RESEARCH ARTICLE

Diagnosis of Musculoskeletal Disorders using Radiography and C-Arm in Dogs

Kendesh[1], Dilipkumar Desai[2], Manjunath Patil[3]*

Abstract

The study was conducted on ten cases of dogs with musculoskeletal disorders over a period of two years, randomly divided into 2 groups, *viz.,* Group I and Group II. Each individual case was subjected to radiography (Group I) and C-arm (Group II) imaging techniques along with recording physiological parameters and blood collection for the estimation of the serum minerals and enzymatic profile at 0 day pre-operative, immediate post-operative and 30th day post-operative. The physiological parameters, *viz.,* respiratory rate, heart rate and rectal temperature remained within normal physiological limits suggesting the injuries occurred in these animals did not produce alarming changes in these parameters. Significant hypercalcaemia, hyperphosphataemia and increase in serum alkaline phosphatase levels were observed on 30th post-operative day, whereas changes in ALT and AST were non-significant. On radiography and C-arm comparison in group I and II dogs; radiographic technique showed superior performance in 17 instances, whereas C-arm technique revealed superior performance on 11 instances. In conclusion, radiographic technique was found superior to the C-arm technique in diagnosis of musculoskeletal disorders in dogs.

Keywords: C-arm, Diagnosis, Dogs, Musculoskeletal disorder, Radiography.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.22.5.10

Introduction

Dogs suffer with various musculo-skeletal disorders leading to lameness and pain. Majority of the disorders include fractures, partial or complete dislocation of joints, tendon and ligament injuries. Most of the disorders occur due to non-infectious causes like accidents, falls and fighting. Evaluation of musculo-skeletal disorders by clinical, bio-chemical and imaging diagnostic techniques helps clinician to analyze the degree and severity of the disorder in order to decide optimum treatment regimen and evaluate healing process. Biochemical parameters like serum calcium, inorganic phosphorus and alkaline phosphatase enzyme activity during fracture healing have been analyzed and evaluated by numerous studies. Assessment of fracture healing and other musculo-skeletal disorders is still debatable as the values vary with different studies as a result of different physiological conditions and complications.

The measurement of serum markers of bone metabolism could assist in the evaluation of the cellular function in the bone fracture healing process, providing near real time information about the organic response to the lesion and to the selected treatment. These assays could also provide simple, accessible and accurate method of assessing disease progression during the bone fracture healing process (Breur *et al.,* 2004). Imaging techniques provide a non-invasive and often instructive reproduction of the repair progress and healing status of the fractures. However, the interpretation of this reproduction is often qualitative and provides only an indirect and surrogate measure of the mechanical stability of the healing fracture (Augat *et al.,* 2014). Plain radiographs provide the ability to determine the bridging of the fracture gap and to quantify the amount of periosteal callus formation. Several radiographic features are easily observed during direct or secondary fracture healing with the production of external callus, these being the formation and growth of a calcified callus and the bridging of the fracture with callus.

C-arm (Fluoroscopy) is an imaging technique commonly used to obtain real time images of the internal structures of the patient. The fluoroscopy usually utilizes x-ray source

[1]Department of Surgery & Radiology, Veterinary College, Bidar-585226, Karnataka Veterinary, Animal and Fisheries Sciences University,

[2]Senior Professor and Director of Instructions (PGS), KVAFSU, Bidar-585226, Karnataka, India

[3]Department of Veterinary Clinical Complex, Veterinary College, Koila-574241, Dakshina Kannada, KVAFSU, Karnataka, India

Corresponding Author: Dr. Manjunath Patil, Professor (VSR) and Head, Department of Veterinary Clinical Complex, Veterinary College, Koila-574241, Dakshina Kannada, KVAFSU, Karnataka, India. e-mail: manjunathpatilvet@gmail.com

How to cite this article: Kendesh, Desai, D., & Patil, M. (2026). Diagnosis of Musculoskeletal Disorders using Radiography and C-Arm in Dogs. Ind J Vet Sci and Biotech, 22(5), 50-55.

