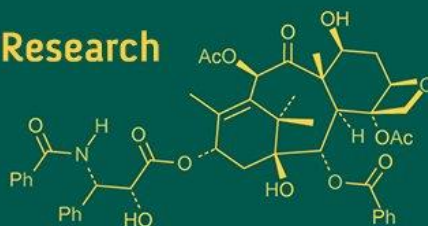


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(8): 240-242
www.biochemjournal.com
Received: 01-06-2026
Accepted: 04-07-2026

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Haemato-biochemical variations during femoral fracture repair by using intramedullary pin and intramedullary horn pegs in dogs

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8c.9514>

Abstract

Femoral fractures in dogs represent a significant clinical challenge requiring stable fixation and biocompatible materials for effective healing. This study evaluated haemato-biochemical variations in twelve dogs with diaphyseal femoral fracture repaired with intramedullary pinning (Group A, n = 6) and intramedullary horn peg (Group B, n = 6). Blood parameters including total erythrocyte count, haemoglobin, total leukocyte count, packed cell volume, differential leukocyte count, serum calcium, serum phosphorus, serum creatinine, serum alanine aminotransferase, and serum alkaline phosphatase were monitored pre-operatively and 0th, 7th, 15th, 30th, 45th and 60th postoperative day. All parameters remained within normal physiological ranges with non-significant variation ($p > 0.05$). Transient postoperative leucocytosis and neutrophilia resolved by day 15, while serum alkaline phosphatase showed a mild rise peaking at day 30, indicating bone remodelling activity. These findings support the biocompatibility of both fixation methods and stable systemic health during fracture healing.

Keywords: Femoral fracture, haemato-biochemical, intramedullary pinning, intramedullary horn peg, fracture healing

1. Introduction

Femoral fractures constitute approximately 37-45% of long bone fractures in dogs, primarily affecting young males of non-descript and large breeds due to road traffic accidents. Diaphyseal fractures demand rigid internal fixation to restore limb function, with intramedullary pinning providing axial stability and biological alternatives like buffalo horn pegs offering semi-rigid support with enhanced biocompatibility. Pre-operative haemato-biochemical profiles assess surgical fitness, while post-operative monitoring detects complications and healing progress. This study analysed changes in these parameters during femoral diaphyseal fracture repair using stainless steel pins versus buffalo horn peg in twelve clinical canine cases.

2. Materials and Methods

Twelve dogs with diaphyseal femoral fractures, were presented to the Veterinary College Hospital, Hebbal, Bengaluru. Irrespective of age, breed and gender, the dogs were randomly assigned to Group A (intramedullary Steinmann pin) and Group B (buffalo horn peg, prepared from compact horn sections, autoclaved). Blood was collected from cephalic/saphenous veins. Hematological parameters including total erythrocyte count (TEC, 10⁶ cells/cmm), total leukocyte count (TLC, 10³ cells/cmm), packed cell volume, hemoglobin (Hb, g/dL), and differential leukocyte count (DLC, %) were analyzed using the Mindray BC-2800 Vet automated hematology analyzer. Biochemical indices such as serum calcium (mg/dL), serum phosphorus (mg/dL), serum alanine aminotransferase (IU/L), serum alkaline phosphatase (IU/L) and serum creatinine (mg/dL) were evaluated using micro lab instruments RX-50 Biochemical semi-auto analyzer using diluent reagents as per the manufacturer guidelines. The resulting hematological and biochemical data were subjected to statistical evaluation through student t test with the computer-based statistical program GraphPad Prism.

3. Results and Discussion

3.1 Haematological Analysis

3.1.1 Total Erythrocyte Count (TEC, millions/cmm)

In Group A, the mean $\pm$ SE total erythrocyte count (TEC) was 6.25 ± 0.25 before surgery and ranged from 6.23 ± 0.35 to 6.42 ± 0.22 on post-operative days 0, 7, 15, 30, 45 and 60 with no significant change during the post-operative period (Table 1). In Group B, the pre-operative mean $\pm$ SE, TEC was 6.30 ± 0.26 and postoperative values ranged from 6.26 ± 0.18 to 6.62 ± 0.06 across the same time points, likewise showing no significant post-operative increase. Overall, there were no statistically significant differences between intervals throughout the study ($p > 0.05$), and all TEC values remained within normal physiological limits. These findings were in alignment with Gahlot (2007) [2].

