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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(12): 1228-1230

www.thepharmajournal.com
Received: 11-10-2023
Accepted: 14-11-2023

Swaroop GL
Ph.D., Scholar, Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, Karnataka, India

Dr Dilipkumar D
Dean of PG's, KVAFSU, Bidar, Karnataka, India

Dr Bhagavantappa B
Associate Professor and Head, Department of Veterinary Surgery and Radiology, Veterinary College, Bidar Karnataka, India

Dr Venkatgiri
Assistant Professor, Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, Karnataka, India

Dr Manjunath Patil
Associate Professor, Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, Karnataka, India

Dr Bijurkar R G
Professor and Head, Department of Teaching Veterinary Clinical Complex (TVCC), Veterinary College, Bidar, Karnataka, India

Corresponding Author:
Swaroop GL
Ph.D., Scholar, Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, Karnataka, India

Biochemical evaluation in femur fracture repair of dogs using mALPS and PAX plating and plate-rod construct techniques

Swaroop GL, Dr. Dilipkumar D, Dr. Bhagavantappa B, Dr. Venkatgiri, Dr. Manjunath Patil and Dr. Bijurkar RJ

Abstract
24 clinical cases of dogs having femoral fractures were randomly divided into 4 groups (I, II, III and IV) consisting of 6 dogs in each group. Group I animals of femoral fractures were treated with modified Advanced Locking Plate System (mALPS). Group II animals of femoral fractures were treated with Polyaxial Locking Plate System (PAX). Group III animals of femoral fractures were treated with plate-rod construct using mALPS and group IV animals of femoral fractures were treated with plate-rod construct using PAX. Biochemical parameters were evaluated on day 0th, 15th, 30th, 60th and 90th post-operatively. There was increase in serum alkaline phosphatase at 30th and 60th day. There was significant increase in serum calcium level on 15th day and serum phosphorous should non-significant changes, by 90th day all the biochemical parameters were with in the normal physiological limits in all the groups.

Keywords: mALPS, PAX, PRC, dog, ALP, Ca and P

Introduction
The femur fracture is a common fracture in dogs. The femoral fracture repair requires use of internal fixatures like plates (Aithal *et al.*, 1999 [1] and Cunningham, 2001 [3]). The fracture healing under stable fixation can be assessed by radiography, CT scanning however these techniques used harmful electro-magnetic radiation like x-rays, hence there is a need for alternate fracture healing evaluation techniques. In this contest biochemical parameters evaluation doesn't produce any health hazards. So present study aimed at evaluation of fracture healing by measuring the levels of serum alkaline phosphatase, serum calcium and serum phosphorous.

Materials and Methods
The study was conducted in 24 clinical cases of dogs having femoral fractures were randomly divided into 4 groups (I, II, III and IV) consisting of 6 dogs in each group. Group I animals of femoral fractures were treated with modified Advanced Locking Plate System (mALPS). Group II animals of femoral fractures were treated with Polyaxial Locking Plate System (PAX). Group III animals of femoral fractures were treated with plate-rod construct using mALPS and group IV animals of femoral fractures were treated with plate-rod construct using PAX. The blood was collected on day 0th, 15th, 30th, 60th and 90th post-operatively. The serum was separated, in the serum sample the alkaline phosphatase, calcium and phosphorus were evaluated by using ARTOS [4] biochemical analyzer using respective diagnostic kit. Statistical analysis of data obtained was carried out by employing Student't' test as per the standard procedure outlined by Snedecor and Cochran (1994) [20].

Results
Serum Alkaline Phosphatase (IU/L): Presented in Fig 1
The Mean ± SE values for the serum alkaline phosphatase (IU/L) in Group I animals at 0th, 15th, 30th, 60th and 90th post-operative days were 138.67±8.25, 138.67±4.13, 141.67±6.14, 143.83±4.86 and 133.34±4.66 respectively.
The Mean ± SE values for the serum alkaline phosphatase (IU/L) in Group II animals at 0th, 15th, 30th, 60th and 90th post-operative days were 123.17±1.68, 128.83±1.56, 133.50±2.91, 135.67±2.11 and 128.34±2.03 respectively.