Source of support: Nil

Conflict of interest: None

Submitted 15/05/2026 **Accepted** 25/06/2026 **Published** 10/09/2026

© The Author(s). 2026 Open Access This work is licensed under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License.

coupled to an image intensifier and video capture device. This allows the clinician to view x-ray images in real time, gaining insight into the dynamic motion of internal structures as well as aiding in localizing the lesions. Definitive diagnosis and fracture assessment were done through radiographic and fluoroscopic imaging of fractures in dogs by Sharma *et al.* (2013). The present study was undertaken to evaluate physiological and biochemical parameters in musculo-skeletal disorders in dogs and to compare diagnostic efficiency of radiography and C-arm in its evaluation.

Materials and Methods

The present study was carried on 10 clinical cases of dogs with musculoskeletal disorders presented at Department of Veterinary Surgery and Radiology, Veterinary College, Bidar (Karnataka, India) over a period of two years. All these dogs were subjected to two imaging techniques, *viz.,* Radiography (Group I) and C-arm imaging (Group II). The animals comprised of both sexes, aged 2 months to 6 years. The dog breeds were one each of Pug, Labrador, Doberman, Mudhol hound, German shepherd and Pomeranian and remaining 4 non-descript. Physiological parameters, *viz.,* respiratory rate (breaths/min), heart rate (beats/min) and rectal temperature (°F) were recorded in all the animals before treatment on "0"day, immediate post-operative day and 30th post-operative day.

All the dogs were subjected to blood collection prior to surgical intervention, immediate post-operative day and 30th day post-operatively for serum biochemical estimation, *viz.,* calcium, phosphorus, alkaline phosphatase, alanine transaminase (ALT), aspartate transaminase (AST) by using semi-automatic biochemical analyzer (ARTOS make) with the kit supplied by Swemed diagnostics, Bengaluru.

Radiographs and C-arm images of affected region in medio-lateral and anterio-posterior views were taken pre-operatively, immediately post-operatively and 30th day post-operatively to record the observations to find out the degree and severity of disorder to look for accuracy of surgical intervention and to record the healing process subsequently. The radiographic and C-arm images were obtained from Allengers ceiling suspended model x-ray machine and Allengers frolley model C-arm machine (Allengers medical systems limited), respectively. All the data obtained were analysed statistically using student's "t" test as described by Snedecor and Cochran (1994).

Results and Discussion

The physiological parameters (Table 1), *viz.,* respiratory rate, heart rate and rectal temperature of all dogs remained within normal physiological limits suggesting the injuries occurred in these animals did not produce alarming changes in these parameters. The similar results in fracture cases were also observed by several earlier studies (Hegade *et al.,* 2007; Daron Joseph, 2013). Among the biochemical parameter (Table 2), significant hypercalcemia, hyperphosphataemia and increase in serum alkaline phosphatase levels were observed on 30th post-operative day in dogs, whereas changes in ALT and AST were non-significant. These results were in accordance with earlier studies (Umarani and Ganesh, 2003; Mahendra *et al*., 2007). The details of individual cases (Table 3) are discussed below.

In Case 1, a 3 months non-descript male dog with simple complete oblique over riding distal epiphyseal fracture of right femur, radiographic image was slightly superior at immediate post-operative phase, whereas C-arm image was slightly superior at "0" day and 30th post-operative days. The radiography was used for successful evaluation of fracture healing by several earlier studies (Singh and Sahay, 2005; Raghunath and Singh, 2008; Bini and Syam, 2014). The C-arm image results were in agreement with the earlier study of Sharma *et al.* (2013).

In Case 2, a 6 years male Pug with simple complete short oblique proximal metaphyseal fracture of ulna, C-arm image was slightly superior on "0" day, whereas radiographic image was slightly superior on 30th day. The C-arm technique is better in detection of subtle changes, whereas well ossified lesions were identified by radiography. The results were in agreement with Raghunath and Singh (2008), whereas C-arm image findings concurred with the findings of Sharma *et al.* (2013).