3.1.2 Haemoglobin (Hb, g/dL)

In Group A, mean hemoglobin prior to surgery was 12.18 ± 0.77 g/dL and post-operatively ranged from 12.12 ± 0.41 to 12.43 ± 0.51 g/dL across days 0, 7, 15, 30, 45 and 60; in Group B, mean pre-operative hemoglobin was 12.20 ± 0.28 g/dL and post-operative values ranged from 12.16 ± 0.11 to 13.02 ± 0.11 g/dL over the same time points (Table 1). No significant changes in mean hemoglobin were observed within either group during the post-operative period, and there were no statistically significant differences between intervals throughout the study ($p > 0.05$). All hemoglobin measurements remained within normal physiological limits. these findings were in agreement with Hansda *et al.* (2012) [3].

3.1.3 Total Leucocyte Count (TLC, thousands/cmm)

In Group A, mean total leukocyte count (TLC) was $13.33 \pm 1.94 \times 10^3/\mu\text{L}$ pre-operatively and ranged from 12.10 ± 0.71 to $13.47 \pm 0.87 \times 10^3/\mu\text{L}$ on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, pre-operative TLC was 13.72

$\pm 0.37 \times 10^3/\mu\text{L}$ and post-operative values ranged from 12.70 to $13.62 \pm 0.30 \times 10^3/\mu\text{L}$ over the same time points. No significant changes in mean TLC were detected within either group during the post-operative period, and there were no statistically significant differences between intervals across the study ($p > 0.05$). All TLC measurements remained within normal physiological limits (Table 1). Similar observations were documented by Tembhrne *et al.* (2010).

3.1.4 Packed Cell Volume (PCV, %)

In Group A, mean packed cell volume (PCV) was $37.65 \pm 2.30\%$ pre-operatively and ranged from $35.90 \pm 2.20\%$ to $37.60 \pm 1.54\%$ on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, preoperative PCV was $38.70 \pm 0.84\%$ and post-operative values varied from $35.65 \pm 0.26\%$ to $40.30 \pm 0.32\%$ over the same time points. There were no statistically significant changes in mean PCV within or between groups throughout the study period ($p > 0.05$), and all PCV measurements remained within normal physiological limits (Table 1). Similar findings were reported by Chaurasia *et al.* (2019) [1].

3.1.5 Differential Leucocyte Count (%)

Group A had preoperative neutrophils $72.98 \pm 2.00\%$ (post-op 71.02 - 76.32%), Group B $78.67 \pm 1.46\%$ (post-op 75.16 - 84.16%) (Table 1). Lymphocytes averaged $20.22 \pm 1.64\%$ (A, post-op 17.90 - 19.22%) and $21.88 \pm 0.72\%$ (B, post-op 18.00 - 21.08%). Monocytes and eosinophils were comparable and stable (A, preop $4.77 \pm 0.35\%$, $3.71 \pm 0.11\%$; B preop $4.78 \pm 0.24\%$, $3.01 \pm 0.18\%$). No basophils were detected. Although Group B showed higher neutrophils, all differentials remained within normal limits and interval differences were not significant ($p > 0.05$) (Table 1). These findings were in accordance with Hansda *et al.* (2012) [3].

Table 1: Haematological parameters (Mean $\pm$ SE)

