



Original Research

Management of Long Bone Fracture Using Titanium Elastic Pin in Canines

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Abstract

The present study was conducted on 06 clinical cases of mature dogs irrespective of sex and breed, had long bone fracture with and without bone loss. All the diaphyseal fractures of the long bones were immobilized by an internal fixation technique using Titanium elastic pin. Post-surgery, clinical examination revealed continuous decrease in lameness and increase in weight bearing score from day 14 to 60. Radiographic examination between 15th to 30th day, revealed moderate periosteal reaction in four animals while exuberant periosteal proliferation in two animals. On 60th day complete union of fracture in two animals were noticed. Radiographic examination on 90th day showed union of fracture fragments in all the animals, except in two animals with faint radiolucent line at the site of fracture. Titanium elastic pin ensures the accurate and safe stabilization of diaphyseal fracture of long bone in dog with rapid return of limb activity.

Key words: Dog, Long Bone Fracture, Radiographic Examination, Titanium Elastic Pin

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Introduction

Intramedullary pinning acts primarily as internal splint of medullary canal of long bone that shares loading with bones, maintain axial alignment of the fracture and resists bending forces in all directions applied to the bone (Beale, 2004). The selection of Titanium-based materials for implant, is due to the combination of its outstanding characteristics such as high strength, low density (high specific strength), complete inertness to body environment, low modulus and high capacity to join with bone and other tissues (Niinomi, 2001).



Titanium is often considered to be better than those of stainless steel with regard to biocompatibility, modulus of elasticity, Osseo integration, corrosion resistance and magnetic resonance imaging compatibility (Kitsugi *et al.*, 1996). Titanium is currently the most popular metal used for elastic stable intramedullary nail fixation of pediatric femoral fractures in human however, its use in veterinary practice is still less. Hence, present study is planned to evaluate the efficacy of Titanium elastic pin as internal fixation technique for the management of long bone diaphyseal fracture in canines.

Materials and Methods

The present study was conducted on 06 clinical cases of adult dogs presented in Department of Veterinary Surgery and Radiology, TVCC, Mhow. A thorough clinical examination and radiographic examination of the animals was performed to localize the fracture and optimize the implant fixation. All the animals were selected randomly irrespective of sex and breed having diaphyseal fracture of long bones (Table 1).

Table 1: Distribution of animals under surgical treatment

Case No.	Bone Affected	Orientation of Fracture	Location of Fracture
A1	Femur	Oblique with bone loss	Proximal diaphyseal
A2	Femur	Transverse with bone loss	Distal third diaphyseal
A3	Tibia	Transverse with bone loss	Mid shaft diaphyseal
A4	Tibia	Transverse	Mid shaft diaphyseal
A5	Femur	Transverse	Distal third diaphyseal
A6	Femur	Transverse	Distal third diaphyseal

All the fractures were repaired by an internal fixation technique using Titanium elastic pin. The surgical procedure in all the animals was performed under general anesthesia using combination of Inj. Atropine sulphate, Inj. Xylazine hydrochloride and Inj. Ketamine hydrochloride. The fractured bone was exposed using a standard procedure. All the fractures of the long bones (femur and tibia) were surgically operated by an internal fixation technique using appropriate size Titanium elastic pin (Fig.1) in retrograde manner.



Fig. 1: Titanium elastic pin of different sizes



The limb was bandaged properly and administration of antibiotic Ceftriaxone @ 20 mg/Kg body wt. twice daily for 7 days and analgesic inj. Meloxicaim @ 0.5 mg/Kg body wt. once daily for 3 days. Temperature, heart rate and respiration rate were recorded before and after surgery to evaluate the clinical status of animal. The weight bearing and lameness was recorded on day 0, 7th, 14th, 21st, 30th and 60th and scored 0-5 viz.- No observable lameness (0), Intermittent, mild weight bearing lameness with no change in the gait (1), Consistent, mild weight bearing lameness with little change in the gait (2), Moderate weight bearing with noticeable change in the gait (3), Severe weight bearing Lameness, toe touching only (4), Non weight bearing (5) as described by Cook *et al.* (1999). The follow up radiographs were taken on day 15th, 30th, 45th, 60th and 90th to evaluate the progress of fracture healing.

