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Evaluation of Serum Biochemical Parameters in the Treatment of Tibial Fractures by Open Plating, Percutaneous Plating and Supracutaneous Plating in Dogs

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A B S T R A C T

The present study was conducted in eighteen dogs with tibial diaphyseal fractures which were brought to Teaching Veterinary Clinical Complex, College of Veterinary Science, Rajendranagar, PVNRTVU, Hyderabad. The dogs were treated by open plating, percutaneous plating as well as supracutaneous plating. Biochemical parameters such as serum calcium, serum phosphorous and serum alkaline phosphatase were estimated on 0 day, 3rd week, 6th week and 9th week. The levels of all the three parameters fluctuated in direct relation to the stage of healing and showed no significant difference between the three groups throughout the observation period.

Introduction

Fracture healing depends on several factors such as degree of injury to adjacent soft tissue, displacement of fracture ends, degree of comminution, selected method for stabilization and various patient related factors such as age and presence of co-morbities (Sousa *et al.*, 2015). Normal imaging modality such as plain radiography and clinical evaluation, remain as standard method for assessment of healing. Apart from these, some serum biochemical markers are also useful in the assessment of fracture healing. Also these serological bone turnover markers are proved for early detection of complications. Bone turnover markers (BTMs) are generally subdivided into bone resorption markers, bone formation markers and osteoclast regulatory proteins (Akesson, 1995).

Alkaline phosphatase which is a bone formation marker increases significantly with the progress of bone healing. Serum levels of alkaline phosphatase are the sum of four isozymes: intestinal, placental, liver and bone.

The bone alkaline phosphatase contributes to around 95% and in the absence of pregnancy or intestinal or liver disorder, ALP remain as inexpensive marker for monitoring the bone fracture healing process (Sousa *et al.,* 2015).

The estimation of concentrations of calcium and inorganic phosphrous in serum, which are the essential elements of fracture healing reflect the stage as well as fate of fracture healing. The present article describes about the fluctuations of serum calcium, serum phosphorous and serum alkaline phosphatase with fracture healing.

Materials and Methods

Eighteen dogs with tibial diaphyseal fractures which were presented to Teaching Veterinary Clinical Complex, College of Veterinary Science, Rajendranagar, PVNRTVU, Hyderabad were divided into three groups. Group I dogs were treated with open plating using locking compression plate, Group II dogs were treated with percutaneous plating using locking compression plate and Group III dogs were treated with supracutaneous plating using locking compression plate.

A 5ml of blood was collected from each dog on 0 day, 3rd week, 6th week and 9th week post-operatively and serum was separated.

The collected serum was subjected to estimation of serum calcium, serum inorganic phosphorous and serum alkaline phosphatase. The data obtained during surgery was subjected to statistics by one –way analysis of variance (ANOVA) described by Snedecor and Cochran (1994).

Results and Discussion

The values of biochemical parameters at different intervals were represented in table 1.

Serum Alkaline Phosphatase

In group I, the mean ± SE values of serum alkaline phosphatase ranged from 84.5 ± 4.11 to 105.33 ± 4.3 in group I, 87.0 ± 4.11 to 105.33 ± 4.3 in group II and 94.5 ± 4.11 to 112.17 ± 4.3 in group III.

The serum alkaline phosphatase levels rised significantly upto three weeks followed by decrease and then reaching to normal levels by nineth week. The mean ± SE values of third week differed significantly ($p \leq 0.05$) with the 0 day in all the three groups, whereas no significant difference noticed between the groups. All the fluctuations were within normal physiological range.

These findings were in accordance with the findings of Hegade *et al.*, (2007), Mahendra *et al.,* (2007), Umashankar and Ranganath (2008), Das (2010) and Phaneendra *et al.,* (2016). The increase might be due to proliferation of osteogenic cells from damaged periosteum during fracture healing which is a rich source of alkaline phosphatase and deposition of calcium salts at the site of fracture.

Further increase in the immediate post-operative period might be due to due to damage to the bone caused by implant fixation (Das, 2010). Further decrease was seen until reaching the normal values by nineth week.

The decrease might be due to decrease in osteoblastic activity and decrease in calcium deposition at the fracture site and the normal values suggested completion of bone healing.

Hence the serum alkaline phosphatase values might be used as biomarker to evaluate the progress of healing especially in cases of delayed union and non-union (Komnenau *et al.,* 2005).

