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Priyanka
MVSc Student, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Tarunbir Singh
Assistant Scientist, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

J Mohindroo
Professor-Cum-Head, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Pallavi Verma
Assistant Professor, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal sciences University, Ludhiana, Punjab, India

Rahul Udheiya
Assistant Professor, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal sciences University, Ludhiana, Punjab, India

N Umeshwori
Assistant Professor, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal sciences University, Ludhiana, Punjab, India

Correspondence
Priyanka
MVSc Student, Veterinary Surgery and Radiology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Evaluation of intramedullary pinning technique for management of tibia fractures in dogs

Priyanka, Tarunbir Singh, J Mohindroo, Pallavi Verma, Rahul Udheiya and N Umeshwori

Abstract
The objective of the study was to evaluate the suitability of intramedullary pinning technique for stabilization of tibia fractures in dogs. In this study, a total of 21 animals with 21 fractures were included and stabilized with intramedullary pin. All the fractures were openly reduced. The signalment and history revealed the disease more common in males (76.19%, n=16). The mean age of animals was 1 year 9 months having mean body weight of 15.86 kg. Non-descript and Labrador breeds was having higher incidence. Automobile accident was the major aetiology. In most of the cases initial weight bearing was noticed by 1 to 10 post operative day. Osteomyelitis and seroma formation was seen in 2 and 1 cases respectively. Post-operatively limb function was judged as excellent (9/21), good (7/21), fair (3/21) and poor (2/21). In the final outcome the excellent limb function was found in 42.86% cases.

Keywords: Tibia fracture, intramedullary pinning, limb function

Introduction
Fracture is defined as the loss of continuity in the bone and/or cartilage. Fractures are one of the most common problems in routine clinical practice [1]. External trauma and mechanical forces such as compression, bending and twisting can cause long bone fractures [2]. Fracture of tibia is second most common long bone affected following the femur [3, 4]. Fracture of tibia may occur at any site but the shaft (73%) is affected more than extremities [5]. The normal anatomic twists and curves of the bone are responsible for oblique or spiral nature of tibial fractures [6]. Many methods of stabilisation of tibia fractures have been advocated like intramedullary pinning, bone plating, intramedullary interlock nailing and external fixation by Plaster of Paris and external skeletal fixators [7, 8]. The primary goal of any method of fracture fixation is to achieve the fastest possible healing and enabling the patient to function normally by allowing early mobility [9, 10]. Intramedullary pinning is the most common technique due to its simplicity and requirement of less exposure for the repair of fractures of dogs. Thus, the present study was undertaken to evaluate the intramedullary pinning technique in tibia fractures of dogs.

Material and methods
The study included twenty one tibia fractures of dogs which were stabilized with intramedullary pin. There was a history of trauma and non weight bearing on the affected limb. Signalment including breed, sex, age, weight, limb involved and aetiology were recorded. Confirmatory diagnosis and AO/ASIF classification of fractures were made by pre-operative cranio-caudal and medio-lateral radiographs (Table 1). On the day of presentation Robert jones bandaging with medial splint was done till the date of surgery.
Cortex to cortex ratio at isthmus region of bone was measured from radiographs to access medullary cavity diameter.
Whole blood was collected aseptically in ethylene diamine tetra-acetic acid (EDTA) pre-operatively before administration of anaesthesia for haematological (Hb, TLC, DLC, Platelets) and serum parameters (Ca, P, CK, Glu). Dogs were fasted 12 hours prior to surgery. On the day of surgery, animals were preanaesthetised with a combination of Inj. Butorphanol [32] @ 0.2 mg/kg b.wt., Inj. Acepromazine [33] @ 0.05 mg/kg b.wt. and Inj. Glycopyrrolate [34] @ 0.01 mg/kg b.wt. intramuscularly. Anaesthesia was induced with Inj. Propofol [35] @ 4 mg/kg b.wt. I.V till effect and maintained by 1-2% Isoflurane [36] inhalation anaesthesia in oxygen through cuffed endotracheal tube connected to the circle system of small animal anaesthetic machine.

