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Comparative evaluation of plain and end threaded Steinmann pin for intramedullary pinning of long bone fractures in dog

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Abstract
The study was conducted to compare the effectiveness of plain and end threaded steinmann pin for intramedullary pinning of long bone fracture in dog. A total of twelve animals with fractures were included in the study and categorised into two groups. The fracture was immobilized by intramedullary pin with plain and end threaded intramedullary pins by retrograde method respectively. Analysis of signalment and history indicated as male dogs showed a higher prevalence of diaphyseal fractures than females, with the juvenile age group being most affected, and automobile accidents being the primary cause. Oblique fractures were more common and predominantly in Mongrels. In group I and II, complete weight bearing observed on 43rd and 38th day postoperatively respectively. All heamato-biochemical parameters have no significant difference on subsequent day of post operative and in both groups also except serum alkaline phosphates. Complications such as proximal or distal pin migration and seroma formation occurred in two cases. In conclusion, dogs undergoing end-threaded pinning compared to those with plain pinning Postoperative outcomes such as early weight bearing, normal gait resumption, and reduced fracture pain were observed earlier.

Keywords: End threaded steinmann pin, Schanz screw, Intramedullary pinning

Introduction
Fractures are among the most common problems encountered in ordinary clinical practice with varying clinical presentation. Now a days, increased vehicular congestion and rise in dog population may lead to cases of fractures. Long bone fractures are caused by external trauma or mechanical forces such as compression, bending, or twisting. The femur is the most commonly fractured long bone and second one is tibia. Intramedullary pinning is the most common internal skeletal fixing procedure for repairing dog fractures since it is simple and requires minimal exposure, with multiple options available. The one is plain intramedullary pins, also known as Steinman pins, are the most widely used type. They can operate as either a single IMP or a stack/multiple IMP. Another, threaded intramedullary pins provide an alternate option, but less frequently used than plain IM pins. They come in two types: fully threaded and end threaded IMP (schanz screw). Plain intramedullary pins provide axial stability and resistance to bending forces from various directions, but they are less effective in countering rotational and shearing forces. The rotational force can be counter acted with end threaded pins and are utilized to manage rotational forces at some extend (De Camp *et al.*, 2016) [3]. End threaded pin gives better holding force compared to plain intramedullary pins. (Ogurtan, 2006) [12]. Therefore this present study was conducted with the objectives to evaluate the effectiveness of plain and end-threaded Steinman pins/Schanz screws for intramedullary pinning in stabilizing long bone fractures.

Materials and Methods
The study was conducted on dogs presented to the Veterinary Clinical Complex at Nagpur Veterinary College, Nagpur from May 2023 to Jan 2024 suffering from long bone fractures. The study was conducted on twelve cases of fracture which were further divided into two equal groups irrespective of their age, sex and breed.
The fracture was immobilized with plain steinmann pin and end threaded pin in group I and II

respectively. The implant size selected was approximately 60%-70% of total medullary canal at the narrowest part of the medullary canal.

The case anamnesis included the age, body weight, breed, sex, and cause of fracture. Animal was examined for general condition, injuries, presence of any open wounds, the amount of swelling, extent of damage to the soft tissues at the fracture site, and any concurrent illness of the animal, were all recorded during a thorough examination. Preoperative radiographs were taken in anterio-posterior and medio-lateral views to check the type of fracture and bone involved. The postoperative mediolateral and anterio-posterior radiographs were evaluated on 7th, 15th, 30th, and 45th days to check the position of the pin, extent of fracture reduction and alignment.

An intravenous (IV) line was maintained with ringer's lactate solution (RL) preoperatively and throughout the surgery until recovery. Animals were pre-anesthetised with Inj. atropine sulphate @ 0.04 mg/kg body weight subcutaneously (SC) and Inj. xylazine hydrochloride @1 mg/kg body weight intramuscularly(I/M), thirty minutes and fifteen minutes before induction of general anaesthesia respectively. The general anaesthesia was induced with Inj. Ketamine Hydrochloride @ 5 mg/kg body weight intravenously (I/V) and Inj. Diazepam @ 0.5 mg/kg body weight I/V and maintained with mixture of Isoflurane and oxygen at 2-4% anaesthesia Gahlod (2007) [5].