Table.1 Mean ± SE values of biochemical parameters at different intervals during the study

Biochemical Parameter	Group	0 Day	3rd wk	6th wk	9th wk
Serum Alkaline Phosphatase	I	89.667 ± 4.377^{b}	105.333 ± 4.304^{a}	97.667 ± 4.496^{ab}	84.50 ± 4.106^{b}
	II	88.50 ± 4.377^{b}	105.333 ± 4.304^{a}	98.833 ± 4.496^{ab}	87.0 ± 4.106^{b}
	III	94.667 ± 4.377^{b}	112.167 ± 4.304^{a}	102.833 ± 4.496^{ab}	94.5 ± 4.106^{b}
Serum Calcium	I	10.333 ± 0.441^{a}	11.333 ± 0.408^{b}	10.50 ± 0.437^{a}	10.50 ± 0.417^{a}
	II	10.333 ± 0.441^{a}	11.167 ± 0.408^{b}	10.833 ± 0.437^{a}	10.33 ± 0.417^{a}
	III	10.167 ± 0.441^{a}	11.167 ± 0.408^{b}	10.833 ± 0.437^{a}	10.167 ± 0.417^{a}
Serum Phosphorous	I	4.500 ± 0.202^{b}	5.333 ± 0.197^{a}	5.167 ± 0.167^{ab}	4.667 ± 0.183^{ab}
	II	4.667 ± 0.202	5.167 ± 0.197	4.833 ± 0.167	4.833 ± 0.183
	III	4.833 ± 0.202	5.333 ± 0.197	5.167 ± 0.167	4.833 ± 0.183

Means bearing different superscripts (a,b) within a column differ significantly at $P \leq 0.05$

Serum Calcium

In group I, the mean ± SE values of calcium ranged from 10.33 ± 0.44 to 11.33 ± 0.40 in group I, 10.33 ± 0.44 to 11.17 ± 0.41 in group II and 10.17 ± 0.44 to 11.17 ± 0.41 in group III. The serum calcium levels showed significant rise upto three weeks followed by decrease and then reaching to normal levels by nineth week. The mean ± SE values of calcium of third week differed significantly ($p \leq 0.05$) with the 0 day, sixth week as well as nineth week, whereas no significant difference noticed between the groups. All the fluctuations were within normal physiological range. These findings were in agreement with Das (2010) and Kranthi (2018). The serum calcium and fracture healing could not be correlated which was confirmed by the findings of Julie (2005), Komnenau *et al.,* 2005, Hegade *et al.,* 2007, Chaurasia *et al.,* (2019) where the authors observed decrease in the values of serum calcium initially followed by decrease and then finally normal values by the end of the observation period. Chaurasia *et al.,* (2019) opined that, deposition of excessive calcium at the fracture site might cause a decrease in the levels of serum calcium during earlier phase of post-operative period and termination of the healing process at the fracture site in later phases might cause elevation of the levels.

Serum Phosphorous

In group I, the mean ± SE values of phosphorous ranged from 4.5 ± 0.20 to 5.33 ± 0.20 in group I, 4.67 ± 0.20 to 5.17 ± 0. 20 in group II and 4.83 ± 0.20 to 5.33 ± 0.20 in group III. The serum phosphorous levels rised upto three weeks followed by decrease and then reaching to normal levels by nineth week. The mean ± SE values of phosphorous of third week differed significantly ($p \leq 0.05$) with the 0 day in group I, whereas no significant difference noticed between the groups. All the fluctuations were within normal physiological range. The alkaline phosphatase released by

the osteoblasts caused elevation of inorganic phosphorous levels in the serum (Komnenau *et al.,* 2005) Hence the values of inorganic phosphorous varied in correlation with those of alkaline phosphatase in the affected dogs. This was supported by the findings of Hegade *et al.,* (2007), Mahendra *et al.,* (2007), Das (2010) and Kranthi (2018).

The values of all the three parameters in one dog of group I and II were significantly lower when compared to other dogs of the same group from certain point of time which reflected the delayed union. In any group of study of bone healing, it is estimated that 5 – 10% of all patients with long bone fractures should develop impaired fracture healing process, especially delayed union and non-union process. Hence it is necessary to include serum biochemical markers in study of fracture healing to detect complications early.

From the above findings, it can be concluded that the changes in biochemical parameters at different post-operative intervals were directly correlated to the different phases of fracture healing. The individual values of dogs in group I and II helped to assess delayed union early and to treat accordingly. Hence, the present article also gives an evidence that impaired fracture healing process can be detected at an early point of time by serum biochemical parameters. But adequate number of patients and appropriate design study were essential to compare and evaluate the healing process of three groups stabilized with three different techniques.

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