SHORT COMMUNICATION

Haemato-Biochemical Effects of Silver Fluorophosphate in Long Bone Fracture Repair in Dogs

Dhruv H. Saradva[1], Jignesh J. Vadalia[2*], Raghuvir H. bhatt[3], Vaibhavsinh D. Dodiya[3], Raisudin N. Badi[1]

Abstract

The objective of this study was to evaluate haematological and biochemical changes with silver fluorophosphate supplementation in the repair of long bone fractures in dogs. In Group I (six dog), long bone fractures were immobilized using a locking compression plate (LCP), while in Group II (six dog) long bone fractures were immobilized using LCP along with additional use of silver fluorophosphate granules. The animals were fasted for 12 h, with water withheld for 6 h before surgery for anaesthesia. Routine antibiotics and analgesics were administered and owners were instructed on wound care and limited movement for minimum 20 days. Results of haemato-biochemical evaluation carried out between two groups at fortnightly intervals showed non-significant ($p>0.05$) differences in all the parameters between the two groups and between periods within the group, except packed cell volume, serum calcium and alkaline phosphatase levels, which while differed significantly ($p<0.05$) between periods, although within normal physiological range.

Key words: Dog, Haemato-biochemical assessment, Long bone fracture, Silver fluorophosphate granules.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.2026.22.06.30

Introduction

Domestic dogs (*Canis lupus familiaris*) are highly prone to fractures from trauma, road accidents or fall from heights. Fracture stabilization can be accomplished through external coaptation (splinting the limb), internal fixation (stabilizing the bone), or external skeletal fixation (Tyagi and Singh, 2008). Treatment of bone defects is a continuous challenge in orthopedic surgery. Large defects that result from trauma, infection, resection of tumors, or other causes usually do not heal spontaneously, and surgical intervention is often required. The most widely used technique for the reconstruction of a bone defect is the use of an autogenous bone graft. However, the disadvantage of this technique is its limited availability and morbidity at the donor site. These disadvantages led to the use of allograft and xenograft. However, the usage of these materials for bone repair has been associated with the risk of rejection and transfer diseases. To overcome these drawbacks of endogenous and exogenous bone grafts, several synthetic bone grafts have been proposed such as silver fluorophosphate in the fracture management Chaurasia *et al.,* 2019; Saradva *et al.* 2025) and dental scaling (Patel *et al.,* 2026).

The primary objective of fracture management is to achieve optimal bone alignment and expedite functional recovery of the affected limb. While radiography is the standard diagnostic tool for monitoring fracture healing, its application in field conditions is challenging. Furthermore, repeated exposure to X-rays poses health risks to both patients and radiographers. In this context, haemato-biochemical parameters may serve as valuable adjuncts in assessing fracture healing (Patil *et al.,* 2017; Reddy *et al.,* 2020; Ruchika *et al.,* 2025). This study was aimed to address this knowledge gap by examining haemato-biochemical changes during the healing of long bone fractures in dogs, with implications of silver fluorophosphate for evaluating fracture repair and patient health.

[1]Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh-362001, Gujarat, India

[2]Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand-388001, Gujarat, India

[3]Veterinary Clinical Complex, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh-362001, Gujarat, India

Corresponding Author: Dr. Jignesh V. Vadalia, Associate Professor & Head, Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand-388001, Gujarat, India. e-mail: jignesh.vadalia@kamdhenuuni.edu.in

How to cite this article: Saradva, D. H., Vadalia, J. J., bhatt, R. H., Dodiya, V. D., & Badi, R. N. (2026). Haemato-Biochemical Effects of Silver Fluorophosphate in Long Bone Fracture Repair in Dogs. Ind J Vet Sci and Biotech, 22(6), 170-173.

Source of support: No specific funding was received for this study.

Conflict of interest: None

Submitted 18/06/2026 **Accepted** 19/07/2026 **Published** 10/11/2026

Materials and Methods

The present clinical study was carried out at the Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University,

© The Author(s). 2026 Open Access This work is licensed under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License.