The intramedullary pinning was performed using retrograde method in both the groups as described by Piermattei (2006) [13]. Pins with diameters of 3mm to 4.5 mm and lengths of 18 to 22 cm were chosen based on bone size. The pin was inserted into the distal fragment and the distal tip was seated at the cancellous part of distal fragment of the bone. Circlage wiring was performed in one case of group II. Postoperatively the operated limb was immobilized with a modified Robert Jones bandage for the two to three weeks. The animals were given antibiotics and anti-inflammatory postoperatiely. Patients were advised supplements like calcium, multivitamins, haematinics, and nerve tonics orally for a duration of two months. The animals were advised to rest and the movements were restricted until complete healing of fracture and physiotherapy.

Following surgery, the surgical incision was cleaned and a Modified Robert Jones bandage was placed on each case. The Robert Jones bandage was replaced every week for next 2-3 times. Regular antiseptic dressing with liquid povidone-iodine solution was used in all instances, and sutures were removed 10-12 days after surgery. Antibiotics, anti-inflammatory medications, and calcium were administered orally to the animals.

Wound healing, weight bearing with operated limb, gait of the animal, pain on palpation and infection were recorded postoperatively. Blood was collected to find out the serum calcium, phosphorus, alkaline phosphatase and complete blood count on day 0th, 15th and 30th day post-operatively. The data gathered for this study were statistically evaluated by comparing means for different parameters using the ANOVA test.

Results and Discussion

Higher prevalance of long bone fracture was observed in males (63.77%) than females. Male were found to be more prone to physical injuries, such as fractures, due to their aggressive behaviour and tendency to leave their homes. Fracture percentage was higher in juvenile age group (54%) due to their active and playful nature, open epiphyseal plates and weak or growing bones. Non-descript dogs were the highest with 54% of prevalance of long bone fractures than other breeds of dogs. This is likely due to the fact that these dogs are more numerously present and spend a lot of time outside. An automobile accident was found to be the primary cause of fracture in 62.99% of cases, followed by fall from stairs. Femur bone fracture cases were found more followed by tibia fracture. Similar findings were reported by Goyal (2017) [6], Sakshi (2019) [14], Subhas Chandra Bose (2017) [16], Kumar (2016) [11], Kaur (2017) [8], and Sran *et al*. (2016) [15].

Intra-Operative Observations

Open reduction with internal fixation method was used to stabilized the long bone fracture of femur, humerus and tibia. Craniolateral incision approach were used in femur and humerus. Mediolateral approach was used in tibial fracture procedures. The dogs having oblique fractures with sharp edges resulted in more surrounding muscle tissue damage and large haematoma was observed at the fracture site two cases. The two late presented cases which showed larger haematomas and adhesions. According to Frigg and Ulrich (2003) [4], the most essential components for bone repair and fracture healing are soft tissue condition and local blood circulation.

All surgical wounds healed without complications, demonstrating primary intention wound healing. Haemato-biochemical values such as complete blood count, serum calcium and phosphorus showed non-significant difference between them and fluctuated within the normal physiological range. But serum alkaline phosphatase showed significant difference between the two groups. Post operatively on 15th day, there was rise in its value and thereafter came to normal on around day 45th of post operatively. Similar findings were recorded by Kumar *et al.* (2018) [9]. Wound healed on the 12th postoperative day in all the animals of both the groups.

Weight bearing: The weight bearing was graded recorded and scored at different levels while standing, walking and running as described by Aithal (1996) [1]. In group I, weight bearing grade was 3.5, 4.5 and 6.5 as recorded on day 15th, 30th and 45th postoperatively respectively. In group II, weight bearing grade was 4, 5.5 and 7.5 on day 15th, 30th and 45th postoperatively respectively. Similar findings were reported by Aithal (1996) [1]. Weight bearing grading score of group II was found to be more than that of group I which indicated early weight bearing in dogs of group II as compared to that of group I.

Gait: Gait recorded on day 15th in group I was found to be abnormal with lameness in all cases. Whereas it showed slight lameness on 30th day in all cases except one case. Gait was normal in all cases on 43rd post operatively. An improved gait with intermittent lameness was noted on 30th day postoperatively in group II. Gait started improving towards normal on day 38th day postoperatively. Delayed normal gait was reported in group I than group II implanted with a plain Steinmann pin. Kaur *et al.* (2015) [7] also found the early returning of normal gait post operatively in animals with end threaded pin compared to plain Steinmann pin.

Callus Formation

Moderate callus formation was observed in four cases with fracture line visible and two cases showed large callus in group I. Fracture healing with primary intention was observed when fracture edges were aligned by anatomical reduction in

one case of group I. Group II showed excellent fracture healing (< 60 days) in four cases with large callus and with no visible fracture line. Moderate callus formation in two cases showed bridging of the fracture gap. Same findings were observed by Kumar (2021) [10].

