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Clinical study on repair of tibial fractures using intramedullary interlocking nailing in dogs

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Abstract
The present clinical study was conducted on seven dogs presented with tibial fractures to Department of Surgery and Radiology at CVSc., Rajendranagar, Hyderabad. The age ranged from 9-42 months, six were male and one was female. The body weight ranged from 12 to 40 kg. Pre-operative radiographs showed as transverse in 3 dogs, oblique in 2 dogs, comminuted in one dog and spiral in one dog. These fractures were stabilized with 5.0 mm, 6.0 mm, 7.0 mm and 8.0 mm interlocking nails. Cranio-medial parapatellar approach provided good exposure of the fracture site. Follow-up radiographs on 15th, 30th, 60th and 90th post-operative days revealed secondary bone healing with periosteal callus formation. Good implant stability without any complications in six dogs. In one dog, nail bending was observed above the fracture site by 15th post-operative day due to overuse of stabilized fractured limb and heavyweight of the dog. All the dogs showed grade V lameness before surgical treatment. Post-operatively, four dogs progressed to grade I lameness by 30th day, two dogs progressed to grade I lameness by 60th day and one dogs progressed to grade II lameness by the end of 60th day. It was concluded that IILN was successful in the treatment of tibial fractures in six out of seven dogs. The application of interlocking nail was found to be effective with features like being light in weight and provides resistance against axial, torsional and bending forces. And opined that IILN has potential for application for repair of tibial fracture in dogs.

Keywords: Intramedullary interlocking nailing, internal fixation, tibial fracture repair, canines, dogs

Introduction
The prevalence of long bone fractures in dogs based on anatomic site as femur 57.69%, tibia and fibula 10.26%, humerus 6.41%, radius-ulna 5.13%, mandible 5.13%, metacarpal 3.85%, tibia 3.85%, metatarsal 2.56%, rib 1.28% and tarsal 1.28% (Eyarefe and Oyetayo, 2016) [6]. The pelvic limb was the most affected limb (85.2%) among which femur bone (29.6%) was the most commonly involved bone followed by tibia-fibula (11.2%) in dogs. (Keosengthong *et al.*, 2019) [11].

The use of Interlocking nail (ILN) to repair diaphyseal fractures of the femur, tibia, and humerus in dogs resulted in a good or excellent functional outcome. (Arican *et al.*, 2017; Jagan and Dilip, 2021) [2, 10]

An intramedullary pin acts as load sharer, they cannot provide sufficient stability in comminuted fractures leading to collapse at the fracture site and it counteracts only bending forces while intramedullary interlocking nails resist both bending as well as torsional forces (Bernarde *et al.*, 2001) [3].

Interlocking nail (ILN) is better suited for comminuted fractures. Interlocking nailing, which preserves the periosteal blood supply, may represent a less invasive alternative to plating (De Camp *et al.*, 2016) [5].

The titanium intramedullary interlocking nail will have lower rate of failure and fewer complications and offered early return of limb function, with good fracture stability till the completion of the bone healing in all dogs (Jagan and Dilip, 2021) [10].

Materials and Methods
Anamnesis
The age of these seven dogs ranged from 9 months to 42 months with a mean of 19.86±5.10 months. Out of these seven dogs six were males and one female. Among the seven dogs, one dog was a Labrador retriever, one was a German shepherd, one was a Great dane, one was a Mongrels, one was a Doberman and two were Golden retriever. The body weight of the dogs ranged from 12-40 kg with a mean of 24.43±3.70 kg.

The main causes for occurrence of fractures were found to be fall from height in four (66.6%) dogs and automobile accident in two (33.3%) dogs. The dogs were presented for treatment between 2 to 7 days after fracture occurrence with a mean of 3.43±0.65 (Table.1)

Pre-Operative observations

The dogs presented for treatment of tibial fractures exhibited symptoms like pain, lameness, swelling, non-weight bearing, abnormal angulation and dangling of the limb (Fig.1). In all the dogs, crepitation was noticed at the fracture site on physical examination. The fractures were temporarily stabilized with Robert Jones bandage without the use of splints until the day of surgery.