Haematological parameters viz. haemoglobin, total erythrocyte count, total leucocyte count, differential leucocyte count and biochemical parameters viz. serum calcium, phosphorus and alkaline phosphatase (ALP) were analyzed on the day of surgery (0 day) and subsequently on 15th, 30th, 45th and 60th day post-operatively. The mean and standard error were calculated on the basis of data and Analysis of Variance was applied for analysis of data using Complete Randomized Design (CRD) as per the standard method described by Snedecor and Cochran (1994).

Result and Discussion

All surgical wound was healed by first intension healing. In the present study, no wound discharge was observed in any of the case as Titanium intramedullary pin has been claimed to reduce infection in animal studies (Eric *et al.*, 2008) and its debris or bulk is biocompatible, causes only transient increase in inflammatory response without macro vascular leakage and oedema (Dickson *et al.*, 2002). The mean weight bearing score improved gradually at different interval of study. All the animals were having non weight bearing on 3rd day hence scored 5.00±0.00. Thereafter significant gradual reduction in lameness was observed in postoperative days till it reached to 2.16±0.60 at 60 day (Table 2).

Table 2: Assessment of weight bearing and lameness score

Days	3	7	14	21	30	60
Score (n=6)	5.00 ^a ±0.00	4.83 ^{ab} ±0.16	4.00 ^{bc} ±0.25	3.83 ^c ±0.30	3.50 ^c ±0.34	2.16 ^d ±0.60

(n- Number of animals)

On 14th day, four animals (A2, A3, A4 and A5) out of six showed toe touching (score - 04), one animal (A6) showed moderate weight bearing (score-03). On 30th day four animals (A3, A4, A5 and A6) showed moderate weight bearing with noticeable change in gait, scored - 03. On 60th day three animals (A2, A3 and A4) showed consistent mild weight bearing lameness with little change in the gait (score-02), one animal (A6) showed no observable lameness (score-0), one animal (A5) showed intermittent mild weight bearing (score-01). In one animal (A1) non weight bearing (score-05) was observed up to 60th day. Functional

outcome of limb might be attributed to less trauma, adequate stabilization and biocompatibility of Titanium elastic intramedullary pin. These findings are in agreement with findings of Singh *et al.* (2015) who also observed good weight bearing by using Titanium elastic intramedullary pin in dogs.

The post-surgery radiographs were taken in two orthogonal views to evaluate apposition, alignment of fracture fragment, callus formation, ossification, organization of callus, reaction of bone to implant if any and stability of implant. Fracture of femur was involved in four cases where as fracture of tibia was involved in two cases. Out of six, three animals had transverse fracture, two transverse with bone loss and one oblique with bone loss (Table 1). Most of the fractures had varying degrees of overriding which was maximum in one animal (A2). Radiographic examination between 15th to 30th day showed perfect apposition of fractured fragments, moderate periosteal reaction and reduction of inter fragmentary gap in all the animals except in two animals (A3 and A4-Fig. 2), where external callus was visible with no change in fracture gap.