Table 1: Mean ±SE values of physiological parameters recorded in dogs (n=10)

Period	Respiratory rate (breaths/minute)	Heart rate (beats/minute)	Rectal temperature (˚F)
"0" day	32.00±1.33	80.50±1.09	102.45±0.09
Immediate post-operative	32.50±1.22	81.50±1.23	101.25±0.06
30th day post-operative	30.50±0.54	78.50±0.93	102.19±0.07

Table 2: Mean ±SE values of serum biochemical parameters recorded in dogs (n=10)

Period	Calcium (mg/dL)	Phosphorus (mg/dL)	ALP (IU/L)	ALT (IU/L)	AST (IU/L)
"0" day	8.80±0.24^{a}	4.50±0.19^{a}	126.03±6.25^{a}	17.04±1.03^{a}	15.43±0.37^{a}
Immediate post- operative	8.90±0.34^{a}	4.65±0.21^{a}	127.50±4.25^{a}	17.50±2.05^{a}	15.85±0.38^{a}
30th day post-operative	10.86±0.48^{b}	5.24±0.16^{b}	136.61±7.48^{b}	17.21±1.36^{a}	15.49±0.23^{a}

Means bearing different superscripts differ significantly ($p \leq 0.05$)

Table 3: Comparative result of radiographic and C-arm images in dog cases (Group I and II)

Case No.	"0" day		Immediate post-operative		30th day post-operative	
	Radiography	C-arm	Radiography	C-arm	Radiography	C-arm
1	Inferior	Superior	Superior	Inferior	Inferior	Superior
2	Inferior	Superior	Not operated	Not operated	Superior	Inferior
3	Superior	Inferior	Superior	Inferior	Superior	Inferior
4	Superior	Inferior	Superior	Inferior	Superior	Inferior
5	a) Superior b) Inferior	a) Inferior b) Superior	a) Inferior b) Inferior	a) Superior b) Superior	a) Superior b) Superior	a) Inferior b) Inferior
6	Equally good	Equally good	Equally good	Equally good	Superior	Inferior
7	Equally good	Equally good	Equally good	Equally good	Inferior	Superior
8	Equally good	Equally good	Superior	Inferior	Superior	Inferior
9	Superior	Inferior	Superior	Inferior	Superior	Inferior
10	Inferior	Superior	Inferior	Superior	Inferior	Superior
Superior	4	4	5	3	8	3
Inferior	4	4	3	5	3	8
Equally good	3	3	2	2	0	0

In Case 3, a 5 months Labrador female with simple complete transverse proximal metaphyseal fracture of right metacarpal, the radiography was slightly superior to C-arm imaging at all stages of study in this case. The radiography results were in agreement with earlier studies (Augat *et al.,* 2014; Bini and Syam, 2014). The C- arm image results concurred with findings of Axelrad and Einhorn (2011).

In Case 4, a 4 months Doberman female with simple complete transverse dentate overriding proximal metaphyseal fracture of right femur, the radiography was slightly superior to C-arm imaging technique at all the stages of present case (Fig.1A to 1F). The radiographic results were in agreement with earlier study by Augat *et al*. (2014). The C-arm image results concurred with the findings of Axelrad and Einhorn (2011).

In Case 5, a 3 years old Mudhol hound male dog with compound oblique overriding mid diaphyseal fracture of right radius and ulna, the radiographic image was slightly superior at "0" day and 30th post-operative day, whereas C-arm image was slightly superior at immediate post-operative phase. The radiographic image results were in agreement with Umarani and Ganesh (2002). The poor radiographic image is in agreement with the earlier study of Blokhuis *et al*. (2001). The C-arm image result concurred with the findings of Sharma *et al.* (2013) and Stephen *et al.* (2015).

In the same Mudhol hound, with simple complete oblique over riding distal diaphyseal right tibial and fibular fracture, the C-arm image was slightly superior on "0" day and at the immediate post- operative phase. The C-arm image was slightly superior on 30th post-operative day. The C-arm imaging was slightly superior in early detection of changes than radiography in this case. The result of C-arm imaging is in agreement with Cook *et al.* (1999) and Custers *et al.* (2010). The radiography was effective in detecting callus formation at 30th day which could be attributed to increased mineral content of callus. The results of radiographic imaging on 30th day were in agreement with Morgan *et al.* (2006).