Fracture healing with callus formation was observed earlier in end threaded pinning stabilized dogs as to plain Steinmann intramedullary pinning. There was a significant effect of threaded ends for pinning on callus formation in fracture healing because it provided more stable fixation. Hence, end threaded pinning technique was found better to stabilize the diaphyseal long bone fracture in dogs.

Complications

Complications were reported in two cases during the study. Pin loosening and proximal migration in one case of group I. Similar complications were also observed by Kaur *et al.* (2015) [7] Pin was unable to hold the distal fracture ends properly due to its plain taper point and migrated proximally. In group II distal migration of implant was observed in only one case, which could be due to very thin cortex and inadequate calcification of bone. Similar findings were reported by Kumar (2016) [11]. Plain steinmann pinning had more chances of seroma and wound formation at the proximal insertion point of the pin which was due to migration of the pin. Less complications were recorded in group II where the cases were stabilized by end threaded pinning.

Implants were removed under general anaesthesia after giving a small incision at the pin insertion point. After that the proximal end of the pin was fixed in Jacob hand chuck and removed by rotating it anti-clockwise.

Table 1: Clinical observations of cases included in group I

Sr. No.	Breed	Age	Sex	Cause of injury	Bone	Type of fracture	Time for healing (days)	Size of IMP (mm)
1.	Gsd	3 yr	F	Automobile accident	Tibia	Transverse	60	4
2.	Spitz	3 month	F	Slipped from floor	Tibia	Transverse	45	3
3.	Cross breed	2 yr	M	Automobile accident	Humerus	Transverse	55	4.5
4.	ND	6 month	M	Automobile accident	Tibia	Long oblique	52	3
5.	ND	1 yr	M	Slipped from floor	Femur	Short oblique	56	4.0
6.	ND	8 month	M	Automobile accident	Humerus	Transverse	53	3.5

Table 2: Clinical observations of cases included in group II

Sr. No.	Breed	Age	Sex	Cause of injury	Bone	Type of fracture	Time for healing (days)	Size of IMP (mm)
1.	Labrador	4 month	M	Automobile accident	Femur	Transverse	50	3.5
2.	Golden Retriever	6 month	F	Automobile Accident	Femur	long oblique	52	4
3.	ND	1.5 year	M	Automobile Accident	Humerus	transverse	55	4
4.	ND	4 year	M	Dog fight	Humerus	short oblique	60	3
5.	Labrador	6 month	F	Automobile accident	Tibia	short oblique	55	4
6.	ND	5 months	M	Automobile accident	Tibia	short oblique	53	3

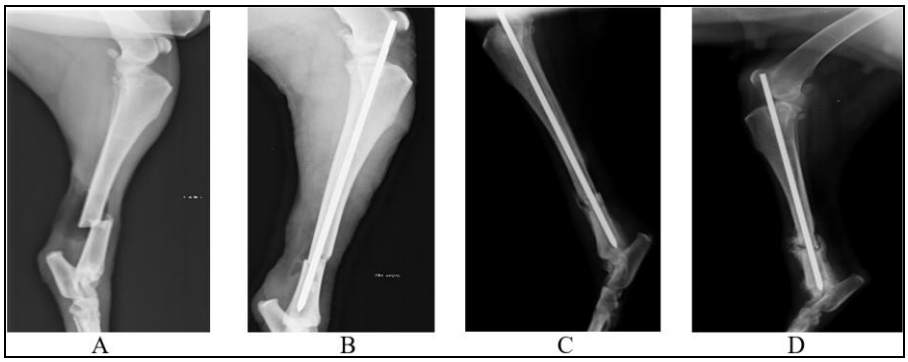

Fig 1: Preoperative radiograph (A), Post-operative radiograph immediately after surgery (B), Post operative on 15th day (C), Post operative radiograph on 45th day (D) of case no.1 of group I