Pre-operative radiographic observations

Orthogonal views of plain Medio-lateral and cranio-caudal radiographs of the affected bone including the proximal and distal joints were found to be satisfactory to confirm the tentative diagnosis. Pre-operative radiographs revealed tibia fractures and also showed the type of fracture as transverse fractures in all seven dogs. Pre-operative radiographs of the dogs with tibia fractures are presented in Fig.2. The details regarding the fractures encountered in all the dogs are presented in Table 2.

Planning of surgery

Measurements obtained from the pre-operative radiographs of the affected limb like length of the bone and trans-cortical diameter at different regions and diameter of medullary cavity at the isthmus region of bone proved vital in selecting the appropriate length and diameter of interlocking nail to be used and the length of the screws.

Patient preparation

The operative site was shaved and scrubbed using povidone-iodine surgical scrub. Painting the surgical site with 5% povidone iodine solution followed by application of surgical spirit and the draping was considered satisfactory since post-operatively no signs of infection were encountered in any of the dogs that underwent surgery.

Anaesthesia

In all the dogs, inhalant anesthetic regimen was followed with the use of Atropine sulphate at the rate of 0.04 mg/kg body weight was administered subcutaneously followed by Dexmedetomidine at the rate of 20 µg/kg body weight intravenously. Dogs were induced with intravenous injection of Propofol at the rate of 4 mg/kg body weight. Following induction, the dogs were intubated with endotracheal tubes of suitable size. Anaesthesia was maintained with isofluraneat the rate of 2.5 in 100% oxygen during the surgical procedure offered a satisfactory surgical plane of anesthesia during the surgical process with no major complications and all dogs recovered quickly.

Positioning of the Animal

The dogs were positioned in lateral recumbency with the medial side of fractured limb facing the surgeon facilitated decent exposure of the surgical site. Covering the distal extremity of the limb with sterile gauze bandage facilitated manipulation of the limb during surgery without compromising sterility. Aseptic preparation of surgical site and adequate draping done was considered satisfactory since infection was not encountered in any of the seven dogs post-operatively.

Materials used

Orthopaedic instruments

The general surgical and standard orthopaedic instruments were used

Implants

Two interlocking instrument box sets (Fig.3) one containing intramedullary interlocking nail[6] (IILN) of varying diameters/thickness of 5 mm, 6 mm and 7 mm with different lengths ranging from (120 mm, 140 mm, 160 mm, 180 mm, 200 mm and 220 mm). 2.0 mm non tapping cortical screws of screw length from 6mm to 20 mm for 5 mm diameter nails and 2.7mm non tapping cortical screws of screw length from 6 mm to 30 mm for 6 mm and 7 mm diameter nails

Along with interlocking nails required accessories like proximal and distal aiming device, conical bolt, cannulated socket wrench, drill sleeve for 5 mm nail, drill sleeve for 6 mm and 7 mm nails, 1.5/2.0 mm drill bit, 2.0/2.7 mm drill bit, 2.0 mm extra-long bone tap with T handle, 2.7 mm extra-long bone tap with T handle, steinmann pin trocar ended 5.0 mm, 6.0 mm and 7.0 mm, 1.5 mm tip extra-long screw driver, 2.7 mm tip extra-long screw driver.

The other instrument box set containing intramedullary interlocking nail (IILN) of diameters/thickness of 8 mm, 9 mm and 10 mm with different lengths ranging from (120 mm, 140 mm, 160 mm, 180 mm, 200 mm and 220 mm). 3.5 mm cortical screws of screw lengths from 14 mm to 60 mm for 8mm and 9mm diameter nails and 4.5 mm cortical screws of screw lengths from 24 mm to 60 mm for 10 mm diameter nails were used along with proximal and distal aiming device, conical bolt, cannulated socket wrench, drill sleeve for 8mm and 9mm nail, drill sleeve for 10 mm nails, 2.5/3.0 mm drill bit, 3.2/4.5 mm drill bit, 3.5 mm extra-long bone tap with t handle, 4.5 mm extra-long bone tap with t handle, Steinmann pin trocar ended 8.0 mm, 9.0 mm and 10.0 mm, 2.5 mm tip extra-long screw driver, 3.5 mm tip extra-long screw driver. The choice of the implant was determined based on the age, weight of the dog and the diameter of the medullary cavity at isthmus region as measured from the pre-operative radiographs and type of fracture.

