B-4742
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RESEARCH ARTICLE Indian Journal of Animal Research

A Clinical Study on the Use of Supracondylar Plate in the Treatment of Distal Femoral Fractures in Dogs

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10.18805/IJAR.B-4742

ABSTRACT

Background: The current study was undertaken to evaluate the clinical efficacy of supracondylar plate for repair of distal femoral fractures in dog. The distal extremity of femur is the greatest weight bearing area, supracondylar plate is an orthopaedic plate system that is pre-contoured to the complex shape of the lateral surface of the canine distal femur.

Methods: The study was conducted on six dogs presented with femur fracture to the Department of Surgery and Radiology, CVSc., Hyderabad over a period of 6 months (2020-21). Diagnosis based on the clinical signs, orthopaedic examination and radiography. Three fractures in right hind limb and three in the left limb. In dogs weighing less than 10 kg (N=3) were stabilized using 2.7 mm supracondylar plate while in dogs weighing more than 10 kg (N=3), 3.5 mm supracondylar plates were used. Right supracondylar plates of 2.7 mm were used in one dog while left supracondylar plates of 2.7 mm were used in two dogs. Similarly, right supracondylar plates of 3.5 mm were used in two dogs and left supracondylar plate of 3.5 mm in one dog. All the three right were 8 H while two left were 8 H and one was 6 holed. All the dogs showed partial weight bearing from 1st post-operative day. Lameness grading on pre-operatively showed grade V. Post-operatively, five dogs progressed to grade I lameness on 60th post-operative day and one dog to grade III lameness by the end of 60th post-operative day and later progressed to grade I by 120th post-operative day. The mean lameness pre-operatively and on 1st day, 15th day, 30th day, 60th day post- operatively were found to be 5.00±0.00, 4.00±0.00, 2.00±0.25, 1.66±0.33, 1.3±0.30 and 1.00±0.00 respectively. Radiographs obtained on the 60th post-operative day revealed dense callus of reduced size; fracture line barely visible with corticomedullary remodelling. The radiographs obtained on the 90th post-operative day clearly shows complete formation of bone with distinct cortex and medulla. Primary bone healing with minimal callus formation was recorded in case 5.

Result: The supracondylar plate was successfully used in the treatment of distal femur fractures in dogs. Its configuration permitted early return to function of dogs affected with distal femur fractures.

Key words: Canines, Dogs, Femur fracture repair, Hockey stick plate, Internal fixation, J-plate, Supracondylar femur fracture, Supracondylar femur plate.

INTRODUCTION

Fracture of femur is most often encountered in dog, comprising forty five per cent of all long bone fractures (Harasen, 2003b). Midshaft diaphyseal fractures are the most common femoral fractures, followed by fractures of the distal epiphysis. Fractures involving the distal femoral physis are common in puppies and kittens of 4 to 11 months of age which account for 37 per cent of the total physeal fractures seen in dogs (Harasen, 2001).

In dogs, distal femoral fractures are classified as supracondylar, condylar and intercondylar. They may be simple or comminuted and may be complicated by damage to the joint capsule and rupture of stifle joint ligaments. The types of fractures encountered in dogs differ in growing and adult animals (Prieur, 1988). Although encountered less frequently, distal metaphyseal fractures of femur are difficult to deal with and their repair is challenging (Gilmore, 1983).

The distal femur has anatomical peculiarities such as caudal bowing, soft cancellous bone in the condylar region and presence of short segment of distal metaphyseal bone. Fractures of the supracondylar region of the femur in adult animals occur infrequently and usually comminuted. The distal extremity of femur is the greatest weight bearing area. A distal fracture produces a short distal fragment from the critical stifle joint and predisposes to significant bending forces, which are magnified in the chondrodystrophic and large breeds (Harasen, 2002).

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How to cite this article: Pravalika, E., Reddy, K.J.M., Latha, C., Rao, T.M. and Purshotham, G. (2022). A Clinical Study on the Use of Supracondylar Plate in the Treatment of Distal Femoral Fractures in Dogs. Indian Journal of Animal Research. DOI: 10.18805/IJAR.B-4742.

