Indian J. Vet. Surg. 45(2): 138-140 December 2024

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Effect of femoral fracture stabilization with titanium elastic stable intramedullary nail on haemato-biochemical profiles in young dogs

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DOI: 10.5958/0973-9726.2024.00032.6 *Received: August, 2024*

Femoral fractures in young dogs pose significant orthopaedic challenges, necessitating comprehensive understanding for effective clinical management. This study aimed to elucidate the hematobiochemical changes in young dogs undergoing surgical stabilization using the titanium elastic stable intramedullary nail (Ti-ESIN) for femoral fractures. Twelve young dogs with femoral fractures received closed reduction and internal fixation via Ti-ESIN, and their haematological and biochemical parameters were evaluated preoperatively and at multiple postoperative intervals.The results revealed a notable rise in haemoglobin and packed cell volume on day 45, coupled with a significant decrease in total leukocyte counts on day 30 and day 45 postoperatively, indicative of preservation of regional blood circulationwith the prevention of infection following the minimally invasive surgical approach. Additionally, fluctuations in mean value of serum calcium and phosphorus were transient in nature and remain within the normal physiologic limits throughout the study period. Bone alkaline phosphatase (BALP) levels underscored the intricate processes of bone healing and turnover during fracture repair. The mean value of BALP significantly higher on day 15 during the study period. These findings provide essential insights into the physiological responses of young dogs to femoral fractures and Ti-ESIN treatment, emphasizing the dynamic adaptation of their bodies to trauma and subsequent surgical intervention.

Key words: *Canine, young dogs, femur fracture, haemoglobin, packed cell volume, total leucocyte count, calcium, phosphorus and bone alkaline phosphatase*

Elastic stable intramedullary nailing (ESIN) is currently considered the gold standard internal fixation technique in surgical treatment of femur and tibial shaft fractures in paediatric patients in human medicine (Marengo *et al*., 2018). In young animals fracture fixation should also focus on minimizing damage to the growth plates and periosteum. The titanium elastic stable intramedullary nail (Ti-ESIN) offers a minimally invasive surgical technique that facilitated early weight-bearing, as it promoted rapid callus formation and restoration of bone continuity (Sandhu *et al*., 2021). The present paper describes the potential impact of this surgical procedure on haematological and biochemical parameters in young dogs.

Twelve apparently healthy young dogs, aged 3-10 months, irrespective of sex and breed, brought for treatment of femur fracture were included in the study. In all the dogs fracture was stabilized with closed reduction and internal fixation technique using Ti-ESIN under general anaesthesia. Postoperatively, antiseptic dressing of the wound was done using 5% povidone-iodine along with parenteral administration of antibiotic ceftriaxone sodium (25 mg/kg body wt, i.m., twice daily for 7 days) and analgesic meloxicam (0.2 mg/kg body wt, i.m. for 3-5 days). Different haematological and biochemical parameters were evaluated on the day of case presentation and on days 15, 30 and 45 postoperatively.

Haematological observations:

The mean values of Hb on the day before surgery was 9.87±0.35, which increased gradually but non-significantly (P>0.05) up to day 30, thereafter on day 45 it increased significantly (11.41±0.35) as compared to the baseline value. The mean values of PCV showed a non-significant (P>0.05) increase on day 15 and day 30 postoperatively, subsequently it increased significantly (P<0.05) on day 45 as compared to baseline value. However, mean values of Hb and PCV fluctuated within normal physiological limits throughout the study period. The increase in Hb and PCV levels may be linked to the physiological stress triggered by the surgical trauma and the release of hormones enhancing the production of red blood cells (Smits *et al*., 2019).

The mean±SE values of TLC varied from 11.05±0.22 to 13.31±0.43. TLC showed a non-significant (P>0.05) decrease on day 15, and a significant (P<0.05) decrease on days 30 and 45 as compared to the baseline value. However, the values remained within the physiological range (5-14 × 10^3/μL) throughout the study period. Reddy *et al.* (2020) have also reported a significant decrease in TLC values on days 15 and 45, postoperatively.