Surgical procedure

Surgical approach to the tibia

For tibial fracture repair, a cranio-medial, parapatellar approach was followed. With the extension of the incision distally provided satisfactory exposure of the fracture fragments. The subcutaneous fascia was opened in the same line followed by a skin incision at the fracture site. Care was taken to protect the dorsal branch of the saphenous vessels and nerves while crossing the field at the midshaft. The bone was exposed by incising the deep crural fascia on the medial shaft of the bone.

Fracture reduction and fixation with IILN

The fracture site and fragments were exposed followed by clearing the fascia. A periosteal elevator was used to remove redundant soft tissue. The point of entry of the nail should be assessed for normograde approach of IILN implant insertion by taking the standard insertion points, locate the medial tibial condyle at the junction of the cranial and middle thirds. Point of entry for Steinmann pin was created with the use of Perthes

bone awl. Fracture reduction was carried out using serrated reduction forceps and the reduced fragments were held in apposition using bone holding forceps. Interlocking nail of suitable length was selected based on diameter of medullary cavity at the isthmus region of bone from pre-operative radiographs. A trocar ended Steinmann pin of diameter 1-2mm less than that of selected IILN was used to ream the medullary cavity to create a guidance tract for the interlocking nail, The Steinmann pin was introduced in the proximal fragment followed by the distal fragment then IILN was attached to the proximal and distal aiming device and it is inserted into the medullary cavity through normograde manner. Nail-aiming device complex should not be disturbed thereon. The screw holes were located by observing the gradation on the aiming device. Trocar was used to make a point of entry for the drill bit in the bone and appropriate drill sleeve is used and screw holes were drilled using either 1.5 mm drill bit (for 5 mm nail) or 2.0 mm drill bit (for 6mm and 7 mm nails) or 2.5 mm drill bit (for 8 mm and 9 mm nails) or 3.2 mm drill bit (for 10 mm nail) across the bone passing through both the cortices of bone and using a low-speed high torque electric drill. To prevent thermal necrosis while drilling, sterile normal saline was used to irrigate the site to cool the drill bit and flush the debris. The length of the screw was determined by measuring the thickness of the bone from pre-operative radiographs and were confirmed during the procedure using the depth gauge. An appropriate bone tap was used based on the screw diameter. The screw of suitable length was then placed at the drilled hole and tightened using a hexagonal orthopaedic screwdriver until the tapered end of the screws exited the far cortex of the bone. First, the distal segment was locked followed by proximal segment. Once the fixation was over and stability ascertained, the aiming device was detached by loosening the threaded bolt in the aiming device. (Fig.4) The fracture gaps were not reconstructed. Bone chips or small fragments were left as such and no further manipulation was done at the fracture site. Minimal instrumentation was used for achieving the reduction of fracture ends. The stability of the implant was ascertained. Interlocking nailing was done in static mode in all the animals.

Closure of the surgical wound

Subcuticular sutures were applied in simple continuous pattern using No. 2- 0 polyglactin 910 and the skin incision was closed in a row of cruciate mattress sutures using 2-0 polyamide

Post-Operative care and management

A thin layer of sterile gauze bandage dipped in 5% Povidone-iodine solution was covered the incision site, and a thick layer of the cotton pad was wrapped over the limb. It was then covered with a gauze bandage and finally, a layer of surgical paper tape was applied to provide additional protection. The dressing was changed every alternate day until the sutures were removed on the 14th post-operative day. Antibiotic therapy with injection Ceftriaxone sodium was administered at the dose rate of 20 mg/kg body weight as an intramuscular injection for 7 days post-operatively. Injection Meloxicam was administered at the dose rate of 0.3 mg/kg by intramuscular injection for 3 days. Owners were advised to restrict the movement of the animal for the first 2 weeks following surgery and then to allow leash walk for the next few weeks.