In Case 6, a 5 years old non-descript male dog with simple complete transverse overriding diaphyseal fracture of right tibia and fibula, both the techniques, *viz.,* C-arm imaging as well as radiographic imaging were equally good at "0" day and immediate post-operative phase. However, at 30th post-operative day radiographic imaging proved to be slightly superior when compared to C- arm imaging. These results indicate that when the callus formation increases, radiography was effective technique in detecting the changes. These results were in agreement with earlier studies of Sharma *et al.* (2013), but differed from the observations of Blokhuis *et al.* (2001) who had reported radiography as poor parameter in evaluation of fracture healing. The C- arm image results were in agreement with Custers *et al.* (2010) and Stephen *et al.* (2015).

In Case 7, a 1 year old German Shepherd male with simple complete transverse eburnate overriding mid diaphyseal fracture of left radius and ulna, the radiography and C-arm imaging were equally good on "0"day and immediately after operation (Fig.2A to 2D), whereas on 30th post-operative day C-arm imaging was slightly superior than radiography (Fig.2E to 2F). The results of C-arm imaging were in agreement with the earlier studies (Cook *et al.,* 1999; Roel *et al.,* 2010; Manjunatha, 2012). The results of radiography concurred with the findings of earlier worker of Blokhuis *et al.* (2001).

In Case 8, a 2.5 years old non-descript male with simple complete oblique overriding proximal metaphyseal fracture of left femur, the radiography and C-arm imaging were equally good on "0" day whereas, immediately after operation and on 30th post-operative day radiography was slightly superior than C-arm imaging. The results of

radiography were in agreement with Umarani and Ganesh (2002), Augat *et al.* (2014) and Bini and Syam (2014). The results of C-arm imaging were in agreement with earlier studies of Axelrad and Einhorn (2011).

In Case 9, a 2 months non-descript male pup with simple complete short oblique overriding proximal metaphyseal right femur fracture, radiography was slightly superior to C-arm throughout the period of study. The results of radiography are in agreement with Umarani and Ganesh (2002) and Bini and Syam (2014). The C-arm imaging concurred with the finding of Axelrad and Einhorn (2011).

In Case 10, a 6 years old Pomeranian female with simple complete oblique distal metaphyseal right tibial and fibular fracture, the radiography and C-arm imaging were equally good on "0" day and in the immediate post-operative phase. However, on 30th post-operative day radiography was slightly superior to C-arm imaging. The results of radiography were in agreement with earlier studies (Umarani and Ganesh, 2002).

Overall, the radiographic technique showed superior performance in 17 instances where as, C-arm technique revealed a superior performance at 10 instances. The radiographic images were inferior 10 times where the value in C-arm imaging was 17. Both the techniques were equally good at 5 instances.

Conclusion

Based on the above observation it can be concluded that radiographic technique was slightly superior to C-arm technique in diagnosing the canine fractures. The effectiveness of radiography could be attributed to more penetrating x-rays in radiography than in C-arm techniques in diagnosis and evaluation of fractures in dogs.

Acknowledgement

Authors would like to acknowledge the Dean, Veterinary College, Bidar for financial assistance in conducting this research.