Submitted: 30-07-2021 **Accepted:** 13-12-2021 **Online:** 25-04-2022

Conventional bone plating which requires three or more screws on either side of a fracture is not suitable in distal femoral fractures as it does not permit enough screws to be placed in distal fragment and the distal end of plate may interfere with proper closure of stifle joint capsule. The function of the distal part of the quadriceps patellar mechanism can be affected. One of the most common complications of healing distal femur fractures is quadriceps contracture (Harasen, 2002). In adult animals, in which biobuttress formation is slow, maximum stability must be obtained from the implant used to repair the fracture (Lidbetter and Glyde, 2000).

Supracondylar fractures can be treated by various methods *viz*, intramedullary pinning (Stigen, 1999, Beale, 2004), cross pinning (Whitney and Schrader, 1987), intramedullary pinning combined with cross pinning (Prieur, 1988), Rush pinning (Coetzee, 1983), lag screw fixation (Gilmore, 1983) and plate fixation (Prieur, 1988). Braden and Brinker (1973) reported that plating was the preferred technique and resulted in more rapid and complete return of limb function.

Supracondylar plate is an orthopaedic plate system that is pre-contoured to the complex shape of the lateral surface of the canine distal femur, facilitates a more precise fit and function with enhanced conformation to the bone. Its configuration permitted placement of more number of screws in the distal fragment (Roch and Gemmil, 2008). Supracondylar plate has mechanical properties that are beneficial considering the loads that it would be subjected to over an extended period of time whilst buttressing a large fracture gap (Glyde *et al.* 2005).

MATERIALS AND METHODS

Anamnesis

The age of the dogs included in the present study ranged from 6-30 months with a mean of 12.5±3.9 months. Out of the six dogs, two were males and four were females. The breeds included were Mongrel (3), Beagle (1), Lhasa Apso (1) and Siberian Husky (1). The body weight of the dogs ranged from 6-14 kg with a mean of 10.5±1.08 kg. The main cause for occurrence of fractures wasfall from height (4 cases) (66.6%) dogs and automobile accident in two (33.3%) dogs. The dogs were presented for treatment between 3 to 14 days after fracture occurrence with a mean of 7.16±1.81 days. The details are shown in Table 1.

Pre-operative observations

The six dogs presented for treatment femur fractures exhibited symptoms like sudden on set of pain and lameness immediately after a trauma (Fig 1). Other symptoms included loss of function, abnormal mobility, deformity or change in angulation of affected limb, pain and crepitation at the fracture site. All the dogs selected were not having any neurological deficits. The fractures were temporarily stabilized with Robert Jones bandage without the use of splints until the day of surgery.

Pre-operative radiographic observations

Medio-lateral and cranio-caudal radiographs of the affected femur including the proximal and distal joints confirmed fractures. Out of six dogs, the radiographs revealed distal complete closed transverse fracture of right femur in three dogs and closed complete distaltransverse fracture of left femur in three dogs (Fig 2).

Planning of surgery

Measurements of the fractured femur and the contralateral normal femur were obtained from the pre-operative radiographs (Langley-Hobbs, 2003). These measurements were used to select suitable supracondylar plate (Fig 3) and screws (Fig 4).

Fig 1: Non-weight bearing of fractured limb (grade V)-case no. 6.

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	Mongrel	6	Female	12	Automobile accident	7
2	Beagle	10	Female	10	Fall from height	3
3	Mongrel	17	Female	14	Automobile accident	14
4	Lhasa Apso	30	Male	10	Fall from height	4
5	Mongrel	6	Female	6	Fall from height	4
6	Siberian Husky	6	Male	11	Fall from height	11
Mean±SE		12.5±3.9		10.5±1.08		7.16±1.81

Patient preparation

The surgical site was prepared for aseptic surgery. The cephalic vein was cannulated and an intravenous line was maintained throughout the course of surgery.