Standard medial surgical approach was used due to presence of less neurovascular bundle on medial aspect of tibial bone [11]. The diameter of pins were determined by pre-operative radiographs, weight of dog and intraoperative assessment. Pin that fitted 60-70% medullary cavity was selected. Ancillary support with full Circlage wiring was provided in long oblique fractures. Intraoperative observations like extent of soft tissue damage (mild, moderate and marked), extent of overriding of main segments (mild, moderate and marked), ease of fracture reduction (Easy, moderate and difficult) were recorded. Postoperatively the dogs were administered broad spectrum antibiotics and analgesics for 5 and 3 days respectively. The operated limb was given external support in the form of modified Robert jone's bandage for 2 weeks. Restricted movement was advised for first two weeks of surgery followed by leash walking for the following weeks until healing was confirmed radiographically. Skin sutures were removed after 10-15 days of surgery.

Postoperatively recovery was determined by radiographic and clinical examination at suitable intervals and by regular telephonic contact with clients. Immediate post operative radiographs and radiographs taken whenever the dog presented to clinic for check up were evaluated for fracture reduction, implant position, complication related to bone or implant failure and bone healing. Healing was considered complete when callus was radiographical visible in both radiographic views at both the fracture level.

Limb usage during the post-operative follow-up period was categorized using the classification used by Cook *et al* in 1999 [12]. Total score was thus calculated by adding the scores obtained for weight bearing at standing and walking (range 0-6) on days 0, 15, 30-45 and 60 postoperatively. At final follow up examination, clinical lameness score (0-5) was given as per Cook *et al.* [12] as follow:

1. No observable lameness
2. Intermittent, mild weight-bearing lameness with little if any change in gait
3. Consistent, mild weight-bearing lameness with little change in gait
4. Moderate weight-bearing lameness - obvious lameness with noticeable "head bob" and change in gait
5. Severe weight-bearing lameness - "toe-touching" only
6. Non-weight-bearing

Table 1: Distribution of affected animals

Case no	Breed	Age (m)	Sex	Body wt(kg)	Etiology	AO/ASIF fracture classification	Limb involved
1	Labrador	12	M	26	Automobile accident	42-A3	Right
2	Pug	3	F	4.2	Automobile accident	42-C3	Right
3	Lhasa Apso	10	M	8	Automobile accident	42-A1	Left
4	Pitbull	8	M	20	Automobile accident	42-A1	Left
5	Labrador	6	M	14	Slipped	42-A1	Right
6	Labrador	7	M	12	Automobile accident	42-A2	Left
7	Rottweiler	60	M	25	Automobile accident	42-A2	Left
8	Bull terrier	6	M	20	Fall from height	42-A2	Right
9	St. Bernard	12	M	34	Fall from height	42-B2	Left
10	Spitz	36	F	8	Fall from height	42-A2	Right
11	Pug	24	M	6	Fall from height	42-A3	Left
12	Pug	8	M	5	Automobile accident	42-A3	Left
13	Spitz	48	F	10	Fight	42-A1	Right
14	Bull terrier	18	F	14	Automobile accident	42-B2	Left
15	Non descript	36	M	20	Automobile accident	42-A2	Left
16	Pitbull	12	M	18	Fight	42-A1	Left
17	Non descript	36	M	15	Automobile accident	43-A1	Right
18	Non descript	12	M	12	Automobile accident	42-B2	Left
19	Non descript	12	M	28	Unknown	42-B1	Left
20	Labrador	78	M	24	Automobile accident	42-A3	Right
21	Dachshund	48	F	10	Fall from height	42-A1	Right