The Mean ± SE values for the serum alkaline phosphatase (IU/L) in Group III animals at 0th, 15th, 30th, 60th and 90th post-operative days were 130.83±3.33, 129.50±2.73, 138.00±4.01, 139.67±2.50 and 132.00±1.26 respectively.
The Mean ± SE values for the serum alkaline phosphatase (IU/L) in Group IV animals at 0th, 15th, 30th, 60th and 90th post-operative days were 129.67±4.24, 135.00±4.37, 141.67±4.41, 139.17±3.81 and 126.67±3.65 respectively.
There was a significantly ($p<0.01$) increasing in serum alkaline phosphatase level were observed at 30th and 60th days interval in all the groups of animals and at 90th day decrease observed with in the normal limit. There were no significant differences observed between the group in all the intervals of the study.

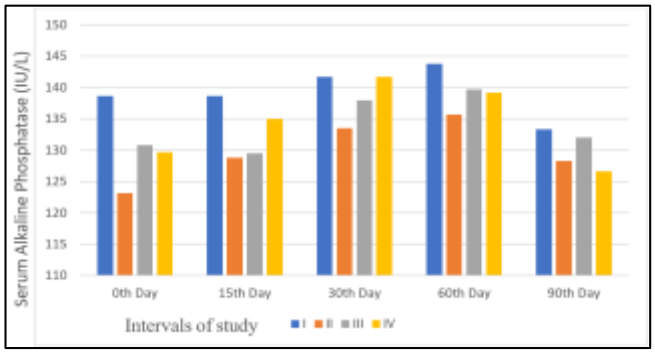

Fig 1: Serum Alkaline Phosphatase (IU/L)

Serum Calcium (mg/dL): presented in Fig 2
The Mean ± SE values for the serum calcium (mg/dL) in Group I animals at 0th, 15th, 30th, 60th and 90th post-operative days were 8.17±0.96, 9.51±0.92, 9.15±0.82, 9.07±0.45 and 9.39±0.56 respectively.
The Mean ± SE values for the serum calcium (mg/dL) in Group II animals at 0th, 15th, 30th, 60th and 90th post-operative days were 8.75±0.23, 10.57±0.22, 9.57±0.23, 9.03±0.21 and 8.76±0.17 respectively.
The Mean ± SE values for the serum calcium (mg/dL) in Group III animals at 0th, 15th, 30th, 60th and 90th post-operative days were 9.43±0.29, 11.19±0.25, 10.01±0.15, 9.40±0.17 and 9.20±0.16 respectively.
The Mean ± SE values for the serum calcium (mg/dL) in Group IV animals at 0th, 15th, 30th, 60th and 90th post-operative days were 9.40±0.20, 10.62±0.25, 9.67±0.20, 9.38±0.18 and 9.13±0. respectively.
There was a significantly ($p<0.01$) increasing in serum calcium level were observed at day 15th interval in all the groups of animals and decrease till the end were observed with in the normal limit. There were no significant differences observed between the group in all the intervals of the study.

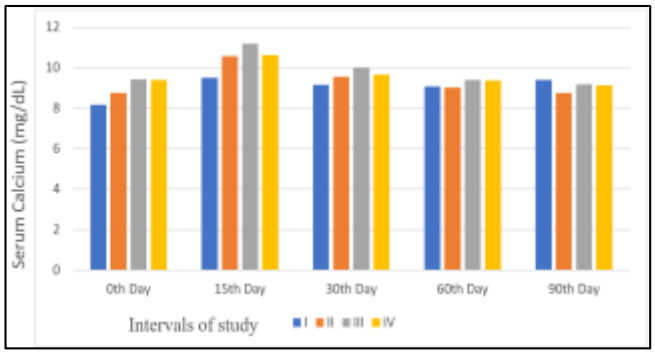

Fig 2: Serum Calcium (mg/dL)