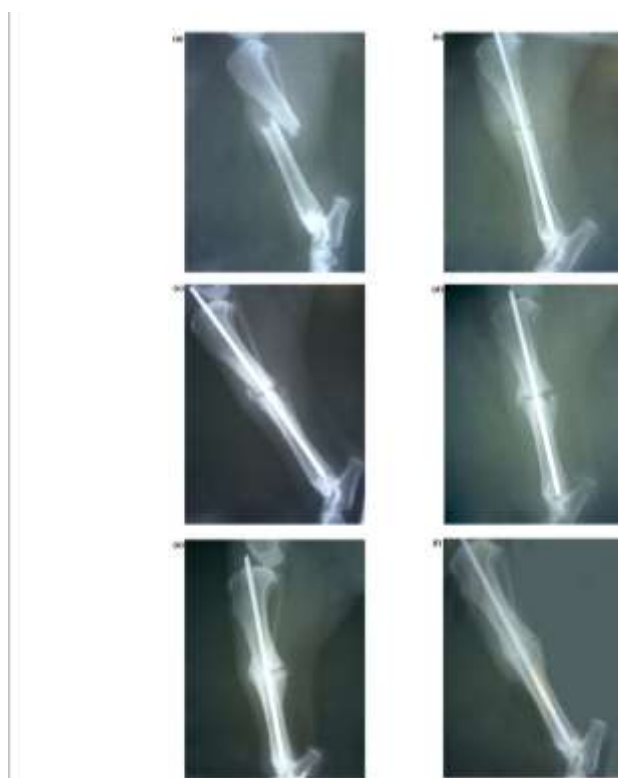


Fig. 2: Radiographs showing progress of fracture healing of A4 animal a) preoperative (0) day: fracture of proximal third of tibia b) 0 day: Internal fixation by Titanium pin, c) 15-30th day: moderate periosteal reaction with no change in inter fragmentary gap, d) 45th day: reduction of fracture gap, e) 60th day: union on one side of cortex, f) 90th day: a faint radiolucent line at fracture site on side of cortex.

In A1 and A6 animals more proliferative external callus was observed at 30th day. On 45th day, further reduction of fracture gap was observed in all animals. Evaluation of radiograph on 60th day showed obliteration of fracture line in two animals (A5 and A6) with moderate external callus in A5 (Fig. 3) animal.

Union on side of cortex with presence of radiolucent area on other side of cortex was observed in remaining four animals (A1, A2, A3 and A4).



Fig. 3: Radiographs showing progress of fracture healing of A5 animal a) preoperative (0) day: fracture of distal third of femur b) 0 day: Internal fixation by Titanium pin with slight overriding of fragments c) 15-30th day: mild periosteal reaction d) 45th day: reduction of fracture gap, e) 60th day: union of fracture fragments, f) 90th day: initiation of remodeling

Radiographic study on 90th day revealed almost complete healing of fractured bone with continuation of medullary cavity in two animals (A5 and A6). Fracture line was completely obliterated by external callus in A2 animal, while in the A1, A3 and A4 (Fig. 2) radiolucent line was visible and healing in progress. Titanium pin can be accurately contoured and impart excellent axial and lateral stability to diaphyseal fractures in long bones (Ligier *et al.*, 1983). Ninand (2015) and Bisnoi *et al.* (2015) also reported that Titanium elastic nail provide excellent union of long bone fracture in skeletally immature dogs. In the present study, some animals showed exuberant periosteal callus formation, might be because of lack of proper fixation or bone loss. This finding was in accordance with the Altunatmaz *et al.* (2012), who also reported excessive callus formation in 16 dogs out of 77 dog's fracture treated by Titanium elastic nail. Biological osteosynthesis is a recent concept, which states that fracture stabilization should be semi-rigid and there should be minimal disturbance at the site of fracture (Broos and Sermon, 2004). As compared to

rigid fixation, dynamic fracture fixation technique causes micro-movement at the fracture site leading to early fracture union (Asif *et al.*, 2011). Similarly, Saha *et al.* (2015) described that the micromotion conferred by the elasticity of the fixation promotes faster external bridging callus formation. In few animal seroma formation was observed at site of pin insertion. Short-term complications like irritation at the nail entry site, local inflammatory responses and bursa formation were seen in about 60 per cent cases of femur fracture in children treated with Titanium elastic nailing (Sarkar *et al.*, 2013).