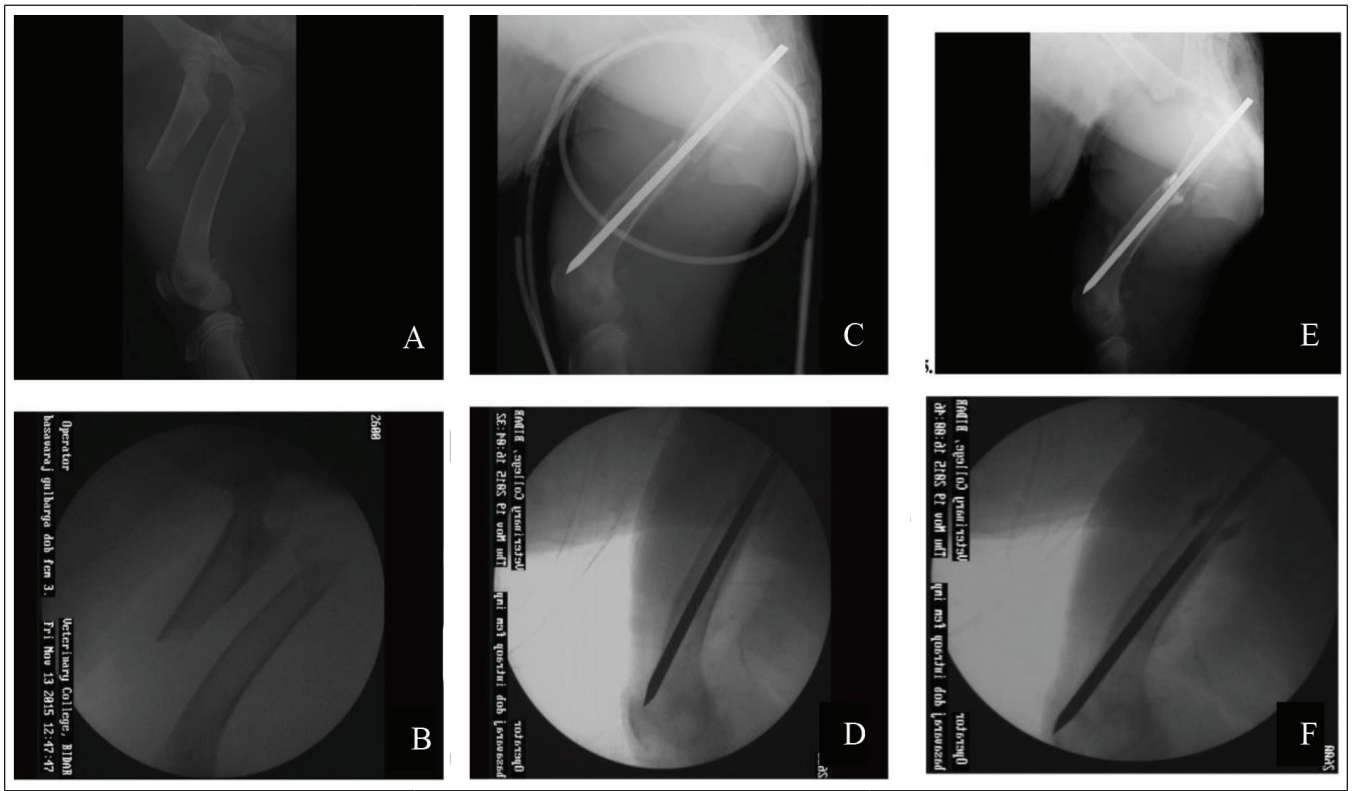


Fig. 1A: A Doberman Dog **(Case No. 4)** "0" day pre-operative radiographic image showed simple complete transverse dentate overriding fracture of proximal metaphysis of femur bone.	**Fig. 1C:** Immediate post-operative radiograph showed clear lodgement of Steinmann pin in distal epiphysis of the femur.	**Fig. 1E:** 30th day post-operative radiograph revealed the presence of Steinmann pin in situ and callus formation at the fracture site.
Fig. 1B: "0" day pre-operative C-arm image showed that there was a complete transverse dentate overriding fracture of proximal metaphysis of femur bone. *The dentate lesion was not appreciable in C-arm as it was observed in radiography.*	**Fig. 1D:** Immediate post-operative C-arm image showed clear image of Steinmann pin lodgement in the distal epiphysis of femur. *However, the fracture site was not clearly visible when compared to radiograph.*	**Fig. 1F:** 30th day post-operative C-arm imaging revealed that the Steinmann pin was in situ. *However, the callus formation was not appreciable in C-arm when compared to radiography.*