Table 2: Fracture related observations in animals

Dog No.	Soft tissue damage	Over-riding	Ease of reduction	Size of proximal fragment (cm)	Size of distal fragment (cm)	Ratio(proximal / distal fragment length)	Type of Implant	Additional implant
G11	Moderate	Mild	Moderate	16.53	7.35	2.25	Steinmann pin	-
G12	Mild	Mild	Easy	20.21	11.60	1.74	Steinmann pin	-
G13	Mild	Moderate	Easy	7.50	5.82	1.29	Shanz pin	-
G14	Mild	Moderate	Moderate	9.15	10.74	0.85	Shanz pin	-
G15	Moderate	Mild	Moderate	10.76	4.19	2.57	Shanz pin	2 circlage wire
G16	Moderate	Mild	Easy	18.73	7.77	2.41	Steinmann pin	-
G17	Moderate	Moderate	Moderate	16.57	4.78	3.47	2 Steinmann pins	2 Circlage wire
G18	Mild	Mild	Moderate	21.26	7.52	2.83	Shanz pin	-
G19	Mild	Mild	Easy	10.22	4.56	2.24	Shanz pin	3 circlage wire
G110	Mild	Mild	Easy	4.92	11.30	0.43	Steinmann pin	-
G111	Moderate	Marked	Difficult	23.87	3.97	6.01	Steinmann pin	-
G112	Moderate	Moderate	Easy	8.81	2.95	2.99	Steinmann pin	-
G113	Moderate	Mild	Easy	14.39	3.17	4.54	Shanz pin	-
G114	Mild	Mild	Easy	16.38	12.45	1.31	Steinmann pin	-
G115	Mild	Mild	Easy	10.17	8.03	1.27	Steinmann pin	-
G116	Moderate	Mild	Easy	9.03	9.23	0.98	Steinmann pin	-
G117	Moderate	Mild	Moderate	11.04	17.14	0.64	Steinmann pin	-

G118	Marked	Mild	Moderate	7.82	6.61	1.18	2 Steinmann pin	-
G119	Mild	Mild	Easy	9.34	8.03	1.16	Steinmann pin	-
G120	Moderate	Moderate	Moderate	12.41	8.12	1.53	Shanz pin	-
G121	Mild	Mild	Easy	4.82	1.90	2.54	Steinmann pin	1 circlage wire

The functional limb usage (poor to excellent) was categorized using classification devised by Fox in 1997 [21] as follow:
Excellent- Weight bearing without lameness.
Good- Weight bearing with slight lameness.
Fair- Slight to moderate lameness mainly after exercise.
Poor- Intermittent or consistent non-weight bearing lameness

Table 3: First weight bearing and limb usage scores

Dog no.	First wt. Bearing (days)	Limb usage score
G_{11}	7	Good
G_{12}	20	Excellent
G_{13}	5	Excellent
G_{14}	123	Good
G_{15}	67	Good
G_{16}	3	Excellent
G_{17}	30	Poor
G_{18}	2	Good
G_{19}	4	Excellent
G_{110}	4	Good
G_{111}	10	Poor
G_{112}	8	Good
G_{113}	2	Good
G_{114}	3	Excellent
G_{115}	5	Excellent
G_{116}	12	Poor
G_{117}	10	Poor
G_{118}	3	Good
G_{119}	2	Excellent
G_{120}	1	Excellent
G_{121}	20	Poor
Mean±SE	16.23±6.24	
Range	1-123	