Results and Discussion

The results of the present study showed that the age of the dogs presented with tibia fractures ranged from 9-42 months with a mean of 19.86 ± 5.10 months. This finding was in agreement with Rhanghani (2014) [17] and Kumar *et al.* (2020) [12]. Varied observations were made in the study Simon *et al.* (2010) [19]. Out of seven dogs the main cause of fractures was found to be trauma due to automobile accidents in four (57.14%) dogs and followed by fall from height in three (42.85%) dogs which concurred with the findings of Saini *et al.* (2017) and Kumar *et al.* (2020) [12]. Varied observations were made in the study of Rhanghani (2014) [17] where unknown trauma was principal cause of fracture followed by motor traffic accidents, human abuse, animal bites, falls and indoor trauma.

Post-Operative clinical observations

Clinical evaluation was carried out every alternate day to check for the presence of swelling, exudation and weight bearing in all the dogs**.** None of the dogs developed post-operative swelling and suture dehiscence and the surgical wounds healed well in all the dogs without any complications.

Implants

Intramedullary interlocking nail used for stabilization of tibia fractures resulted in good fracture fixation and immobilization. The length and diameter of the nail to be used was determined by the length of the bone and diameter of medullary cavity at the isthmus region measured from the medio-lateral radiographs obtained pre-operatively. 5.0 mm intramedullary interlocking nails of lengths 120 mm, 140 mm, 160 mm were used in animals weighing 12kg, 20kg and 14kg dogs respectively. 6.0 mm intramedullary interlocking nails of lengths 160 mm and 180 mm were used in two dogs weighing 30kg and 28kgs respectively. 7.0 mm intramedullary interlocking nail of length 200 mm was used in one dogs weighing 27 kg 8.0 mm intramedullary interlocking nail of length 220 mm was used in one dog weighing 40 kg.

Anaesthetic protocol with atropine sulphate as pre-anaesthetic, dexmedotomidine as premedicant, induction with propofol infusion and maintenance with isoflurane gas in 100% oxygen was considered satisfactory for surgical procedure. Similar protocol were adopted by so many researchers in their studies like Morgan and Legge (1989) [16], Kuusela *et al.* (2001) [13], Kuusela *et al.* (2003) [14], Tsai *et al.* (2007) [20], Bustamante *et al.* (2018) [4] and Hampton *et al.* (2019) [8].

Lameness grading

Post-operative Lameness Grading

The post- operative day on which the dog started bearing weight was recorded and graded. All the dogs in the present study showed partial weight bearing from 1st postoperative day. Weight bearing was by 3rd post-operative day in two dogs, 4th post-operative day in two dogs, 7th post-operative day in one dog, 10th post-operative day in one dog and 45th post-operative day in one dog. Lameness grading based on weight bearing was recorded in all animals pre-operatively showed grade V lameness before surgical stabilization of the fracture. Post-operatively, four dogs progressed to grade I lameness by 30th post–operative, two dogs by 60th post – operative day and one dog progressed to grade II by the end of 60th post-operative day. All the cases under this study were examined for functional limb outcome and categorized as

excellent, good, fair and poor. The functional outcome was graded excellent in six dogs and good in one dog (Table 3)

Post-operative radiographic observations

Post-operative radiographic evaluation confirmed proper placement of the intramedullary interlocking nail and screws, good apposition and proper alignment of the fracture fragments in all the seven dogs. An additional cerclage wiring was applied in one dog (case no.2) along with intramedullary interlocking nail to immobilize the large wedge fracture fragments. Length of the pin and screws, their size and position were appropriate in all cases. Sequential post-operative radiographs showed progressive bone healing. Post-operatively no screw loosening was observed in any of the cases.

