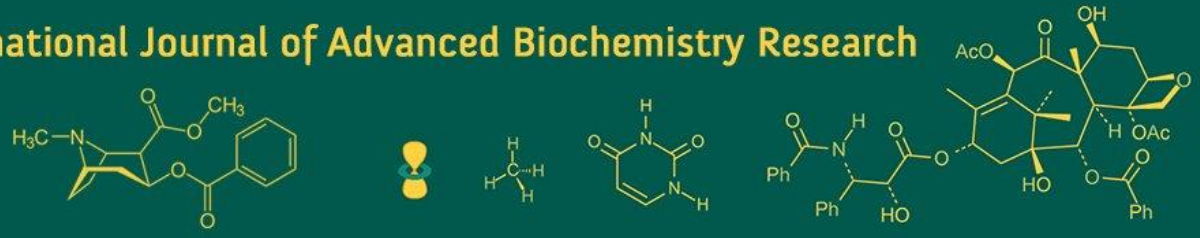
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(12): 618-621
www.biochemjournal.com
Received: 26-10-2025
Accepted: 29-11-2025

Sachin D Huddar
MVSc Scholar, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Ravi Raidurg
Professor & Head, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Dilipkumar D
Senior Professor & DI (PGs), Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Bhagavantappa B
Associate Professor & Head, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Manjunath Patil
Associate Professor, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Sandeep Halmandge
Professor & Head, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Corresponding Author:
Sachin D Huddar
MVSc Scholar, Department of Veterinary Surgery and Radiology, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India

Biochemical evaluation during femoral and tibial fracture repair in dogs using point contact fixator plate system (PC-Fix) and Locking Compression Plate (LCP)

Sachin D Huddar, Ravi Raidurg, Dilipkumar D, Bhagavantappa B, Manjunath Patil and Sandeep Halmandge

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i12h.6597

Abstract
This clinical study evaluated biochemical markers of fracture healing in dogs treated with Point Contact Fixator (PC-Fix) and Locking Compression Plate (LCP) systems. Twelve dogs with femoral or tibial diaphyseal fractures were randomly assigned to two groups: Group I treated with PC-Fix and Group II treated with LCP. Serum alkaline phosphatase, serum calcium and serum phosphorus levels were measured pre-operatively and on post-operative days 0, 15, 30, 45 and 60. Alkaline phosphatase was highest pre-operatively, declined by day 30 and showed a slight increase by day 60, reflecting osteoblastic activity. Calcium and phosphorus concentrations increased steadily until day 30, then declined, indicating active bone remodelling and mineral metabolism. All values remained within physiological limits. Both implant systems demonstrated effective stabilization and comparable biochemical healing profiles, with PC-Fix showing slightly earlier functional recovery. These findings highlight the utility of biochemical markers in monitoring fracture healing and affirm the clinical viability of both implant systems in canine orthopaedics.

Keywords: Canine fractures, PC-Fix, locking compression plate, serum alkaline phosphatase, serum calcium, serum phosphorus

Introduction
Fractures of long bones in companion animals represent a major orthopaedic concern in veterinary medicine, with dogs being particularly predisposed (Raouf *et al.*, 2017) [1]. The growing canine population and changing urban lifestyles have increased the likelihood of accidents involving vehicles and built environments, contributing to a steady rise in fracture incidence over recent decades. Such injuries occur when external forces exceed the bone's inherent tensile or compressive strength, resulting in disruption of its continuity (Sumiran *et al.*, 2021) [14]. In canine patients, fractures not only cause immediate pain and functional impairment however, if inadequately managed, may progress to complications such as chronic lameness, osteomyelitis, or non-union, all of which significantly reduce quality of life and impose financial burdens on owners.

Fracture repair is a multifaceted biological process characterized by cellular proliferation, callus development and subsequent mineralization. Epidemiological data consistently highlight the femur as the most frequently fractured long bone in dogs, accounting for more than half of reported cases, followed by the tibia-fibula complex at approximately 10%. Other sites, including the radius-ulna and humerus, show comparatively lower frequencies (Aithal *et al.*, 1999) [2]. Biochemical indicators such as serum alkaline phosphatase, calcium and phosphorus serve as useful markers of osteoblastic activity and bone remodelling during recovery. While radiographic imaging and clinical evaluation remain the primary methods for assessing fracture healing, biochemical monitoring provides an additional perspective on the kinetics of repair.