Result and Discussion

In present study, a total of 21 cases of canine tibial fractures were stabilized with intramedullary pinning of which simple intramedullary Steinmann pin was used in 12 animals, end threaded pin (shanz pin) was used in 7 animals and stack pinning was done in 2 animals. In four cases, additional stabilization with full Circlage wire was done.
Higher incidence of tibia fracture was found in male (76.19%, n=16) as compared to female (23.81%, n=5) with an mean age of 1 year 9 months (3 months - 6.5 years) (Table 1) and mean body weight of 15.86 kg ranged from 4.2 to 34 kg (Table 1). As noted by Ramesh in 2011 [14], it was found that the most consistent factor in choosing the implant size was patient weight along with the bone size. Light weight animals (15.86±1.80) with an average age of 1 year 9 months, having mostly Diaphyseal spiral or oblique fracture were operated with intramedullary pin. In present study highest incidence of fracture was found in males due to the fact that males are relatively more aggressive [15]. In majority of cases Labrador retriever and non-descript breeds were found to be most affected and automobile accident (12; 57.14%) contributed the most common aetiology of tibia fractures in dogs. Higher incidence in Labrador may be due to breed preference of these dogs as guard dogs in and around Ludhiana, similar findings were also observed by Rhangani, 2014 [16]. Ben Ali in 2013 [17] found automobile accidents the major cause of fractures in dogs. Mean time since fracture to presentation of animal to the clinic was 5.04±0.77 days with a range of 1 to 15 days. Left limb was found most commonly affected (57.14%, n=12) as compared to right limb (42.86%, n=9). Diaphyseal spiral (42-A1) and oblique fractures (42-A2) were more common. The normal anatomic twists and curves of the bone are responsible for oblique or spiral nature of tibial fractures [6]. Boone *et al* in 1986 [18] also reported spiral and oblique fracture patterns, the most frequent in juvenile (<12 months old) and adult animals (>12 months old). Majority of the fractures recorded were simple type (16; 76.20%) followed by wedge (4; 19.04%) and complex fracture (1; 4.76%) (Table 2). Mean length of proximal and distal fragments were 12.56±1.17 (4.82-23.87cm) and 7.48±0.81 (1.90-17.14) respectively. Preoperative blood samples showed mean haemoglobin value within the normal range (9.79±0.42) whereas mean total leukocyte count (10^3/cumm) was elevated (14.67±1.25) with neutrophilia (77.14±2.18). Elevated levels of neutrophils might be induced by corticosteroids released due to stress, pain, trauma and surgical manipulation [19]. Mean calcium (10.46±0.24), phosphorus (5.93±0.73) and glucose (98.19±4.03) values were with in normal ranges while mean creatine kinase values (433.66±103.31) was elevated. The mean creatinine kinase values were elevated could be due to damage to muscle tissue by fracture fragments [20]. Intra-operatively, degree of soft tissue damage was mild in ten, damage was moderate in ten and marked in one case (table 2). Frigg and Ulrich in 2003 [21] opined that soft tissue condition and local blood circulation were the most important factors for bone reconstruction and healing of fractures. Overriding was mild in 15, moderate in 5 and marked in 1 case (table 2). Reduction was found easy in 12, moderately difficult in 8 and difficult in 1 case due to displaced and overriding of fragment (Table 2). Easy reduction in most of the cases was due to mild degree of overriding in these fracture cases, while reduction was difficult in one case having marked overriding.
Time taken for completion of surgery ranged from 30-90 minutes. Advantage of intramedullary pin is that it require less exposure to bone and fracture site and the cambium layer of periosteum which is needed for bony healing is preserved. In 2 animals stack pinning was done using two Steinmann pins resulted in satisfactory fracture fixation. Stack pinning for treatment of long bone fractures was also recommended by some workers [22, 23]. Multiple IM pin fixation of the femur in dogs and cats had increased fracture fixation stability was also reported by a research worker [24]. For proper stabilisation of fracture fragments by intramedullary pinning technique the pin should be as large as can be accommodated by the medullary canal to resist the bending forces and therefore, capable of maintaining axial alignment [25]. The dimensions of the pin should be 70-80 % of the isthmus of the medullary canal. If the pin is too small it will not have adequate strength or bending stiffness to maintain stability [26]. Immediate post operative radiographs revealed anatomic reduction with good cortical contact and stable implant in all the cases. The ratio of implant to medullary cavity was found to be 0.64±0.02. Sutures were removed 10-12th post operative day. In all the cases initial weight bearing was noticed by 1 to 10th post operative day except in four cases where it was more than 20 days (Table 3). Mean weight bearing scores at 0, 15, 30-45 and >60 days were 0.24±0.09, 2±0.32, 3.28±0.39, 4.86±0.28 respectively.