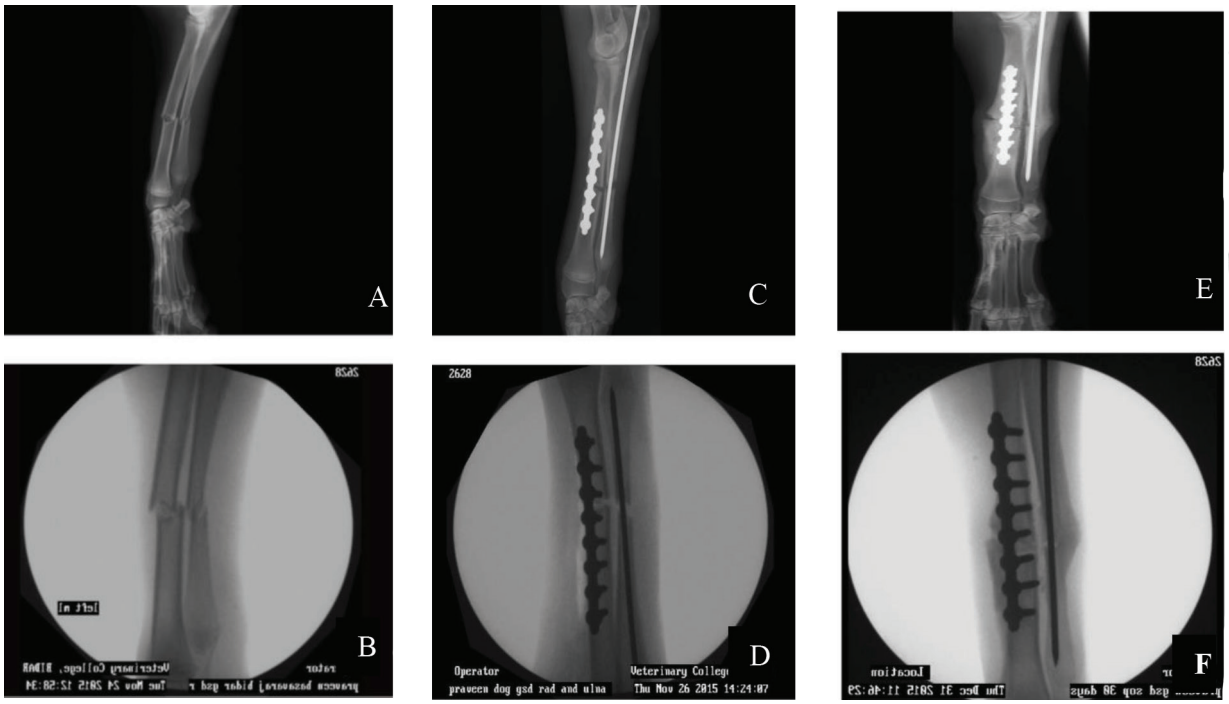


Fig. 2A: German Shepherd dog **(Case No. 7)** "0" day pre-operative radiographic image showed simple complete transverse eburnate fracture of radius and ulna bone. The image was clear.	**Fig. 2C**: Immediate post-operative radiograph showed presence of string of pearls plate in situ on radius and K-wire in the ulna. The fracture site of both radius and ulna were visible clearly.	**Fig. 2E**: 30th day post-operative radiograph showed presence of string of pearls plate in situ on radius and K-wire in the ulna. The radius had less callus when compared to ulna at the fracture site.
Fig. 2B: "0" day pre-operative C-arm image also revealed clear presence of simple complete transverse eburnate fracture of radius and ulna bone. *Both techniques were equally good.*	**Fig. 2D**: Immediate post-operative C-arm image showed presence of string of pearls Plate in situ on radius and K-wire in the ulna. The fracture site of both radius and ulna were visible clearly. *Both techniques were equally good at this stage of study.*	**Fig. 2F**: 30th day post-operative C-arm imaging revealed presence of string of pearls plate in situ on radius and K- wire in the ulna. There was excess callus formation in ulna when compared to radius at the fracture site. *The C-arm image was superior when compared to radiography at this stage.*

References

Augat, P., Morgan, E.F., Lujan, T.J., Macgillivray, T.J., & Cheung, W.H. (2014). Imaging techniques for the assessment of fracture repair. *Injury, 45*, 16-22.

Axelrad, T.W., & Einhorn, T.A. (2011). Use of clinical assessment tools in the evaluation of fracture healing. *Injury, 42*, 301-305.

Bini, J., & Syam, K.V. (2014). Successful management of metatarsal fracture in a goat using external skeletal fixation. *International Journal of Science and Research, 3*, 357- 359.

