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Evaluation of serum calcium, phosphorus and alkaline phosphatase levels during long bone fracture repair in dogs stabilized with string of pearls plating technique#

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Abstract

The present study was conducted to evaluate biochemical parameters like serum calcium, phosphorus and alkaline phosphatase during long bones fracture healing in six dogs, which were stabilized with string of pearls (SOP) plate. Statistical analysis revealed no significant variation (P<0.05) in these parameters during the entire period of healing and the values were within the normal range.

Keywords: *Fracture, serum biochemistry, string of pearls*

Fracture is a clinical condition in which there is partial or complete break in the continuity of the hard tissues like cartilage and bone. Fractures of long bones are commonly encountered in small animal orthopaedics (Julie *et al*., 2007, Prabhukumar *et al*., 2019). Faster healing and early ambulation are the ultimate aim of fracture repair (Minar *et al.,* 2013). Hence, monitoring of fracture healing is necessary to track the rate and pattern of fracture healing for early detection of the complications in healing so that necessary intervention can be done. Mukhopadhyay *et al.* (2011) reported that among various monitoring protocols, serum biochemical analysis provides the early sign of fracture healing, fracture complications and fracture diseases. The present study was carried out with the objective of assessing the fracture healing based on serum calcium,

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phosphorus and alkaline phosphatase levels after stabilising the fracture of long bones with string of pearls (SOP) plates in dogs.

Materials and methods

The study was conducted in six clinical cases of fracture of long bones in dogs presented to University Veterinary Hospital, Mannuthy and Kokkalai during the period from March 2019 to December 2020. Routine clinical, radiographical, haematological and serum biochemical examinations were employed following signalment and anamnesis. After confirmation of complete fracture of long bones, six cases irrespective of breed, sex and age were selected for the study. Fractures were stabilised with String of Pearls (SOP) plate using with standard cortical screws following principle laid down by Association of Osteosynthesis (AO).

Whole venous blood samples were collected and serum was separated in all the cases before and immediately after surgery and on second, fourth, sixth and eighth post-operative week. The collected serum was estimated for serum calcium, phosphorus and alkaline phosphatase levels. The level of calcium (mg/dl) in serum was estimated by modified OCPC method using semi auto biochemical analyser (Serum biochemistry analyser-Master T, Hospitex diagnostic, Brentwood, US) with commercially available kit. The level of serum phosphorus (mg/dl) was estimated by phosphomolybdate method using semi auto biochemical analyser with inorganic phosphorus kit. Serum alkaline phosphatase (IU) was estimated by DGKC-SCE recommended procedure using semi auto biochemical analyser with alkaline phosphatase kit. The data regarding serum biochemical parameter values were subjected to standard statistical analysis using SPSS version 24.0.

Results and discussion

Serum calcium level (mg/dL) was 11.97 ± 1.37 on the preoperative day. It was 12.22 ± 1.39 on the day of surgery, 9.59 ± 0.46, 9.58 ± 0.63, 9.89 ± 0.37 and 10.27 ± 0.92 on second, fourth, sixth and eighth postoperative week respectively. In dogs the normal serum calcium values ranged between 9.1- 11.7 mg/dL (Latimer, 2011)

Serum phosphorus level (mg/dL) was 5.6 ± 0.95 on the preoperative day. It was 5.5 ± 1.03 on the day of surgery 5.25 ± 0.54, 4.99 ± 0.52, 5.78 ± 0.56 and 5.61 ± 0.66 on second, fourth, sixth and eighth postoperative week respectively. In dogs the normal phosphorus values ranged between 3.9- 11.7 mg/dL (Latimer, 2011).

Serum alkaline phosphatase level (IU/L) was 261.05 ± 50.01 on the preoperative day. It was 265.75 ± 50.08 on the day of surgery, 263.6 ± 27.81, 254.02 ± 30.6, 233.72 ± 24.62 and 206.98 ± 25.07 on second, fourth, sixth and eighth postoperative week respectively. In dogs the normal alkaline phosphatase values ranged between 1-114 IU/L (Latimer, 2011).

Calcium plays a major role in the process of fracture healing so as to convert soft callus to hard callus through the process of mineralisation (Einhorn *et al.*, 1986 and Claes *et al.*, 2012). In the present study mean serum calcium values were higher on the preoperative day and on the day of surgery and later returned to normal values during subsequent postoperative weeks. The initial