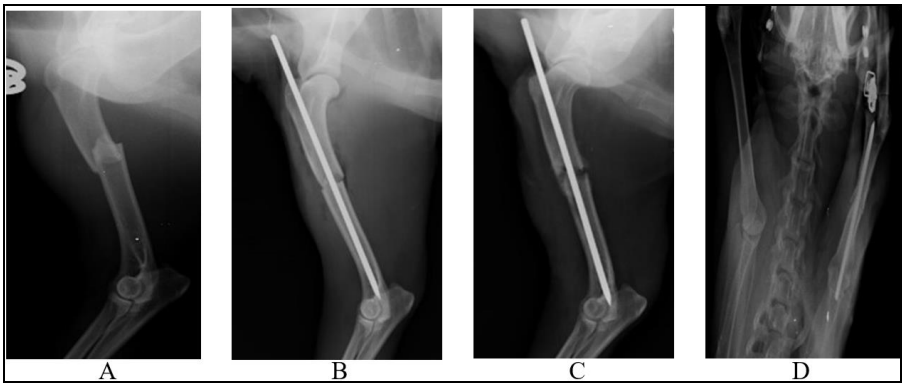

Fig 2: Preoperative radiograph (A), Post operative radiograph immediate after surgery (B), Post operative on15th day(C), Post operative radiograph on 45th day(D) of case no.3 of group I

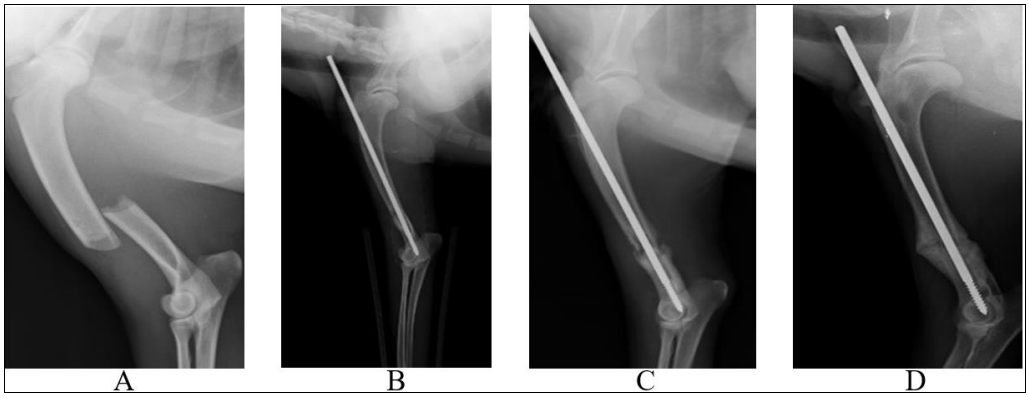

Fig 3: Preoperative radiograph (A), Post operative radiograph immediate after surgery (B), Post operative on15th day (C), Post operative radiograph on 45th day (D) of case no.3 of group II

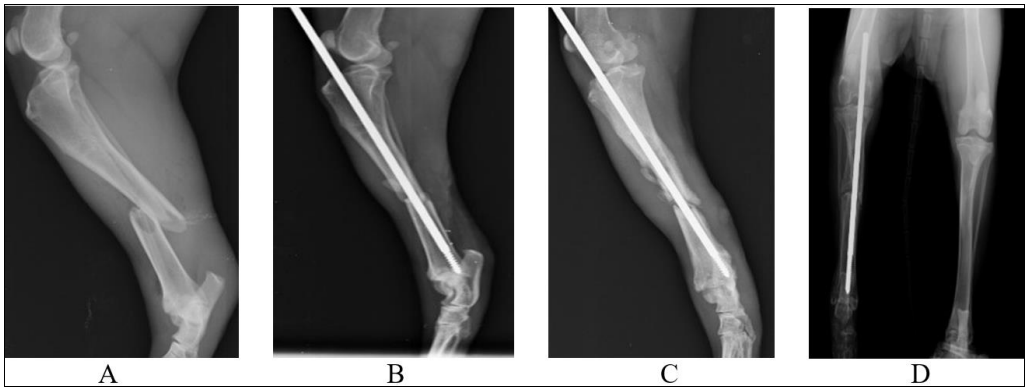

Fig 4: Preoperative radiograph (A), Post operative radiograph immediate after surgery (B), Post operative on 15th day(C), Post operative radiograph 45th day (D) of case no.6 of group II

Fig 5: Complete weight bearing of case no. 6 in group I on day 43

Fig 6: Complete weight bearing of case no. 3 in group II on day 38

Conclusion

Automobile accidents were the main cause of fractures in dogs, with highest prevalence of femur bone amongst all long bone fractures. End threaded pin is better technique to stabilize the diaphyseal long bone fracture as compare to plain steinmann intramedullary pinning, which resulted in better physiological and anatomical repair at fracture site with early weight bearing and normal gait in dogs.

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