In recent years, internal fixation techniques employing Point Contact Fixator (PC-Fix) and Locking Compression Plate (LCP) systems have gained prominence in canine orthopaedics due to their mechanical and biological advantages.

Nevertheless, limited information exists regarding the biochemical changes associated with these implants. The present study aims to evaluate serum marker dynamics in dogs treated with PC-Fix and LCP systems, thereby establishing correlations between biochemical fluctuations and the progression of fracture healing.

Materials and Methods

The clinical investigation was carried out in the Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, with the objective of evaluating the effectiveness of point contact fixator (PC-Fix) plate and locking compression plate (LCP) systems for managing femoral and tibial fractures in dogs. A total of 12 canine patients with femoral or tibial fractures were randomly allocated into two groups of six (Table 1). Fracture stabilization in Group I was achieved using PC-Fix plates, whereas Group II received fixation with LCP. All surgeries were performed through open reduction and internal fixation (ORIF) technique.

Table 1: Design of study for the repair of femoral and tibial fracture in dogs

Groups	No. of dogs	Implant used for repair of fracture in dogs
I	6	Femoral or tibial fracture repair using Point Contact Fixator plate system (PC-Fix)
II	6	Femoral or tibial fracture repair using Locking Compression plate (LCP)

Clinical observations, including swelling, crepitus, pain and absence of weight-bearing on the affected limb, were documented (Fossum, 2013) [5]. Radiographic assessment was performed using medio-lateral and cranio-caudal views to determine fracture type and implant dimensions. The required screw length and plate size were estimated from measurements taken on the contra-lateral limb (Guiot and Dejardin, 2012) [6].

Prior to surgery, animals were fasted for 12 hours and water was withheld for 6 hours. The operative site was aseptically prepared. Ceftriaxone-tazobactam (20 mg/kg IV) and tramadol (2 mg/kg IV) were administered 30 minutes before anaesthetic induction. Premedication consisted of atropine sulphate (0.045 mg/kg IM) followed by xylazine hydrochloride (1 mg/kg IM). Anaesthesia was induced with propofol (3 mg/kg IV to effect) and maintained using isoflurane (2-2.5%) in oxygen. Endotracheal intubation was performed with appropriately sized tubes.

Dogs were positioned in lateral recumbency. Femoral fractures were exposed through a cranio-lateral incision, involving dissection of the tensor fascia lata, biceps femoris and vastus lateralis muscles. Tibial fractures were approached medially, with careful preservation of neurovascular structures. Fracture fragments were reduced and stabilized using PC-Fix or LCP plates with suitable screws. Surgical wound was closed in layers with polyglycolic acid for muscles and subcutaneous tissue and polyamide sutures for skin. Standard orthopaedic instruments, including bone holding forceps, drill sleeves, depth gauges and battery-powered drills were employed. Implants consisted of 2.7 mm and 3.5 mm PC-Fix or LCP plates (6-11 holes) with non-locking or locking screws respectively ranging from 14-26 mm.

Post-operative care included daily IV ceftriaxone-tazobactam (20 mg/kg) for seven days and tramadol (2 mg/kg) for three days. Dressings were changed every alternate day and sutures were removed on day 14. Controlled leash walking and passive range-of-motion exercises were recommended for 4-6 weeks. Clinical assessments were carried out on days 0, 15, 30, 45 and 60 to evaluate weight-bearing and implant stability. Biochemical markers, serum alkaline phosphatase, calcium and phosphorus were measured pre-operatively and at each post-operative interval using a biochemical analyzer (ERBA-Mannheim, Germany). Intra-operative and post-operative complications were recorded. Statistical analysis of biochemical data was performed using Student's *t*-test (Snedecor and Cochran, 1994) [13]. A *p*-value less than 0.05 was considered statistically significant.

Results

Serum alkaline phosphatase (IU/L): In Group I, enzyme concentrations showed a statistically significant decline on days 0, 15, 30, 45 and 60 ($p \leq 0.01$) when compared with pre-operative values. A comparable pattern was observed in Group II, with significant reductions at the same post-operative intervals ($p \leq 0.01$) relative to baseline. For both groups, peak enzyme activity was noted prior to surgery, after which levels progressively decreased up to day 60. Despite these variations, all measurements remained within the normal physiological range (Table 2).