Result of haematological and blood biochemical profiles are presented in Table 3. The mean values of haemoglobin and total erythrocyte count were fluctuated non significantly at different time intervals within the normal reference range. The mean total leucocyte count was higher at 0 and 15th day thereafter expressed a decreasing pattern from the 30th days post operatively. These findings were in accordance with the findings of Rajhans (2013), Toth *et al.* (2014) and Singh (2015) in canines, who also reported slight increase in total leucocyte count during early post-operative period. The higher values at day 0 may be attributed to the systemic inflammatory changes after fracture (Claes *et al.*, 2012). The mean neutrophil counts were, non-significantly higher during the initial observation period (from 0 day to 30th day) followed by gradual decline from 45th day onwards. Tembhurne *et al.* (2010) and Verma (2014) also reported increase in neutrophil count following the surgical treatment of fracture in dogs. Increase in neutrophil count is characteristic feature of acute inflammation due to trauma and injury (Vagad, 2007). The lymphocyte count was decreased on 15th and 30th day, thereafter increased non significantly on 45th day.

Table 3: Result of haemato-biochemical parameters of animals

Group	0 Day	15 Day	30 Day	45 Day	60 Day
Hb (g/dl)	14.43±1.09	13.98±1.01	14.26±0.89	14.41±0.89	14.25±0.73
TEC (m/cumm)	6.52±0.21	6.05±0.17	6.21±0.16	6.20±0.6	6.34±0.19
TLC (103/ μ l)	13.54±0.43	13.67±0.68	13.07±0.23	12.72±0.47	12.72±0.24
Neutrophil (%)	67.33±3.66	68.33±2.33	67.50±1.23	63.44±1.64	62.83±1.96
Lymphocyte (%)	29.50±1.80	28.00±2.46	27.33±1.54	33.50±1.72	31.00±2.78
Monocyte (%)	2.50±0.42	2.50±0.66	4.16±0.94	2.66±0.42	5.00±0.81
ALP (unit/liter)	155.05 ^a ±15.30	128.28 ^{ab} ±8.11	109.86 ^{bc} ±12.5	88.58 ^c ±5.35	82.86 ^c ±5.92
Calcium (mg /dl)	8.91±0.13	8.83±0.20	9.16±0.11	10.00±0.37	10.13±0.41
Phosphorus (mg /dl)	5.03±0.15	4.83±0.15	5.13±0.30	5.11±0.24	4.88±1.56

^{abc}values within groups with different superscript differ significantly ($p < 0.05$)

The decrease in lymphocyte count during the early post-operative period was due to tissue injury or inflammation elicited production of immunoregulatory cytokines which results reduction in circulating lymphocytes (Kaneko, 1997). Non-significant fluctuation was recorded in eosinophil and monocyte count during the study period. The mean concentration of alkaline phosphatase was decreased from 15th day, however significant decrease from 45th to 60th day was noticed. Similarly, While Hegade *et al.* (2007) reported that serum alkaline phosphatase (ALP) was significantly higher on operative day than post-



operative days in dogs during fracture healing. Increase in the level of alkaline phosphatase during initial period of fracture healing might be due to increased activity of hypertrophic chondrocytes and latter osteoblast (Aithal *et al.*, 1999). The serum calcium concentration revealed marginal non-significant increase from 15th to 60th day. Similar trend has been reported by Verma (2014) and Singh (2015), who also observed non-significant marginal increase in calcium level during fracture healing in dogs. Further, the initial decline in the serum calcium could be due to increased urinary excretion after traumatic bone injury as stated by Kumar *et al.* (1992). There was non-significant variation in mean phosphorus concentration. These findings are similar to the findings of Verma (2014) and Nagaraju *et al.* (2014), who also reported non-significant change in level of phosphorus during the fracture healing in dogs.

Conclusion

On the basis of clinical and radiographic examination, it was concluded that Titanium elastic pin ensures the accurate and safe stabilization of diaphyseal fracture of long bone in dog. It is associated with rapid return of limb activity. The fluctuation in haemato-biochemical values were within the normal limits and correlated with different stages of fracture healing in canines.

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