Serum Phosphorous (mg/dL): presented in Fig 3
The Mean ± SE values for the serum phosphorous (mg/dL) in Group I animals at 0th, 15th, 30th, 60th and 90th post-operative days were 5.03±0.10, 4.94±0.09, 4.93±0.12, 4.82±0.21 and 4.83±0.25 respectively.
The Mean ± SE values for the serum phosphorous (mg/dL) in Group II animals at 0th, 15th, 30th, 60th and 90th post-operative days were 4.65±0.26, 4.99±0.20, 5.11±0.21, 4.80±0.19 and 4.72±0.20 respectively.
The Mean ± SE values for the serum phosphorous (mg/dL) in Group III animals at 0th, 15th, 30th, 60th and 90th post-operative days were 4.49±0.24, 4.80±0.19, 4.64±0.20, 4.36±0.26 and 4.24±0.24 respectively.
The Mean ± SE values for the serum phosphorous (mg/dL) in Group IV animals at 0th, 15th, 30th, 60th and 90th post-operative days were 4.69±0.27, 4.99±0.25, 4.93±0.22, 4.60±0.21 and 4.59±0.21 respectively.
There were no significant differences in serum phosphorus levels were observed within and between the group in all the intervals of the study.

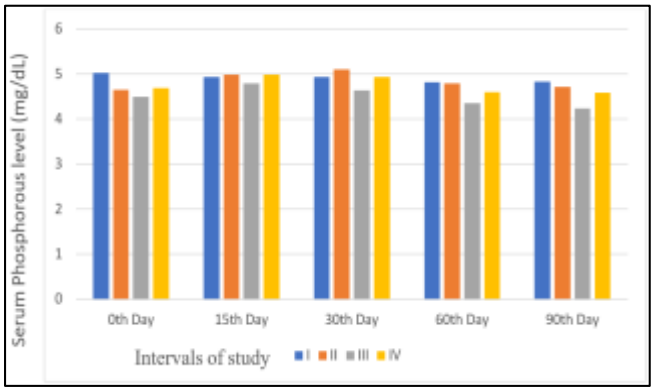

Fig 3: Serum Phosphorous (mg/dL)

Discussion

The biochemical changes indicated that serum alkaline phosphatase enzyme was significantly ($p\leq0.01$) increased on 30th and 60th post-operative days in all the groups of animals which was correlative with the callus formation at the fracture site. The elevated alkaline phosphatase level could be attributed to proliferation of osteogenic cells and maximum contribution from periosteum of destructed bone, which is a rich source of alkaline phosphatase. These results differ from the earlier workers *viz.*, Hunsberger and Ferguson (1932) [8], Brinker (1965) [2], Shirfin (1970) [18], Katerjian and Arsenia (1975) [9], Singh *et al.* (1976) [19], Hosking (1978) [7], Pandey and Udapa (1981) [13], Volpin *et al.*, (1986) [23], Sahay *et al.* (1988) [17], Vasantha (1991) [22], Maiti *et al.* (1999) [11], Manjubala *et al.* (2001) [12], Hegade *et al.* (2007) [5] and Phaneendra *et al.* (2016) [14].
The serum calcium showed significant ($p\leq0.01$) increase on 15th post-operative day in all the groups of animals. This could be attributed to initiation of calcification at the fracture site. The elevation in calcium level with in normal physiological limits was observed several earlier workers *viz.*, Lauren and Kelly (1969) [10], Pandey and Udapa (1981) [13], Rao (1991) [16] and Vasantha (1991) [22].
The serum phosphorous showed no significant difference in both within and between the groups of animals. The results are in agreement with the findings of Henderson and Nobel (1926) [6], Pandey and Udapa (1981) [13], and different from findings of Soliman and Hassan (1964) [21], Vasantha (1991)

[22] and Prachasilpchai *et al*. (2003) [15], who observed a non-significant change in serum phosphorus level during fracture healing.

Conclusion

Serum alkaline phosphatase is more reliable marker for assessment of fracture healing when compared to serum calcium and phosphorous estimation.

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