Anaesthesia

Atropine sulphate at the rate of 0.04 mg/kg body weight was administered subcutaneously as pre-anesthetic medication followed 10-15 minutes later by xylazine hydrochloride at the rate of 1 mg/kg body weight intramuscularly (Pardeshi and Ranganath, 2008). Ten minutes later, general anaesthesia was induced with intramuscular injection of ketamine hydrochloride at the rate of 10 mg/kg body weight (Fattahian *et al.*, 2011). Following induction, the dogs were intubated with endotracheal tubes of suitable size. Anaesthesia was maintained with intravenous injection of propofol at the rate of 4 mg/kg body weight. Additional doses of propofol were also administered whenever necessary during surgical procedure through the intravenous line.

Positioning of the animal

The dogs with fracture of femur were positioned in lateral recumbency with the fractured limb uppermost.

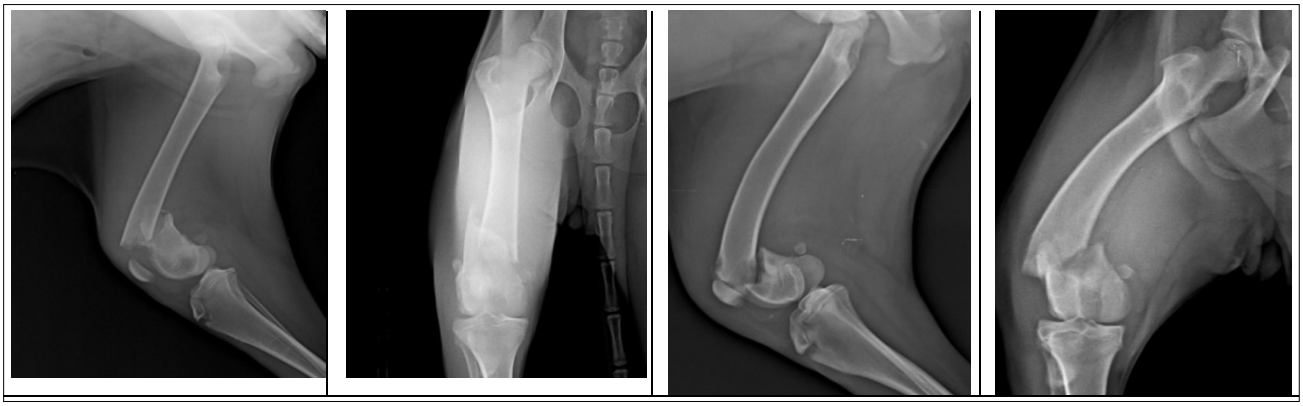
Materials used

Orthopaedic instruments

The general surgical and standard orthopaedic instruments were used.

Implants

The choice of implant and its size was determined on the basis of the age, weight of the dog and the diameter of the bone as measured from the pre-operative radiographs and type of fracture. The 2.7 mm supracondylar plate was used



Case 3 Pre-operative radiograph (medio-lateral and cranio-caudal view).

Case 1 Pre-operative radiograph (medio-lateral and cranio-caudal view).

Fig 2: Pre-operative skiagram showing distal fracture of femur in a dogs.

Fig 3: Radiographs showing length of the bone in medio-lateral view.

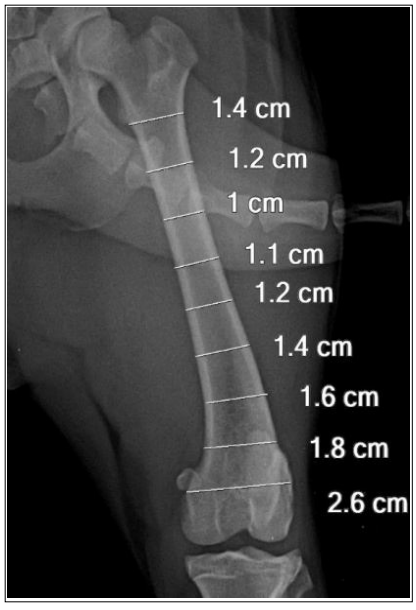


Fig 4: Radiograph showing trans-cortical diameter of femur at different distances in cranio-caudal view.

in dogs weighing less than or equal to 10 kg and 3.5 mm supracondylar plate was used in dogs weighing more than 10 kg (Fig 5).