Follow-up radiographs obtained on the 15th post-operative day depicted proper position and good alignment of the fracture fragments in all dogs and presence of periosteal callus seen in five out seven cases and minimum to no callus in remaining two cases. However, the radiolucent fracture line was still discernible in all the cases (Langley-Hobbs, 2003 and Guiot and Dejardin, 2011) [15, 7]. Radiographs obtained on the 30th post-operative day showed evidence of callus formation in all dogs. The callus was opaque and smooth. Radiolucent fracture line was faintly visible. The closure of fracture gap and presence of complete bridging periosteal callus was seen in almost all cases (Hudson *et al.*, 2009) [9]. Radiographs obtained on the 60th post-operative day revealed dense callus of reduced size; fracture line barely visible and corticomedullary remodelling (stage of early clinical union). Radiographs obtained on the 90th post-operative day revealed distinct cortico-medullary separation caused by remodelling; fracture line not visible Aikawa *et al.* (2018) [1]. Radiographic healing shown in Fig.5

Table 1: History and Signalment of the dogs selected for the study in this group

Case no.	Breed	Age (months)	Sex	Body weight (kg)	Cause	Days since fracture
1.	Labrador Retriever	11	Male	30	Fall from height	3
2.	Mongrel	36	Female	20	Automobile accident	4
3.	German Shepherd	42	Male	27	Fall from height	3
4.	Golden Retriever	9	Male	12	Fall from height	2
5.	Doberman	10	Male	14	Automobile accident	7
6.	Great Dane	13	Male	40	Automobile accident	3
7.	Golden Retriever	18	Male	28	Automobile accident	2
Mean		19.86±5.10		24.43±3.70		3.43±0.65

Table 2: Fracture classification

S. No.	Affected side	Location of fracture	Type of fracture
1.	Right	Proximal diaphyseal	Closed complete oblique overriding
2.	Right	Distal diaphyseal	Closed complete spiral overriding
3.	Left	Mid-diaphyseal	Closed complete transverse overriding
4.	Right	Proximal diaphyseal	Closed complete oblique overriding
5.	Right	Mid-diaphyseal	Closed complete transverse overriding
6.	Left	Mid-diaphyseal	Closed complete communited overriding
7.	Right	Mid-diaphyseal	Closed complete transverse overriding

Table 3: Post operative details of lameness grading

Case No.	Intra medullary inter locking nail diameter used	Pre- operative Lameness Grading	Post - operative Lameness Grading on					Complete Weight Bearing on
			1	15	30	60	90	
1.	6.0 mm	V	III	I	I	I	I	3rd day
2.	7.0 mm	V	IV	III	I	I	I	10th day
3.	5.0 mm	V	IV	III	II	I	I	7th day
4.	5.0 mm	V	III	I	I	I	I	3rd day
5.	5.0 mm	V	III	I	I	I	I	4th day
6.	8.0 mm	V	IV	IV	III	II	II	45th day
7.	6.0 mm	V	III	II	II	I	I	4th day
Mean		5.0± 0.0	3.43± 0.20	2.14± 0.46	1.43± 0.30	1.14± 0.14	1.14± 0.14	

Grade I- Normal weight bearing on all limbs at rest and while walking.
Grade II- Normal weight bearing at rest, favors affected limb while walking.
Grade III- Partial weight bearing at rest and while walking.
Grade IV- Partial weight bearing at rest; does not bear weight on affected limb while walking.
Grade V- Does not bear weight on limb at rest or while walking.

Fig 1: Non-weight bearing of fractured limb (grade V)

Fig 2: Pre-operative skiagram showing fractures of tibia in dogs (cranio-caudal view)

Fig 3: Implants
a) Interlocking instrument box set for 8, 9 &10 mm nails along with 3.5 mm and 4.5 mm cortical screws
b) Interlocking instrument box set for 5, 6 &7 mm nails along with 2.0 mm and 2.7mm cortical screws
c) Interlocking nails of 8, 9 &10 mm diameter
d) Interlocking nails of 5, 6 &7mm diameter