Serum Calcium (mg/dL): In Group I, serum calcium levels exhibited statistically significant increase on days 0, 15 and 30 following surgery ($p \leq 0.01$) compared with pre-operative values. Group II showed a comparable pattern, with a significant rise on day 0 ($p \leq 0.05$) and further increases on days 15 and 30 ($p \leq 0.01$) relative to baseline. Across both groups, calcium concentrations increased progressively from the pre-operative stage until day 30, when peak values were observed, before declining by day 60. Throughout the study period, all recorded measurements remained within the normal physiological range (Table 2).

Serum Phosphorous (mg/dL): In Group I, serum phosphorus concentrations showed statistically significant variations ($p \leq 0.01$) at all postoperative intervals compared with pre-operative values. Group II displayed a similar pattern, with significant differences ($p \leq 0.01$) recorded on days 0, 15, 30, 45 and 60 following surgery. Across both groups, phosphorus levels were consistently elevated, rising steadily from the pre-operative stage to reach a peak on day 30, after which they declined by day 60. The maximum values were observed on the 30th day in each group. Despite these changes, all measurements remained within the normal physiological limits (Table 2).

Table 2 illustrates the variations in mean ± SE values of serum alkaline phosphatase, serum calcium and serum phosphorus across different time intervals.

Table 2: Mean±SE of biochemical parameters at different intervals in dogs of Group I and Group II

Biochemical parameter	Groups	Pre-operative	0th day	15th day	30th day	45th day	60th day
Serum alkaline phosphatase (ALP)	I	106.13±0.88	101.65±0.92**	93.10±0.64**	88.93±0.79**	89.37±0.53**	94.62±0.50**
	II	106.42±0.84	101.57±0.74**	94.98±1.16**	90.07±0.41**	91.12±0.65**	96.07±0.42**
Serum calcium (Ca)	I	10.32±0.15	11.05±0.13**	11.54±0.13**	12.00±0.07**	10.60±0.13	9.97±0.09
	II	10.48±0.16	11.07±0.15*	11.67±0.13**	12.02±0.07**	10.75±0.14	10.08±0.17
Serum phosphorous (P)	I	3.23±0.07	3.62±0.07**	4.20±0.09**	4.70±0.06**	4.43±0.07**	4.13±0.05**
	II	3.32±0.08	3.78±0.09**	4.15±0.08**	4.85±0.08**	4.34±0.10**	4.05±0.09**

- Means bearing superscript * differs significantly ($p \leq 0.05$) from interval 'before' with in group
- Means bearing superscript ** differs significantly ($p \leq 0.01$) from interval 'before' with in group

At each time point, comparison of the two groups showed no statistically significant differences ($p>0.05$) across the three biochemical parameters.

Discussion

Serum Alkaline Phosphatase (IU/L): In Groups I and II, enzyme levels were highest pre-operatively and reached their lowest on day 30, with a slight rise by day 60, all within normal limits. Similar trends were noted by Patil *et al.* (2017) [10], Ojus *et al.* (2022) [9] and Kumar *et al.* (2023) [8]. Elevated values during healing have been linked to chondroblastic activity and periosteal enzyme content of fractured bone (Ojus *et al.*, 2022) [9]. While Chaurasia *et al.* (2019) [4] and Bidari *et al.* (2023) [3] reported increases up to days 15 and 30, respectively.

Serum Calcium (mg/dL): Both groups showed a steady rise from pre-operative day to a peak at day 30, followed by gradual decline through day 60, with all values within physiological range. These findings agree with Kumar *et al.* (2018) [7], Reddy *et al.* (2021) [12] and Pooja *et al.* (2025) [11]. The transient rise until day 30 may reflect osteoclastic resorption of necrotic bone (Pooja *et al.*, 2025) [11]. Conversely, Chaurasia *et al.* (2019) [4] reported significantly higher pre-operative levels that declined until day 30, then slightly increased by day 60.

Serum Phosphorus (mg/dL): Mean phosphorus levels increased until day 30, then declined through day 60, remaining within normal limits. Similar patterns were noted by Bidari *et al.* (2023) [3] and Kumar *et al.* (2023) [8]. Bidari *et al.* (2023) [3] attributed the decline to osteoclastic resorption, whereas Patil *et al.* (2017) [10] found no significant differences across time points, reporting a gradual increase until day 60.