Follow up examination showed homogenous callus formation, with obliterated fracture line and complete fracture union (fig.2d). Callus formation with massive bone trabeculae crossing the fracture line with discernible fracture line and complete bone union were also observed. A stable fracture may produce very little visible callus, whereas an unstable fracture will require the formation of a massive bridging callus, which is referred to as the exuberant callus of fracture repair [27]. Fractures treated by intramedullary pinning must unite by peripheral callus because the pin blocks the endosteal callus and new bone does not develop from the vascular cortical ends [28]. Moreover, the insertion of intramedullary pin promote bone healing even by bringing in contact with the bone fragments, pluripotent cells derived from bone marrow [29].

In two animals osteomyelitis was observed with draining tract on the medial aspect of tibia which was treated with broad spectrum antibiotic based on culture sensitivity test, the dogs showed an uneventfull recovery thereafter. If any internal fixation was used in treatment of open fractures, it must produce very stable fixation, because bone can heal in the presence of infection if it is stabilized [30]. Minor complication such as late weight bearing in four cases and seroma in one case and in one animal external rotation of paw and inward rotation of hock joint was also noticed. This may be due to the fact that pins provide poor axial stability and are liable to migration and arthrosis due to some amount of rotational deformity which may be present after implant placement [31]. In rest of the animals there was no rotational deformity or gait abnormality. Implants were removed once satisfactory healing occurred and the animals showed pain free functional usage of the operated limb. Four animals started weight bearing on operated limb after the pin removal who were having radiographically healed fracture. Intramedullary pin was removed in 4 cases those presented to clinics for implant removal. In two young animals intramedullary pin was seen embedded into the tibia bone (fig. 4c). Owners of these animals visited late to the clinics for pin removal and pins were engulfed by the bone so pins were left in place. It has been reported that intramedullary pins can be left in place unless there is loss of function or pin loosening. There was no pin migration in any of the animal.

In 14 animals there was no lameness, 5 animals were having mild lameness and 2 animals were having moderate and severe lameness respectively (Table 35). Excellent limb usage was seen in 42.86% of animals. At final follow up examination, out of 21 animals 14 animals showed no observable lameness, whereas in one animal severe lameness was noted i.e only the toe was touching the ground. Final clinical outcome was graded as Limb usage score, it was excellent in 9 cases, Good in 7, fair in 3 and poor in 2 cases (Table 3).

Conclusion

So, from present study it was concluded that intramedullary pinning technique can be used in simple fractures possessing low body weight. This technique was found to be most economical and less time consuming and sometimes willingness of the owner for simple technique were the important considerations while selecting this technique.

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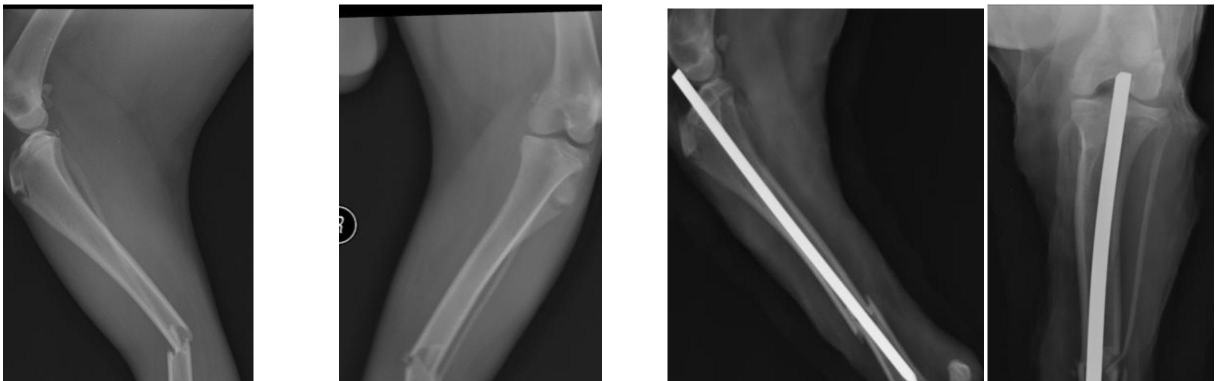

Fig 1: (a) Pre operative and (b) immediate post operative radiographs showing transverse fracture stabilized with intramedullary pin.