Table 1. Comparison of Serum Biochemistry values

Variables	Pre operative day	Day of surgery	2nd week post operative	4th week post operative	6th week post operative	8th week post operative	F-value (P-value)
Alkaline phosphatase IU/dL	261.05 ± 50.01	265.75 ± 50.08	263.6 ± 27.81	254.02 ± 30.6	233.72 ± 24.62	206.98 ± 25.07	1.663^{ns} (0.232)
Calcium (mg/dL)	11.97 ± 1.37	12.22 ± 1.39	9.59 ± 0.46	9.58 ± 0.63	9.89 ± 0.37	10.27 ± 0.92	1.490^{ns} (0.228)
Phosphorus (mg/dL)	5.6 ± 0.95	5.5 ± 1.03	5.2 ± 0.54	4.99 ± 0.52	5.78 ± 0.56	5.61 ± 0.66	0.296^{ns} (0.791)

ns: non-Significant (P>0.05)

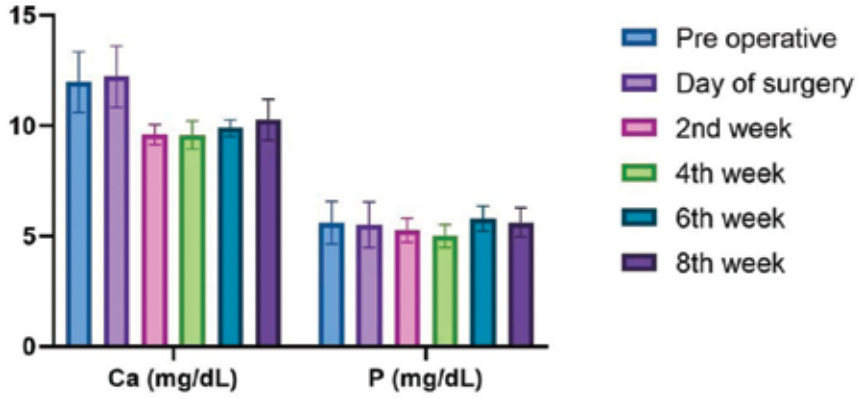

Fig.1. Changes in serum alkaline phosphatase level – Preoperative to 8th post-operative week

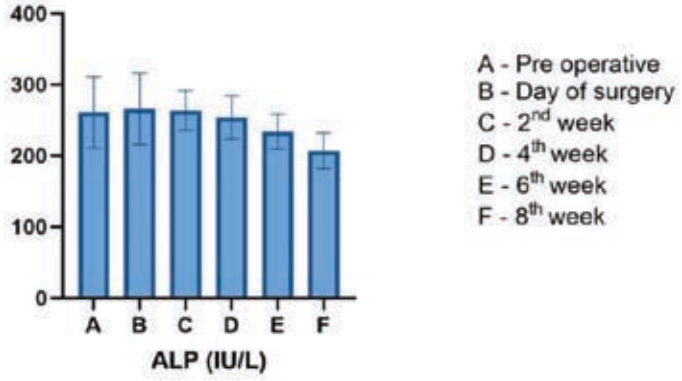

Fig.2. Changes in serum calcium (Ca) and phosphorus (P) levels – Preoperative to 8th post-operative week

rise and subsequent decrease in the levels of serum calcium could be attributed to the crystalline salt deposition in the organic matrix which was principally composed of calcium and phosphates (Fischer *et al.*, 2018). The variation in the level of serum calcium was statistically insignificant. The insignificant variation in the level of serum calcium was in accordance with Subhashchandrabose (2017) and Swathi (2019).

The mean values of serum phosphorus were within the normal range throughout the observation period. Serum phosphorus level decreased for the initial four weeks of post-operative observation followed by an increase in the subsequent weeks. The increase in the levels of serum phosphorus indicated the formation of hydroxyappetite during the mineralisation of extra cellular matrix (Komnenou *et al*., 2005). The variation in the serum phosphorus level was insignificant. These findings were in accordance with the observations of Singh *et al.* (1976), Chandy (2000) and Patil *et al.* (2017).

The mean serum alkaline phosphatase levels were elevated on the preoperative day, on the day of surgery and second postoperative week. Thereafter, there was a decrease in the levels of serum alkaline phosphatase when compared to the day of presentation. The alkaline phosphatase activity might serve as a biomarker for the course and rate of bone healing. The callus formation correlated with either increase, decrease or no change in the activity of alkaline phosphatase in proportionate with amount of callus formation. The minor or no change in the activity of alkaline phosphatase could be attributed to minimal callus formation on account of stable and rigid fixation of fracture (Muljačić *et al.*, 2013). In the present study the variations in the levels of serum alkaline phosphatase was not statistically significant.

The insignificant variation of serum alkaline phosphatase level in the present study was a suggestive of for stable and rigid fixation of fracture with minimum callus formation (Muljačić *et al.*, 2013).

Conclusion

The present study confirmed that serum calcium, phosphorus, and alkaline phosphatase levels were within the normal range suggestive of minimal callus formation during fracture healing. The SOP plate provided stable and rigid fixation of fracture with faster healing of fracture. These biochemical parameters may have to be combined with other parameters for a realistic evaluation of fracture healing process.

Conflict of interest

The authors declare that they have no conflict of interest.

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