Conclusion

Biochemical evaluation revealed consistent patterns of fracture healing in dogs treated with PC-Fix and LCP systems. Serum alkaline phosphatase peaked pre-operatively, decreased following surgery and increased modestly by day 60, reflecting osteoblastic function and periosteal healing. Serum calcium and phosphorus reached maximum levels around day 30 before declining, consistent with ongoing bone remodelling and mineral metabolism during recovery. Both implants demonstrated reliable stabilization and effective healing, with minimal complications. Biochemical markers serve as useful adjuncts to clinical and radiographic assessments, enhancing understanding of fracture healing dynamics.

References

1. Abd El Raouf M, Mekkawy NH, Abd El-Aal AM. Femur fractures and treatment options in 20 dogs admitted to our clinic from January 2013 to December 2015. Iraqi Journal of Veterinary Sciences. 2017;31(2):117-122.
2. Aithal HP, Singh GR, Bisht GS. Fractures in dogs: A survey of 402 cases. Indian Journal of Veterinary Surgery. 1999;20(1):15-21.
3. Bidari K, Doddamani Jahangirbasha DD, Bhagavantappa B. Biochemical changes during repair of long bone fracture using string-of-pearls locking plate in dogs. Pharma Innovation Journal. 2023;12(9):1481-1484.
4. Chaurasia A, Jawre S, Singh R, Shahi A, Pathak R, Das B, Verma NK. Evaluation of haemato-biochemical parameters using different biomaterials in fracture healing of dogs. International Journal of Current Microbiology and Applied Sciences. 2019;8(5):2265-2271.
5. Fossum TW. Fundamentals of orthopedic surgery and fracture management. In: Fossum TW, editor. Small Animal Surgery. 4th ed. St. Louis (MO): Elsevier Health Sciences; 2013. p. 1034-1036.
6. Guiot LP, Déjardin LM. Perioperative imaging in minimally invasive osteosynthesis in small animals. Veterinary Clinics of North America: Small Animal Practice. 2012;42(5):897-911.
7. Kumar KM, Prasad VD, Lakshmi ND, Raju NK. Evaluation of biochemical parameters for assessment of fracture healing in dogs. Pharma Innovation Journal. 2018;7(3):577-580.
8. Kumar R, Prasad D, Sreenu M, Naidu V, Raju NKB. Biochemical evaluation of the effect of biomaterials on long bone fractures stabilized with positive profile end-threaded stainless steel and titanium intramedullary pins in dogs. Pharma Innovation Journal. 2023;12(7):1801-1803.
9. Ojus S, Dilipkumar D, Bhagavantappa B, Vijay Kumar M, Halmandge S, Patil M, Venkatgiri. Physiological and biochemical analysis of dogs undergoing femoral fracture repair using advanced locking plate system II and locking compression plate. Pharma Innovation Journal. 2022;11(1):1137-1141.
10. Patil M, Dilipkumar D, Shivaprakash BV, Kasaralikar VR, Tikare VP, Ramesh BK. Physiological and haemato-biochemical changes during repair of femur fracture in dogs. Pharma Innovation Journal. 2017;6(8):381-385.
11. Pooja HS, Desai D, Patil M. Evaluation of modified advanced locking plate system by MIPO and ORIF techniques for tibial fracture repair in dogs. Indian Journal of Veterinary Sciences and Biotechnology. 2025;21(1):52-57.
12. Reddy KJ, Kumar DD, Sekhar EC, Kulkarni S, Kumar MV, Dhoolappa M. Evaluation of haemato-biochemical

parameters in repair of femoral fractures using titanium implants of intramedullary interlocking nail, dynamic compression plate and locking compression plate in dogs. Journal of Experimental Zoology India. 2021;24(1):223-226.
13. Snedecor GW, Cochran WG. Statistical Methods. 8th ed. Ames (IA): Iowa State University Press; 1994. p. 138-169.
14. Sumiran N, Rao T, Latha C, Kumar D, Lakshman M. Incidence, occurrence and classification of tibial diaphyseal fractures in dogs. International Journal of Livestock Research. 2021;11(9):9-15.