Parameter		Before surgery	0 th day	7 th day	15 th day	30 th day	45 th day	60 th day
TEC (millions/cmm)	Group A	6.25 ± 0.25	6.23 ± 0.35	6.30 ± 0.36	6.35 ± 0.12	6.36 ± 0.30	6.38 ± 0.16	6.42 ± 0.22
	Group B	6.30 ± 0.26	6.26 ± 0.18	6.35 ± 0.15	6.41 ± 0.10	6.46 ± 0.08	6.48 ± 0.07	6.62 ± 0.06
Hb (g/dL)	Group A	12.18 ± 0.77	12.12 ± 0.41	12.25 ± 0.73	12.27 ± 0.68	12.29 ± 0.62	12.32 ± 0.56	12.43 ± 0.51
	Group B	12.20 ± 0.28	12.16 ± 0.11	12.29 ± 0.09	12.31 ± 0.09	12.41 ± 0.08	12.28 ± 0.12	13.02 ± 0.11
TLC (thousands/cmm)	Group A	13.33 ± 1.94	13.47 ± 0.87	12.68 ± 1.53	12.36 ± 0.65	12.20 ± 0.70	12.12 ± 0.59	12.10 ± 0.71
	Group B	13.72 ± 0.37	13.62 ± 0.30	13.42 ± 0.29	13.30 ± 0.24	13.25 ± 0.18	12.95 ± 0.16	12.70 ± 0.11
PCV (%)	Group A	37.65 ± 2.30	36.65 ± 1.23	35.90 ± 2.20	37.00 ± 2.05	36.80 ± 1.85	37.10 ± 1.68	37.60 ± 1.54
	Group B	38.70 ± 0.84	36.70 ± 0.33	35.65 ± 0.26	36.55 ± 0.26	37.45 ± 0.24	38.65 ± 0.35	40.30 ± 0.32
Neutrophil (%)	Group A	72.98 ± 2.00	74.58 ± 1.93	$76.32^* \pm 1.45$	$74.54^* \pm 1.35$	72.70 ± 1.90	71.02 ± 2.44	73.58 ± 2.70
	Group B	78.67 ± 1.46	80.62 ± 1.32	82.22 ± 1.30	$84.16^* \pm 0.99$	$82.55^* \pm 0.63$	80.48 ± 0.66	75.16 ± 0.47
Lymphocytes (%)	Group A	20.22 ± 1.64	19.22 ± 1.01	$19.18^* \pm 1.53$	18.95 ± 1.50	18.87 ± 2.08	18.72 ± 2.08	17.90 ± 2.18
	Group B	21.88 ± 0.72	21.08 ± 0.73	$19.72^* \pm 0.50$	$18.00^* \pm 0.56$	$18.65^* \pm 0.55$	$19.48^* \pm 0.55$	21.08 ± 0.32
Monocytes (%)	Group A	4.77 ± 0.35	4.78 ± 0.61	4.65 ± 0.50	4.54 ± 0.35	4.43 ± 0.65	4.27 ± 0.35	4.14 ± 0.24
	Group B	4.78 ± 0.24	4.55 ± 0.45	4.12 ± 0.25	4.65 ± 0.18	4.91 ± 0.01	4.75 ± 0.22	4.57 ± 0.15
Eosinophils (%)	Group A	3.71 ± 0.11	3.68 ± 0.24	3.53 ± 0.21	3.33 ± 0.13	3.20 ± 0.18	3.14 ± 0.20	3.08 ± 0.38
	Group B	3.01 ± 0.18	2.93 ± 0.26	2.89 ± 0.17	3.03 ± 0.28	3.12 ± 0.28	3.08 ± 0.29	2.97 ± 0.28

Note: Means with the superscript *differ significantly ($p < 0.05$) from intervals within the Group

3.2 Biochemical Parameters

3.2.1 SERUM CREATININE (mg/dL)

In Group A, mean serum creatinine was 0.68 ± 0.05 mg/dL pre-operatively and ranged from 0.64 ± 0.02 to 0.69 ± 0.02 mg/dL on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, pre-operative creatinine was 0.69 ± 0.04 mg/dL with post-operative values from 0.62 ± 0.01 to 0.67 ± 0.04 mg/dL over the same time points (Table 2). No statistically

significant changes were observed between intervals during the study ($p > 0.05$), and all serum creatinine values remained within normal physiological limits.

3.2.2 Serum Calcium (mg/dL)

In Group A, mean serum calcium was 9.95 ± 0.19 mg/dL pre-operatively and ranged from 9.89 ± 0.22 to 10.10 ± 0.18 mg/dL on post-operative days 0, 7, 15, 30, 45 and 60; in

Group B, pre-operative mean was 9.78 ± 0.15 mg/dL with post-operative values varying from 9.69 ± 0.12 to 10.18 ± 0.27 mg/dL over the same time points (Table 2). Mean calcium decreased slightly until day 15 and then rose gradually, but interval differences were not statistically significant ($p > 0.05$). All measurements remained within normal physiological limits. Similar findings were reported by Rani *et al.* (2012) [7].

3.2.3 Serum Phosphorus (mg/dL)

In Group A, mean serum phosphorus was 5.03 ± 0.43 mg/dL pre-operatively and ranged from 5.01 ± 0.29 to 5.69 ± 0.19 mg/dL on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, pre-operative mean was 5.12 ± 0.12 mg/dL with post-operative values between 5.15 ± 0.20 and 5.45 ± 0.27 mg/dL over the same time points (Table 2). A gradual increase in mean phosphorus was observed during the study, but differences between time intervals were not statistically significant ($p > 0.05$), and all values remained within normal physiological ranges. The findings were in concurrence with Prachasilpchai *et al.* (2003) [6].