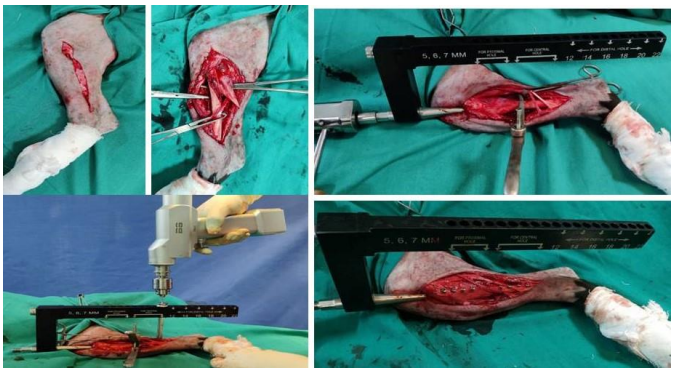

Fig 4: Surgical approach and fracture reduction and application of IILN in tibia in dog.

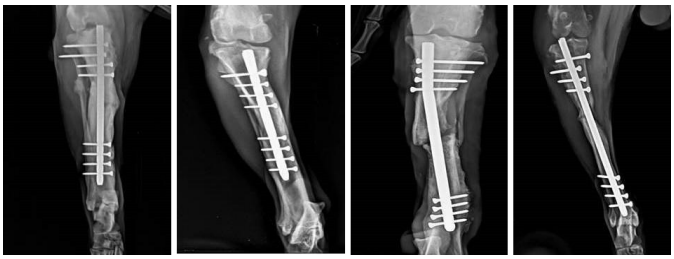

Fig 5: 90th day Post-operative radiographs of dogs with tibia fractures stabilized with intramedullary interlocking nail (cranio-caudal view).

Complications

One complication was observed in a dog on 15th postoperative day, in which dog showed signs of mild to moderate weight bearing lameness. Up on radiographic examination revealed that nail was slightly bent above fracture site near screw area in the proximal fracture fragment this was due to weight and hyperactivity of the dog (Arican *et al.*, 2017) [2].

Conclusion

Based on the present study, it was concluded that intramedullary interlocking nail was successful in the treatment of tibia fractures and offered remarkable improvement in the limb function with good fracture stability till the completion of the bone healing in six out of seven dogs. Though radiographs on 90thpostoperative day revealed complete bone healing in case 6, but animal showed normal weight bearing at rest, favors affected limb while walking (grade II lameness). The use of intramedullary interlocking nail fixation in the treatment of tibial diaphyseal fractures was found to be effective as it provided resistance against axial, bending and torsional forces acting on the bone.

