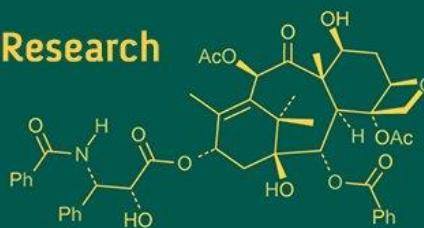


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Haemato-biochemical variations during mandibular fracture with bone defect fixation in dogs using deproteinized microcrystalline hydroxyapatite complex granules along with titanium miniplates

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Abstract

Mandibular fractures in dogs present clinical challenges requiring effective fixation and biocompatible bone regeneration materials. This study evaluated haematological, and biochemical variations during fracture healing in six canine cases treated with titanium miniplates and deproteinized microcrystalline hydroxyapatite complex (MCHC) granules. Blood samples were analysed for total erythrocyte count, total leukocyte counts, hemoglobin, differential leukocyte profiles, and biochemical markers including calcium, phosphorus, creatinine, alanine aminotransferase, and alkaline phosphatase. Haematological parameters remained within normal ranges, with transient leucocytosis and neutrophilia observed in early post-operative days. Biochemical indices showed minor, non-significant fluctuations. Serum alkaline phosphatase exhibited a temporary rise, suggestive of bone regeneration. Calcium and phosphorus levels indicated their utilization in mineral deposition and bone remodeling. Overall, findings confirmed stable systemic health and effective fracture healing, supporting the biocompatibility of deproteinized MCHC granules with titanium miniplates in mandibular defect repair.

Keywords: Mandibular fracture, haemato-biochemical, titanium miniplate, microcrystalline hydroxyapatite complex granules

1. Introduction

Fracture is a break in the continuity of bone or hard tissue (like cartilage). It can be partial or complete, and may involve one or multiple bones. Occurrence of mandibular fracture is 10%, in that miniature, less than one year old and males are most commonly involved (Minar *et al.* 2013) [6]. Titanium mini-plates were successfully used to repair maxillary and mandibular fractures in dogs and cats, achieving rigid fixation, maximum immobilisation, and early return to eating within six to nine weeks (Bilgili and Kurum, 2003) [2]. Hydroxyapatite, being chemically identical to the inorganic matrix of natural bone, offers synthetic processability, favorable biocompatibility, and osteoconductive properties suitable for filling bone voids and defects, with minimal resorption and rapid osseous integration (Mamun *et al.* 2009) [5]. Pre-operative physiological and haemato-biochemical evaluations are vital for assessing surgical fitness, while post-operative monitoring aids in understanding fracture healing and complications. This study examined changes in these parameters during mandibular fracture repair in six dogs using deproteinized microcrystalline hydroxyapatite complex granules along with Titanium miniplates.

2. Materials and Methods

The present study was carried out among the six clinical cases of dogs presented to the Department of Veterinary Surgery and Radiology, Veterinary College Hospital, Hebbal, Bengaluru. Mandibular fracture with bone defect cases were selected for the study with irrespective of age, breed and sex. For hematological and biochemical assessment, blood samples were obtained from the cephalic or saphenous veins of all six dogs. Hematological parameters—including Total Erythrocyte Count (TEC, 10^6 cells/cmm), Total Leukocyte Count (TLC, 10^3 cells/cmm), 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), alanine aminotransferase (IU/L), 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 one-way Analysis of Variance (ANOVA) with the computer-based statistical program GraphPad Prism.

3. Results and Discussion

3.1 Haematological analysis

3.1.1 Total erythrocyte count ($10^6/\text{cmm}$)

The pre-operative Mean $\pm$ SE of total erythrocyte count was 5.67 ± 0.34 and post-operatively varied from 5.50 ± 0.43 to 6.51 ± 0.27 . The values were gradually increased from 7th post-operative day to 60th post-operative day, this might be due to normal erythropoiesis. All recorded values were within normal range and statistically non-significant ($p > 0.05$). These findings were in agreement with Srinivasa Murthy (2015) [13], and Reddy *et al.* (2020) [11].

3.1.2 Haemoglobin (gm/dL)

The pre-operative Mean $\pm$ SE of haemoglobin level was 12.55 ± 0.86 gm/dL. In post-operative days ranged from 12.03 ± 0.83 to 12.54 ± 0.63 . From post-operative day 7 to day 60 haemoglobin values gradually increased, yet remained within the normal expected range and statistically non-significant ($p > 0.05$). This subtle upward trend might be attributed to natural erythropoietic activity. These findings were in agreement with the findings of Patil *et al.* (2017) [7] and Reddy *et al.* (2020) [11].

3.1.3 Total leucocyte count ($10^3/\text{cmm}$)

The pre-operative Mean $\pm$ SE of total leucocyte count was 15.33 ± 1.88 . Post-operatively varied from 12.86 ± 0.80 to 16.15 ± 1.96 . During the early post-operative days slight increase in the total leucocyte count was noticed and thereafter values were reduced gradually up to 60th day. This transient leucocytosis might be attributed to corticosteroid release influenced by factors such as pain, anaesthesia, trauma, surgical intervention, and localized inflammation. All obtained values were within the normal range and statistically non-significant ($p > 0.05$). Similar observations were documented by Mahesh (2009) [4], and Reddy *et al.* (2020) [11]. Rashmitha (2022) [10] found a statistically significant difference in the total leucocyte count in their study on mandibular plating in dogs.