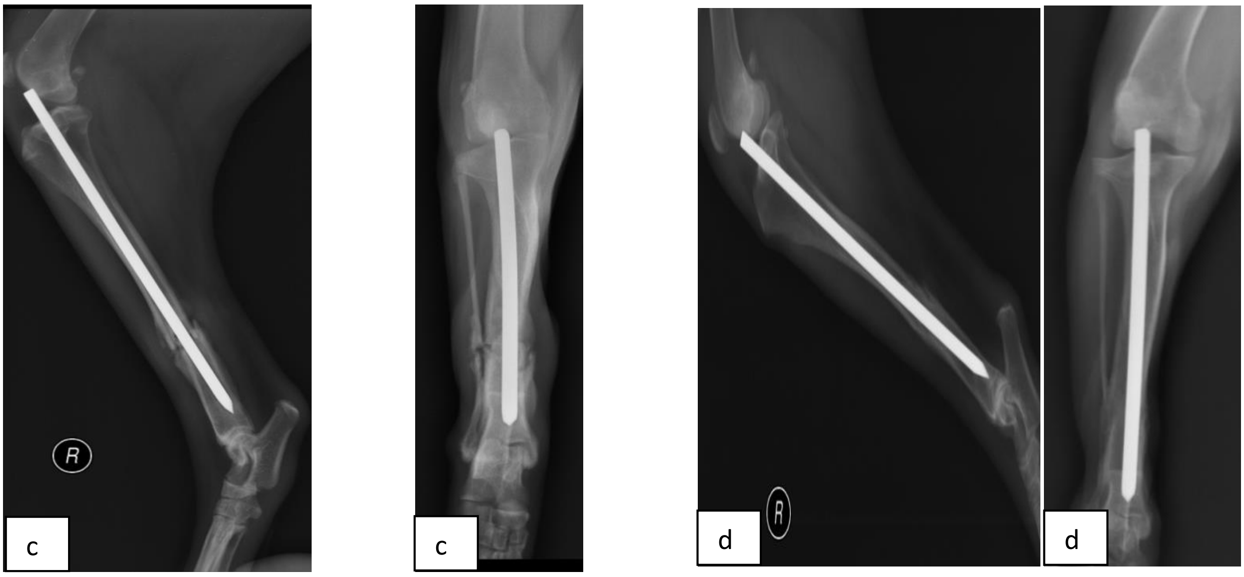

Fig 2: (c) 60 days and (d) 75 days post-operative medio-lateral and cranio-caudal radiographs showing sequence of fracture healing.

Fig 3: Radiograph at (e) 80 days and (f) 60 days post operative complete bone union and complete weight bearing respectively