Junagadh (Gujarat, India) during the year 2024. This clinical study was conducted on 12 cases of long bone fractures in dogs, randomly divided into two groups, each comprising six dogs.

Radiographic Evaluation

In both groups, following a thorough clinical evaluation, the dogs underwent pre-operative mediolateral and cranio-caudal radiographs encompassing the relevant joints using a mobile X-ray machine, which were then processed using a Computed Radiography System. These measurements were crucial in selecting the correct size and length of LCP and screws for the surgical procedure.

Pre-Operative Preparation, Anaesthesia and Surgical Procedure

The affected limb was immobilized with a Robert-Jones bandage until surgery, which was scheduled promptly with routine pre-operative preparations, prophylactic antibiotics (Inj. Amoxicillin-sulbactam, 12.5 mg/kg) and analgesic (Inj. Tramadol, 2 mg/kg) administered intravenously. Pre-anaesthetic Inj. Atropine sulphate, @ 0.04 mg/kg b.wt., was administered subcutaneously along with Ketamine (10 mg/kg b.wt.) and Diazepam (0.5 mg/kg b.wt.) intravenously. Anaesthesia was maintained as needed using the same combination. Animals were positioned in lateral recumbency for the procedure. All the dogs of group-I were operated by open reduction with locking compression plate (LCP), while those of group-II were operated with LCP plate along with silver fluorophosphate (procured from Pandian Advanced Medical Center (P) Ltd. Madurai, Tamil Nadu, India) for immobilization of bone fragments.

After surgical exposure of the fracture site, the fracture fragments were aligned and anatomically reduced to restore both the length and correct rotational alignment of the bone. An LCP was then positioned and fixed over the fracture site. The appropriate screw length for the application of the LCP was determined by measuring the antero-posterior thickness of the bone at various points from the fracture site, as observed on preoperative radiographs. These measurements were confirmed intraoperatively using a depth gauge. Attention was paid to ensure that the locking screws were inserted perpendicular to the plate holes to guarantee proper engagement between the screw threads and the plate. In Group II dogs, the sterilized granular silver fluorophosphates was introduced into the medullary cavity to bridge the defect and promote stabilization (Fig. 1). After the fracture fixation, the fascia lata and subcutaneous tissue were sutured with Vicryl (Polyglactin 910) using a continuous lockstitch suture pattern. The skin incision was subsequently closed with nylon, employing either a horizontal mattress suture or a simple interrupted suture pattern.

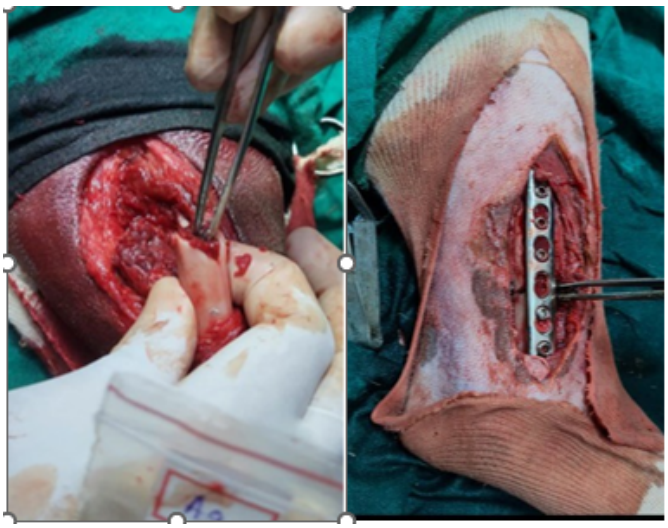


Fig. 1: Placement of the granules at the fracture site and both fracture ends of medullary cavity