Conflict of Interest

No conflict of interest

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References

1. Aikawa T, Miyazaki Y, Shimatsu T, Lizuka K, Nishimura M. Clinical outcomes and complications after open reduction and internal fixation utilizing conventional plates in 65 distal radial and ulnar fractures of miniature and toy- breed dogs. Vet. Comp. Orthop. Traumatol. 2018;31(3):214-217.
2. Arican M, Alkan F, Altan S, Parlak K, Yavru N. Clinical Experience of Interlocking Nail Stabilization of Long Bone Fractures in Dogs–A Retrospective Study of 26 Cases. Israel Journal of Veterinary medicine. 2017;72(2):45-50.
3. Bernarde A, Diop A, Maurel N, Viguier E. An *in vitro* biomechanical study of bone plate and interlocking nail in a canine diaphyseal femoral fracture model. Vet Surg. 2001;30(5):397-408.
4. Bustamante R, Aguado D, Cediel R, de Segura IG, Canfrán S. Clinical comparison of the effects of isoflurane or propofol anaesthesia on mean arterial blood pressure and ventilation in dogs undergoing orthopaedic surgery receiving epidural anaesthesia. The Veterinary Journal 2018;233:49-54.
5. DeCamp CE, Johnston SA, Déjardin LM, Schaefer SL. Fractures and Orthopedic Conditions of the Hindlimb. In: Brinker, Piermattei, and Flo's Handbook of Small Animal Orthopedics and Fracture Repair. 5 th Edn. Elsevier, Missouri, USA; c2016. p. 434-758.
6. Eyarefe OD, Oyetayo SN. Prevalence and pattern of small animal orthopaedic conditions at the Veterinary Teaching Hospital, University of Ibadan. Sokoto Journal of Veterinary Sciences. 2016;14(2):8-15.
7. Guiot LP, Dejardin M. Prospective evaluation of minimally invasive plate osteosynthesis in 36 non articular tibial fractures in dogs and cats. Vet Surg. 2011;40:171-182.
8. Hampton CE, Riebold TW, LeBlanc NL, Scollan KF, Mandsager RE, Sisson DD. Effects of intravenous administration of tiletamine-zolazepam, alfaxalone, ketamine-diazepam, and propofol for induction of anesthesia on cardiorespiratory and metabolic variables in healthy dogs before and during anesthesia maintained with isoflurane. Am. J Vet. Res. 2019;80(1):33-44.
9. Hudson CC, Pozzi A, Lewis DD. Minimally invasive plate osteosynthesis: Applications and techniques in dogs and cats. Vet. Comp. Orthop. Traumatol. 2009;22:175-82.
10. Jagan Mohan Reddy K, Dilip Kumar D. Clinical Efficacy on the Use of Titanium Intramedullary Interlocking Nailing (Ti-IILN) for Repair of Communited Diaphyseal Femur Fractures in Dogs. Journal of Animal Research. 2021;11(05):807-817.
11. Keosengthong A, Naruepon K, Jitpean S, Seesupa S, Kunkitti P, Hoisang S. Incidence and classification of bone fractures in dogs and cats: a retrospective study at a Veterinary Teaching Hospital, Khon Kaen University, Thailand (2013-2016). Veterinary Integrative sciences. 2019;17(2):127-139.
12. Kumar BB, Sharma AK, Reetu PK, Kumar C, Kumar R. Study on incidence of fractures with respect to breed, age, sex, type and location of fractures and bone involved. J Entomol. Zool. Stud. 2020;8(2):21-24.
13. Kuusela E, Raekallio M, Väisänen M, Mykkänen K, Ropponen H and Vainio O. Comparison of medetomidine and dexmedetomidine as premedicants in dogs undergoing propofol-isoflurane anesthesia. Am. J Vet. Res. 2001;62(7):1073-80.
14. Kuusela E, Vainio O, Short CE, Leppäluoto J, Huttunen P, Ström S, *et al*. A comparison of propofol infusion and propofol /isoflurane anaesthesia in dexmedetomidine premedicated dogs. J Vet. Pharmacol. Ther. 2003;26(3):199-204.

15. Langley-Hobbs S. Biology and radiological assessment of fracture healing. In Practice 2003;25:26-35.
16. Morgan DW and Legge K. Clinical evaluation of propofol as an intravenous anaesthetic agent in cats and dogs. The Veterinary Record. 1989;124(2):31-3.
17. Rhangani AT. Incidence, classification and management of appendicular bone fractures in dogs in Nairobi County, Kenya. A retrospective study. Doctoral dissertation submitted to the University of Nairobi; c2014. p. 22-31.
18. Saini SPS, Singh T, Singh SS and Sangwan V. Distribution of multifragmental diaphyseal fractures of femur and tibia in dogs. Indian Journal of Veterinary Surgery. 2017;38(2):111-113.
19. Simon MS, Ganesh R, Ayyappan S, Rao GD, Kumar RS, Kundave VR and Das BC. Incidences of pelvic limb fractures in dogs: A survey of 478 cases. Veterinary World, 2010, 3(3).
20. Tsai YC, Wang LY, Yeh LS. Clinical comparison of recovery from total intravenous anesthesia with propofol and inhalation anesthesia with isoflurane in dogs. J Vet. Med. Sci. 2007;69(11):1179-1182.
21. Vasseur PB, Johnson AL, Buderberg SC, Linwln JB, Toombs JP, Whitebain JG *et al*. Randomized, controlled trials of the efficacy of carprofen, a non- steroidal anti-inflammatory drug in the treatment of osteoarthritis in dogs. J Am Vet Med Assoc. 1995;206:807-881.