Biochemical observations

The mean values of serum calcium (mg/dL) ranged from 10.18±0.18 to 10.70±0.18, serum phosphorus (mg/dL) ranged from 6.42±0.37 to 7.28±0.18 at different

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Table 1: Mean values (Mean±SE) of haemoglobin (Hb) (g/dl), packed cell volume (PCV (%) and total cell leucocyte (TLC) (10^3/µl) at different time intervals

S. No.	Days	Hb	PCV	TLC
1	0	9.87^{A}±0.35	28.76^{A}±1.26	13.31^{A}±0.43
2	15	10.11^{A}±0.3	30.9^{A}±0.79	12.5^{AB}±0.39
3	.30	10.85^{AB}±0.29	32.45^{AB}±0.79	11.28^{BC}±0.31
4	45	11.41^{B}±0.35	35.06^{B}±1.13	11.05^{C}±0.22

Mean value bearing different superscript in a column (uppercase) differ significantly ($p<0.05$)

Table 2: Mean values (Mean±SE) of calcium (Ca) (mg/dl), phosphorus (P) (mg/dl) and bone alkaline phosphatase (BALP) (ng/dl) at different time intervals

S. No.	Days	Calcium	Phosphorus	BALP
1	0	10.62±0.2	7.23±0.39	8.44^{A}±0.45
2	15	10.18±0.18	6.42±0.37	14.35^{C}±0.91
3	30	10.33±0.11	6.88±0.3	$13B^{C}$±0.48
4	45	10.7±0.18	7.28±0.18	10.68^{AB}±0.59

Mean value bearing different superscript in a column (uppercase) differ significantly ($p<0.05$)

time intervals. The Ca and P levels showed a gradual non-significant decrease on day 15, and subsequently a gradual but non-significant increase up to day 45. However, the values fluctuated within the normal physiological limits throughout the study period.

The decline in Ca and P levels on 15th postoperative day may be due to excessive mobilization of calcium and phosphorus towards the ongoing healing process at the fracture site. Goff (2005) opined that the bone, rich in calcium and phosphorus, experiences increased osteoblast activity, causing an initial transfer of these minerals from the blood to the fracture site causing a temporary reduction in serum Ca and P levels. However, the subsequent increase in serum P levels in later stages could be attributed to heightened osteoblastic activity and collagen synthesis at the fracture site (Singh *et al.,* 2022). These results were similar with the findings of Chourasia *et al.* (2019) and Singh *et al.* (2022), who have reported significant decrease in serum Ca and non-significant decrease in serum P on day 15 postoperatively, and thereafter fluctuation in the values within normal physiological limits up to day 60.

The mean±SE values of bone alkaline phosphatase (BALP) ranged from 8.44±0.45 to 14.35±0.91. The mean BALP value increased significantly on day 15, and then decreased on day 30 but to remain significantly higher as compared to the base line value. The BALP level further decreased on day 45 to remain non-significantly different from the baseline value.

The role of canine bone-specific alkaline phosphatase in fracture healing is significant, as it is an enzyme involved in osteoblast genesis and bone formation. Studies have shown that alterations in BALP were associated with bone turnover, which was more intense in young, growing stage and in the healing process of fractures in canines. This enzyme synthesized by osteoblasts in response to bone injury and played a crucial role in bone matrix calcification (Belic *et al.,* 2010; Sahukhal *et al.,* 2020) correlating with fracture callus volume, bone formation and fracture healing rates. An initial increase in BALP activity in the present study could be related to rapid bone healing (Reddy *et al.,* 2020). Mohamadnia *et al.* (2007) opined that serum activity of bone specific alkaline phosphatase was an excellent indicator of bone formation.

To conclude, the changes in haematological and biochemical parameters following surgical fixation of fractures using Ti-ESIN indicate least surgical trauma and good healing of bone in growing dogs.

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