Clinico-Haemato-Biochemical Evaluation

The clinical parameters like rectal temperature, heart rate, respiration rate, colour of mucous membrane and capillary refilling time of all dogs were recorded on the day of presentation and a day after surgery in both groups. Blood samples (2 mL) were collected from each dog in EDTA vials to evaluate haematological parameters on the 0^{th}, 15^{th} and 30^{th} postoperative days using automatic haemato-analyzer (Abacus Vet5, Diatron, Budapest, Hungary). Blood samples (4 mL) were collected from each dog in vials without anticoagulant for serum biochemical analysis on the 0^{th}, 15^{th}, 30^{th}, 45^{th} and 60^{th} postoperative days. Serum was separated and stored at -20° C until analysed for calcium, phosphorus and alkaline phosphatase using standard commercially available kits in automatic serum biochemical analyzer (LWC 100 autochemistry analyzer, Shenzhen Landwind Medical, Shenzhen, China). The data generated was analyzed statistically using one way ANOVA and student's 't' test.

Results and Discussion

Clinical Parameters

Upon initial presentation, the recorded rectal temperature (101.68 vs 101.82 °F), respiratory rates (25.17 vs 23.33 beats/min), heart rates (105.33 vs 107.5 pulse/min), colour of mucus membrane (Slight congested to pink) and capillary refill time (1-2 sec) were within normal range, without significant group difference, and almost similar values were noted one day after surgery. Patil *et al.* (2017), and Padaliya

(2024) recorded similar findings in rectal temperature, respiration rates, and heart rates for all fracture cases at the time of presentation, identifying normal values with minor deviations in some parameters

Haematological Parameters

The mean (±SE) values of haemotological parameters recorded in groups I and II dogs preoperatively and on 15th and 30th post-operative day are summarized in Table 1.

Table 1: (Mean ± SE) haematological values of dogs under group I (LCP) and group II (LCP + silver fluorophosphate granules) at different time intervals of long bone fracture repair

Parameter	Days	Group I	Group II
Haemoglobin (g/dL)	0	10.43±0.72	12.05±0.85
	15	11.93±0.77	12.43±0.87
	30	12.47±1.16	13.32±0.82
PCV (%)	0	33.01±1.21^{a}	37.58±1.78^{a}
	15	38.55±1.53^{ab}	40.18±2.20^{ab}
	30	41.91±2.50^{b}	45.76±2.30^{c}
TEC (x10^{6}/µL)	0	5.30±0.38	5.63±0.38
	15	6.53±0.73	5.95±0.39
	30	6.76±0.74	6.30±0.35
TLC (x10^{3}/µL)	0	20.38±5.80	22.62±1.46
	15	17.15±2.58	20.20±1.68
	30	16.11±3.02	18.23±2.03
Neutrophils (%)	0	72.25±0.66	70.92±0.49
	15	71.12±0.49	69.95±0.51
	30	70.38±0.48	69.72±0.52
Lymphocytes (%)	0	22.42±0.75	23.67±0.57
	15	22.93±0.74	24.35±0.62
	30	24.13±0.59	25.38±0.39
Monocytes (%)	0	3.68±0.17	3.75±0.24
	15	4.47±0.43	4.28±0.21
	30	3.82±0.47	3.50±0.19
Eosinophils	0	1.07±0.06	1.15±0.06
	15	1.12±0.05	1.07±0.09
	30	1.28±0.14	1.03±0.15

Means bearing different superscripts (a,b) differ significantly between periods (p≤0.05).

Haematological evaluation revealed no significant (p>0.05) differences in Hb, TEC, TLC, neutrophil, lymphocyte, monocyte, and eosinophil counts between groups throughout the study period (Table 1). However, a progressive increase in Hb, TEC, and PCV values was observed post-operatively with, significant difference only in PCV, indicating erythropoiesis associated with fracture healing, while remaining within normal physiological limits. TLC and neutrophil counts showed a gradual decline from day 0 to day 30, reflecting resolution of inflammation and absence of infection, whereas lymphocyte counts exhibited a mild increase during later post-operative periods, suggesting tissue repair and reduced surgical stress. Monocyte and eosinophil counts showed only minor non-significant fluctuations. These findings were in accordance with Patil *et al.* (2017), Reddy *et al.* (2020), Chaurasia *et al.* (2019), Marvania *et al.* (2020), Deshpande (2023) and Padaliya (2024). PCV values increased progressively from day 0 to day 30 in both groups, with significant changes (p≤0.05) observed within group. All values remained within the normal physiological range. Similar findings were reported by Padaliya (2024). In the present clinical study, changes in monocyte count observed might be attributed to several factors, including inflammation, tissue repair, immune response and stress response. Monocyte fluctuations are a natural part of the immune and healing responses following fracture repair.