3.1.4 Differential leucocyte count

Mean $\pm$ SE value of neutrophils (%), lymphocytes (%), monocytes (%) and eosinophils (%) counts post-operatively varied from 70.36 ± 3.08 to 74.32 ± 1.85 , 18.85 ± 1.82 to 21.90 ± 2.38 , 4.10 ± 0.61 to 5.08 ± 0.03 , and 2.73 ± 0.30 to 3.10 ± 0.24 . During the study period all observed values were within the normal range and statistically non-significant ($p > 0.05$). The neutrophil count was higher on initial post-operative days and thereafter reduced gradually. This could be attributed to a diminished inflammatory response, facilitating continuous fracture healing in the absence of exudate formation. Similar findings were reported by Madhura (2013) [3], and Srinivasa Murthy (2015) [13].

3.2 Biochemical parameters

3.2.1 Serum creatinine (mg/dL)

The pre-operatively noticed Mean $\pm$ SE value of the serum creatinine was 0.88 ± 0.07 . Post-operatively up to 60th day, ranged from 0.77 ± 0.06 to 0.97 ± 0.06 . Throughout the study period, the values were fell within the normal range and statistically non-significant ($p > 0.05$). The findings indicate that the anaesthetic protocol, antibiotic and analgesic administration, and MCHC granules utilized for this study had no adverse impact on renal function. These findings were in accordance with Rashmitha (2022) [10] and Yelmule *et al.* (2025) [15].

3.2.2 Serum Alanine aminotransferase (IU/L)

The Mean $\pm$ SE value of pre-operative serum alanine aminotransferase was 43.53 ± 5.70 . Post-operatively up to 60th day, Mean $\pm$ SE of serum alanine aminotransferase level ranged from 33.14 ± 2.62 to 45.62 ± 2.32 . All observed values were within the normal range during the study period and statistically non-significant ($p > 0.05$). Similar findings were reported by Pooja *et al.* (2023) [9] and Yelmule *et al.* (2025) [15].

3.2.3 Serum Alkaline phosphatase (IU/L)

The Mean $\pm$ SE value of pre-operative serum alkaline phosphatase was 127.90 ± 12.19 . Post-operatively up to 60th day, Mean $\pm$ SE of serum alkaline phosphatase level ranged from 132.20 ± 7.07 to 160.94 ± 11.84 . The mean serum alkaline phosphatase (ALP) levels exhibited a gradual rise up to the 30th post-operative day, then gradually decreased up to 60th day. Although the increase in ALP was statistically non-significant ($p > 0.05$), it likely reflects enhanced chondroblastic activity contributing to bone regeneration. The findings were in concurrence with Rashmitha (2022) [10] and Yelmule *et al.* (2025) [15]. Whereas Phaneendra *et al.* (2016) [8] found a significantly increase in the serum alkaline phosphatase values up to 14th post-operative day and values were reached the normal range by 21th post-operative day.

3.2.4 Serum Calcium (mg/dL)

The Mean $\pm$ SE value of pre-operative serum calcium was 9.82 ± 0.17 . Post-operatively values were varied from 9.41 ± 0.32 to 10.48 ± 0.34 . The decrease of serum calcium was noticed from pre-operative day to post-operative 7th day. Thereafter it gradually increased, with a peak was noted on 30th day. The initially reduced serum calcium concentration was likely due to its increased utilization at the fracture site, where it was deposited as calcium salts. In later post-operative days serum calcium values were gradually increased within normal limits and statistically non-significant ($p > 0.05$) might reflect hormonal regulation of calcium metabolism. The observed results were in agreement with Yashvanth (2023) [14] and Yelmule *et al.* (2025) [15]. On the contrary, Srinivas (2022) [12] observed that serum calcium levels were increased up to 15th post-operative day and thereafter decreased gradually up to 60th day in their study.

3.2.5 Serum phosphorus (mg/dL)

The pre-operative Mean $\pm$ SE value of serum phosphorus was 4.07 ± 0.47 . It varied from 3.96 ± 0.27 to 4.35 ± 0.26 post-operatively up to 60th day. The gradual increase in mean serum phosphorus levels occurred up to 7th post-

operative day, thereafter decreased gradually. Statistically non-significant ($p > 0.05$) fluctuations were noted at various points and all values remained within expected normal range. The increase in the serum phosphorus levels indicated the formation of new bone during the mineralisation of extra cellular matrix. The progressive decline in serum phosphorus concentration might be

attributed to osteoclastic activity at the fracture site, resulting in the resorption of necrotic bone tissue. The observed results were in agreement with Pooja *et al.* (2023)^[9] and Yelmule *et al.* (2025)^[15]. However, Bidari *et al.* (2023)^[1] in their study reported that serum phosphorous level was significantly increased on 30th post-operative day thereafter it decreased by 60th post-operative day.