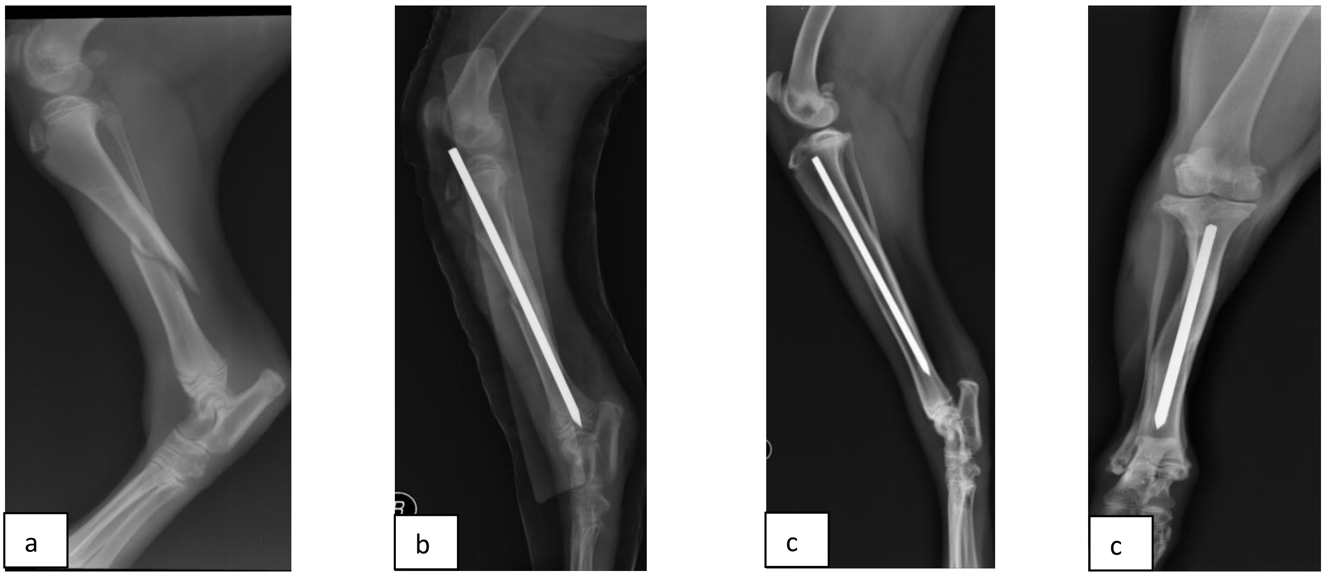

Fig 4: (a) Pre-operative, (b) immediate, (c) 6 months post operative radiographs showing sequence of fracture healing with embedded intramedullary pin.

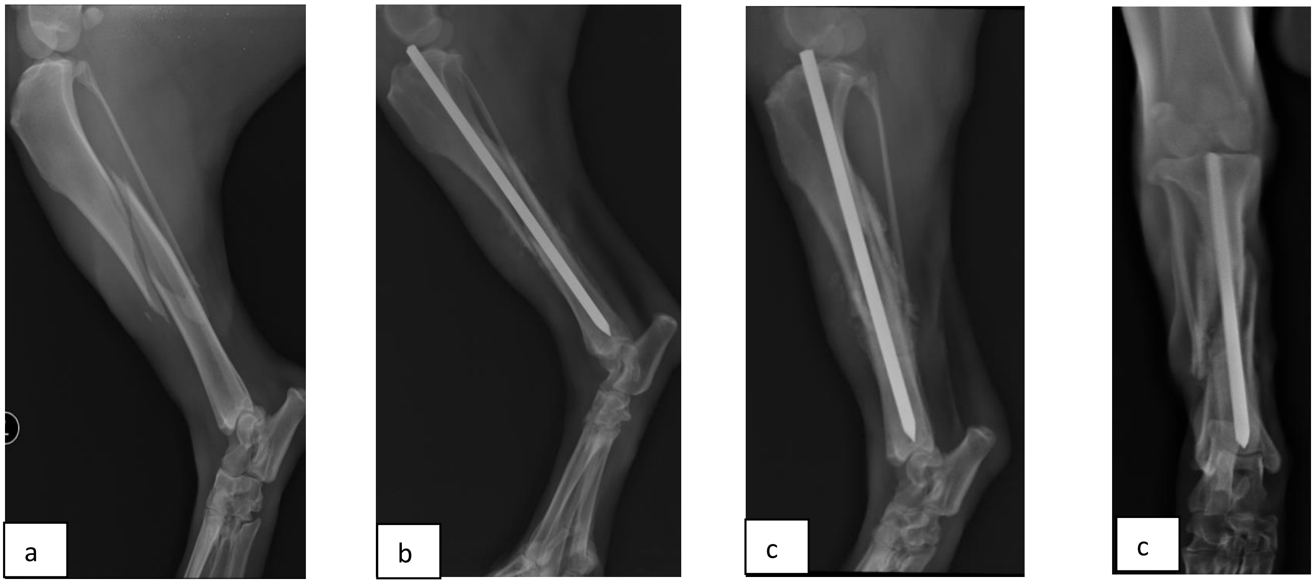

Fig 5: (a) Pre-operative, (b) immediate, (c) 30 days post operative radiographs showing signs of Osteomyelitis at fracture site.

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