Biochemical Evaluation

The mean (±SE) values of serum biochemical parameters recorded in groups I and II dogs preoperatively (day 0) and on 15^{th,} 30th, 45th and 60th post-operative days are summarized in Table 2.

Table 2: (Mean ± SE) serum biochemical of dogs under group I (LCP) and group II (LCP + silver fluorophosphate granules) at different time intervals of long bone fracture repair

Parameter	Days	Group I	Group II
Calcium (mg/dL)	0	9.20±0.25^{ab}	9.49±0.15^{ab}
	15	8.71±0.2^{a}	9.11±0.16^{a}
	30	9.56±0.12^{bc}	9.75±0.2^{ab}
	45	9.84±0.17^{bc}	9.98±0.18b^{c}
	60	10.19±0.25^{c}	10.53±0.22^{c}
Phosphorus (mg/dL)	0	3.24±0.28	3.42±0.17
	15	3.56±0.27	3.60±0.12
	30	3.71±0.07	3.69±0.24
	45	3.82±0.20	3.87±0.25
	60	4.17±0.13	4.04±0.2
ALP (U/L)	0	104.9±2.97^{ab}	103.9±2.84^{ab}
	15	160.58±6.10^{d}	154.6±5.88^{d}
	30	132.85±5.19^{c}	131.62±5.28^{c}
	45	115.67±2.44^{b}	113.33±3.95^{b}
	60	92.77±1.84^{a}	91.35±2.34^{a}

Means bearing different superscripts (a,b) differ significantly between periods (p≤0.05).

Serum calcium levels showed non-significant differences between groups throughout the study, while significant variations (p<0.05) were observed within groups over time periods. An initial decline in calcium levels up to day 15 was followed by a gradual increase, reaching the highest values on day 60, with all values remaining within the normal physiological range. Similar findings were reported by Reddy *et al.* (2020), Deshpande (2023), Padaliya (2024) and Ruchika *et al.* (2025). The transient decrease in calcium may be due to its utilization during callus mineralization, followed by restoration during the remodeling phase.

Serum phosphorus levels showed non-significant variations (p>0.05) both between and within groups

throughout the study, with all values remaining within the normal physiological range. Similar findings were reported by Kumar *et al.* (2018), Deshpande (2023), and Huddar *et al.* (2025). The gradual slight increase in phosphorus levels during the study may indicate hydroxyapatite formation and mineralization during fracture healing.

Serum ALP levels showed non-significant differences between groups, while significant changes ($p<0.05$) were observed within groups over time periods. ALP levels peaked on day 15 and gradually declined to near-baseline values by day 60. Similar findings were reported by Kumar *et al.* (2018), Reddy *et al.* (2020), Bhavani *et al.* (2022), Padaliya (2024), Huddar *et al.* (2025), and Ruchika *et al.* (2025). The transient rise in ALP reflects increased osteoblastic activity and bone formation during fracture healing, making ALP a useful indicator of the healing process. Osteoblasts play a pivotal role in tissue formation and mineralization, releasing significant amounts of ALP. As callus formation concludes, serum ALP activity returns to baseline levels, along with calcium and phosphorus activity. The elevation in serum ALP is attributed to the periosteum of damaged bone, a rich source of this enzyme. The introduction of osteoinductive biomaterials at the fracture site can amplify osteoblastic activity, leading to increased ALP levels. The presence of an internal fixation device provides stability, reduces trauma-induced stress, and results in a gradual reduction in ALP (Reddy *et al.,* 2020; Bhavani *et al.,* 2022).