3.2.4 Serum Alanine Amino Transferase (IU/L)

In Group A, mean serum ALT was 24.62 ± 3.39 IU/L pre-

operatively and ranged from 24.25 ± 2.08 to 25.65 ± 2.87 IU/L on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, pre-operative mean ALT was 24.34 ± 4.15 IU/L with post-operative values between 24.41 ± 4.98 and 25.37 ± 3.39 IU/L over the same time points (Table 2). There were no statistically significant differences between intervals during the study ($p > 0.05$), and all ALT values remained within normal physiological limits. Similar findings were reported by Mahendra *et al.* (2007) [5].

3.2.5 Serum Alkaline Phosphatase (IU/L)

In Group A, mean serum alkaline phosphatase (ALP) was 175.90 ± 11.07 IU/L pre-operatively and ranged from 176.28 ± 11.75 to 180.65 ± 6.99 IU/L on post-operative days 0, 7, 15, 30, 45 and 60; in Group B, pre-operative ALP was 174.35 ± 6.02 IU/L with post-operative values between 176.07 ± 3.50 and 180.53 ± 3.23 IU/L over the same time points (Table 2). There were no statistically significant differences between intervals during the study ($p > 0.05$), and all ALP values remained within normal physiological limits. The observed results were in agreement with Hegde *et al.* (2010) [4].

Table 2: Biochemical parameters (Mean $\pm$ SE)

Parameter		Before surgery	0 th day	7 th day	15 th day	30 th day	45 th day	60 th day
Serum Creatinine (mg/dl)	Group A	0.68 ± 0.05	0.67 ± 0.04	0.66 ± 0.05	0.64 ± 0.02	0.66 ± 0.04	0.67 ± 0.04	0.69 ± 0.02
	Group B	0.69 ± 0.04	0.67 ± 0.04	0.66 ± 0.05	0.63 ± 0.01	0.62 ± 0.02	0.64 ± 0.04	0.62 ± 0.01
Serum Calcium (mg/dl)	Group A	9.95 ± 0.19	9.89 ± 0.22	9.81 ± 0.18	9.80 ± 0.26	9.98 ± 0.26	$10.06 \pm 0.10^*$	10.10 ± 0.18
	Group B	9.78 ± 0.15	9.75 ± 0.13	$9.71 \pm 0.12^*$	$9.69 \pm 0.14^*$	9.89 ± 0.11	10.10 ± 0.17	10.18 ± 0.27
Serum Phosphorous (mg/dL)	Group A	5.03 ± 0.43	5.01 ± 0.29	5.26 ± 0.19	5.33 ± 0.14	$5.57 \pm 0.22^*$	5.63 ± 0.11	5.69 ± 0.19
	Group B	5.12 ± 0.12	5.15 ± 0.20	5.20 ± 0.14	5.22 ± 0.12	5.30 ± 0.17	5.32 ± 0.25	5.45 ± 0.27
Serum Alanine Amino Transferase (IU/L)	Group A	24.62 ± 3.39	25.45 ± 1.85	25.15 ± 2.86	24.25 ± 2.08	25.65 ± 2.87	25.48 ± 3.12	25.62 ± 2.31
	Group B	24.34 ± 4.15	24.41 ± 4.98	24.65 ± 3.50	24.85 ± 2.27	25.02 ± 2.59	25.11 ± 3.82	25.37 ± 3.39
Serum alkaline phosphatase (IU/L)	Group A	175.90 ± 11.07	176.28 ± 11.75	176.46 ± 9.16	176.53 ± 10.70	$178.74 \pm 9.70^*$	$180.55 \pm 8.84^*$	180.65 ± 6.99
	Group B	174.35 ± 6.02	176.08 ± 6.93	176.07 ± 3.50	$177.13 \pm 5.12^*$	$178.20 \pm 5.11^*$	180.42 ± 5.11	180.53 ± 3.23

Note: Means with the superscript *differ significantly ($p < 0.05$) from intervals within the Group

4. Conclusion

Haemato-biochemical parameters stayed within normal limits, with minor non-significant changes indicating no adverse effects from fixation methods or surgery. Early leucocytosis/neutrophilia and ALP fluctuations aligned with inflammation resolution and bone regeneration, affirming both implants' safety for femoral repair.

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