Table 1: Mean $\pm$ SE values of total erythrocyte count (10^6 cells/cmm), haemoglobin (gm/dL), total leukocyte count (10^3 cells/cmm) and differential leukocyte count (%) in dogs

	TEC (10^6 /cmm)	Haemoglobin (gm/dL)	TLC (10^3 /cmm)	Neutrophils (%)	Lymphocytes (%)	Monocytes (%)	Eosinophils (%)
Before surgery	5.67 $\pm$ 0.34	12.55 $\pm$ 0.86	15.33 $\pm$ 1.88	72.98 $\pm$ 2.00	19.22 $\pm$ 1.68	4.85 $\pm$ 0.43	2.98 $\pm$ 0.14
After surgery	5.60 $\pm$ 0.45	12.22 $\pm$ 0.52	15.76 $\pm$ 1.07	73.23 $\pm$ 2.01	19.47 $\pm$ 1.15	4.48 $\pm$ 0.85	2.82 $\pm$ 0.31
Day-7	5.50 $\pm$ 0.43	12.03 $\pm$ 0.83	16.15 $\pm$ 1.96	74.32 $\pm$ 1.85	18.85 $\pm$ 1.82	4.10 $\pm$ 0.61	2.73 $\pm$ 0.30
Day-15	5.89 $\pm$ 0.27	12.25 $\pm$ 0.80	13.28 $\pm$ 0.77	72.55 $\pm$ 1.87	19.57 $\pm$ 1.85	4.85 $\pm$ 0.44	3.03 $\pm$ 0.15
Day-30	6.13 $\pm$ 0.43	12.28 $\pm$ 0.77	12.98 $\pm$ 1.15	71.66 $\pm$ 2.50	20.16 $\pm$ 2.39	5.08 $\pm$ 0.03	3.10 $\pm$ 0.24
Day-45	6.24 $\pm$ 0.13	12.38 $\pm$ 0.69	13.22 $\pm$ 0.97	71.36 $\pm$ 2.55	20.72 $\pm$ 2.14	4.86 $\pm$ 0.51	3.06 $\pm$ 0.28
Day-60	6.51 $\pm$ 0.27	12.54 $\pm$ 0.63	12.86 $\pm$ 0.80	70.36 $\pm$ 3.08	21.90 $\pm$ 2.38	4.76 $\pm$ 0.35	2.98 $\pm$ 0.49

Table 2: Mean $\pm$ SE values of serum creatinine (mg/dl), serum calcium (mg/dl) serum phosphorous (mg/dl), serum alkaline phosphatase (IU/L) and serum alanine amino-transferase (IU/L) in dogs

	Serum creatinine (mg/dL)	Serum Alanine aminotransferase (IU/L)	Serum Alkaline phosphatase (IU/L)	Serum calcium (mg/dL)	Serum phosphorus (mg/dL)
Before surgery	0.88 $\pm$ 0.07	43.53 $\pm$ 5.70	127.90 $\pm$ 12.19	9.82 $\pm$ 0.17	4.07 $\pm$ 0.47
After surgery	0.87 $\pm$ 0.07	45.62 $\pm$ 2.32	138.72 $\pm$ 14.31	9.72 $\pm$ 0.30	4.15 $\pm$ 0.27
Day-7	0.77 $\pm$ 0.06	44.10 $\pm$ 3.79	141.98 $\pm$ 8.10	9.41 $\pm$ 0.32	4.35 $\pm$ 0.26
Day-15	0.87 $\pm$ 0.03	40.00 $\pm$ 2.47	144.08 $\pm$ 9.51	10.14 $\pm$ 0.30	4.25 $\pm$ 0.28
Day-30	0.91 $\pm$ 0.03	36.66 $\pm$ 3.85	160.94 $\pm$ 11.84	10.48 $\pm$ 0.34	4.32 $\pm$ 0.21
Day-45	0.97 $\pm$ 0.06	37.56 $\pm$ 4.22	152.90 $\pm$ 9.27	9.75 $\pm$ 0.15	4.00 $\pm$ 0.17
Day-60	0.82 $\pm$ 0.05	33.14 $\pm$ 2.62	132.20 $\pm$ 7.07	9.65 $\pm$ 0.38	3.96 $\pm$ 0.27

4. Conclusion

The haematological and biochemical evaluations revealed that all parameters remained within normal physiological limits throughout the study period, with only minor, non-significant fluctuations. Transient leucocytosis and elevated neutrophil counts in the early days indicated short-lived inflammatory responses that subsided with healing. Biochemical markers such as serum creatinine and alanine aminotransferase confirmed that anaesthetic, antibiotic, analgesic protocols, and MCHC granules did not adversely affect renal or hepatic function. Serum alkaline phosphatase exhibited a non-significant rise, suggestive of chondroblastic activity and bone regeneration during fracture healing. Serum calcium and phosphorus levels showed minor fluctuations, reflecting their utilization in mineral deposition and remodeling at the fracture site. Overall, haematological and biochemical findings demonstrated stable systemic health, with observed trends supporting effective fracture healing and biocompatibility of MCHC granules.

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