In brief, the present findings on haemato-biochemical parameters did not reveal significant differences between the treatment groups, indicating that silver fluorophosphate granules had no adverse effect and were biocompatible in dogs undergoing long bone fracture repair

Acknowledgement

Authors are grateful to the authorities of Kamdhenu University, Principal, College of Veterinary Science & A.H., and Head, Veterinary Clinical Complex, KU, Junagadh for the support and facilities provided.

References

Bhavani, D. S., Krishna, N. H., Sreenu, M., & Venkata, G. (2022). Evaluation of biochemical parameters for assessment of long bone fracture healing in young dogs subjected to bone plating. *The Journal of Pharmaceutical Innovation, 11*(7), 642–644.

Chaurasia, A., Jawre, S., Singh, R., Shahi, A., Pathak, R., Das, B., & Verma, N. K. (2019). Evaluation of haemato-biochemical parameters using different biomaterials in fracture healing of dogs. *International Journal of Current Microbiology and Applied Sciences, 8*(5), 2265–2271.

Deshpande, D. (2023). *Clinical evaluation of zinc and silver fluorophosphate graft strips as osteoinducers for long bone fracture management in dogs* [M.V.Sc. thesis]. Krantisinh Nana Patil College of Veterinary Science, Shirwal, MAFSU, Nagpur, Maharashtra, India.

Huddar, S. D., Raidurg, R., Dilipkumar, D., Bhagavantappa, B., Patil, M., & Halmandge, S. (2025). Biochemical evaluation during femoral and tibial fracture repair in dogs using point contact fixator plate system (PC-Fix) and locking compression plate (LCP). *International Journal of Advanced Biochemistry Research, 9*(12), 618–621.

Kumar, K. M., Prasad, V. D., Lakshmi, N. D., & Raju, N. K. B. (2018). Evaluation of biochemical parameters for assessment of fracture healing in dogs. *The Pharma Innovation, 7*(3), 577–580.

Marvania, N. T., Tank, P. H., Vadalia, J. V., Singh, V. K., & Kamaliya, R. U. (2020). Comparative assessment of minimally invasive plate osteosynthesis and open plating for repair of long bone fracture in dogs. *Indian Journal of Veterinary Surgery, 41*(1), 1–5.

Padaliya, N. R. (2024). *Comparative clinical evaluation of bone substitute along with locking compression plate for repair of long bone fracture in dogs* [Ph.D. thesis]. College of Veterinary Science and Animal Husbandry, Kamdhenu University, Gandhinagar, Gujarat, India.

Patel, R., Parihar, A. S., Gangil, R., Raghuvanshi, P. D. S., & Shrivastava, N. (2026). Comparative evaluation of silver nanoparticles gel and metronidazole gel with dental scaling in dogs. *Indian Journal of Veterinary Science and Biotechnology, 22*(4), 140–142.

Patil, M., Dilipkumar, D., Shivaprakash, B. V., Kasaralikar, V. R., Tikare, V. P., & Ramesh, B. K. (2017). Physiological and haemato-biochemical changes during repair of femur fracture in dogs. *The Pharma Innovation, 6*(8), 381–385.

Reddy, G. A. K., Kumar, V. G., Raghavender, K. B. P., & Kumar, D. P. (2020). Evaluation of haemato-biochemical parameters for assessment of fracture healing in dogs. *Pharma Innovation Journal, 9*(9), 123–125.

Ruchika, Nagaraja, B. N., Mahesh, V., Anilkumar, M. C., & Girish, M. H. (2025). Evaluation of physiological, haemato-biochemical parameters in tibial shaft fracture repair by supracutaneous plating technique in cats. *Indian Journal of Veterinary Science & Biotechnology, 21*(1), 69–72.

Saradva, D. H., Vadalia, J. J., Parmar, V. L., Fefar, D., & Padaliya, N. R. (2025). Clinical and radiological evaluation of silver fluorophosphate in the treatment of long bone fractures in dogs. *Indian Journal of Veterinary Sciences and Biotechnology, 21*(6), 71–77.

Tyagi, R. P. S., & Singh, J. (2008). Fractures. In *The musculoskeletal system* (Section D, pp. 343). CBS Publishers and Distributors.