Blokhuis, T.J., Debruine, J.H.D., Bramer, J.A.M., Denboer, F.C., Bakker, F.C., Patka, P., Haarman, H.J.TH.M., & Manoliu, R.A. (2001). The reliability of plain radiography in experimental fracture healing. *Skeletal Radiology, 30,* 151-156.

Breur, G.J., Allen, M.J., Carlson, S.J., & Richardson, D.C. (2004). Markers of bone metabolism in dog breeds of different size. *Research in Veterinary Science, 76,* 53-55.

Cook, J.L., Tomlinson, J.L., & Reed, A.L. (1999). Fluroscopically guided closed reduction with internal fixation of fractures of the lateral portion of the humeral condyle: Prospective clinical study of the technique and results in ten dogs. *Veterinary Surgery, 28,* 315-321.

Custers, R.J., Dhert, W.J., Saris, D.B., Verbout, A.J., Vanrijen, M.H., Mastbergen, S.C., Lafber, F.P., & Creemers, L.B. (2010). Cartilage degeneration in the goat knee caused by treating localized cartilage defects with metal implants. *Osteoarthritis and Cartiage, 18,* 377-388.

Daron Joseph (2013). Comparison of fibre glass with plaster cast for treatment of long bone fractures in goats. *MVSc Thesis,* Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India.

Hegade, Y., Dilipkumar, D., & Usturge, S.M. (2007). Comparative evaluation of biochemical parameters during fracture healing in dogs. *Karnataka Journal of Agricultural Sciences, 20,* 694–695.

Mahendra, A.M., Ranganath, L., & Vasanth, M.S. (2007). Effect of Poly methyl methacrylate in femoral fracture repair on hemato biochemical parameters in dogs. *Indian Veterinary Journal, 84,* 587-589.

Manjunatha, D.R. (2012). Comparison of "c-arm guided" and "aiming device" interlocking nailing of femoral fracture repair in dogs. *MVSc Thesis,* Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India.

Morgan, J.W., Santschi, E.M., Zekas, L.J., Scollay ward, M.C., Markel, M.D., Radtke, C.L., Sample, S.J., Keuler, N.S., & Muir, P. (2006). Comparison of radiography and computed tomography to evaluate metacarpo/metatarso phalangeal joint pathology of paired limbs of thoroughbred race horses with severe condylar fracture. *Veterinary Surgery, 35,* 611- 617.

Raghunath, M., & Singh, S. S. (2008). Intramedullary Interlocking Nailing for management of long bone diaphyseal fractures in dogs: A study of 17 clinical cases. *Indian Journal of Veterinary Surgery, 29,*106-109.

Roel, J.H.C., Daniel, B.F.S., Laura, B.C., Verbout, A.B.J., Mattiehp, Varijen, Simon, C.M., Floris, P.L., & Wouter, J.A.D. (2010). Replacement of medial tibial plateau by a metallic implant in Goat model. *Journal of Orthopaedic Research, 28,* 429-435.

Sharma Shivali, Kanwar, M.S., Tyagi, S.P., & Imran, Sheikh (2013). Comparison of fluoroscopic and radiographic imaging of long bones in healthy dogs. *Journal of Applied Animal Resarch, 41,* 339-346.

Singh, H., & Sahay, P.N. (2005). Radiographic evaluation of transfixation osteosynthesis for long bone fractures in goats. *Indian Veterinary Journal, 82,* 625-627

Snedecor, G. W., & Cochran, W. B. (1994). *Statistical Methods*. 8th edn., Iowa State University Press, Ames, Iowa, USA. pp 138-169.

Stephen, C.J., Daniel, D.L., & Matthew, D. W. (2015). Fluoroscopic-assisted olecranon fracture repair in three dogs. *Case Reports in Veterinary Medicine, 2,* 1-11.

Umarani, R., & Ganesh, T.N. (2002). Kuntschner nails for immobilization of femur fractures in goats – clinical and radiological study. *Indian Veterinary Journal, 79,* 1089- 1091.

Umarani, R., & Ganesh, T.N. (2003). Study of serum calcium, phosphorus and alkaline phosphatase during fracture healing of femur in goats. *Indian Veterinary Journal, 80,* 377-378.