Surgical procedure

Fractures of the distal femur were approached using a cranio-lateral, parapatellar approach to the distal femur and stifle joint (Fig 6). The tensor fascia lata was incised and biceps femoris and vastus lateralis muscles were separated followed by stifle arthrotomy. Stifle arthrotomy was performed in four cases. For plate application to the distal femur, the incision was extended proximally to expose part of the shaft of the femur (Tomlinson, 2005). A combined approach was used for distal femur fractures (Piermatteiand and Greeley, 2014). The fracture fragments were exposed (Fig 7). Periosteal elevator was used to remove redundant soft tissue. Fracture reduction was carried out using serrated reduction forceps and the reduced fragments were held in apposition using bone holding forceps (Fig 8). The plate of suitable length was then positioned over the lateral surface

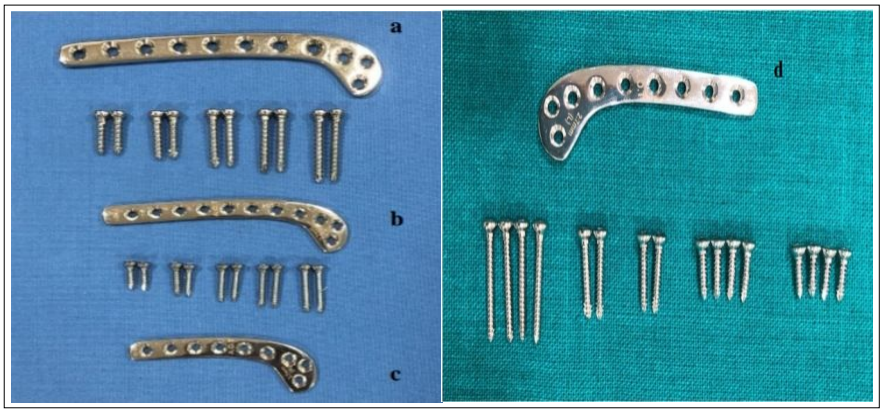


Fig 5: Supracondylar plates used in the study a. 2.7 mm b. 3.5 mm.

Fig 6: Cranio-lateral skin incision.

Fig 7: Fracture fragments exposed.

Fig 8: Fracture fragments reduced and aligned.

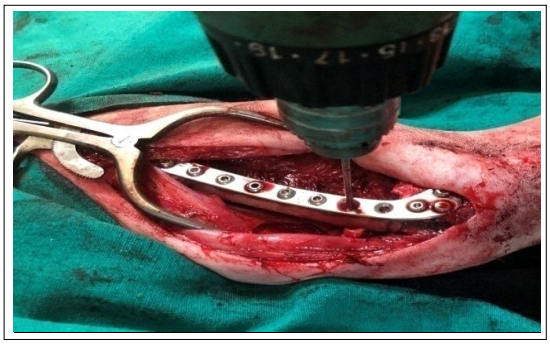


Fig 9: Drilling a hole across the bone through supracondylar plate using low speed high torque electric drill.

of femur. The plate was fixed in position, by plate cum bone holding forceps, holes were drilled using either 2mm drill bit (for 2.7 mm plate) or 2.7 mm drill bit (for 3.5 mm plate) across the bone passing through both the cortices of bone using a low speed high torque electric drill (Fig 9). During drilling, sterile normal saline was used to irrigate the site to cool the drill bit and to flush the debris and to prevent thermal necrosis. 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. Screw of suitable length was then placed at the drilled hole and tightened using hexagonal orthopaedic screw driver (Fig 10) until the taper end of the screws exited far cortex to secure supracondylar plate to the bone (Fig 11).

Closure of the incision

The arthrotomy incision, vastus lateralis and biceps femoris muscle and tensor fascia lata were closed in apposition using 2-0 polyglactin 910 in a simple continuous pattern. Subcuticular sutures were applied in 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.

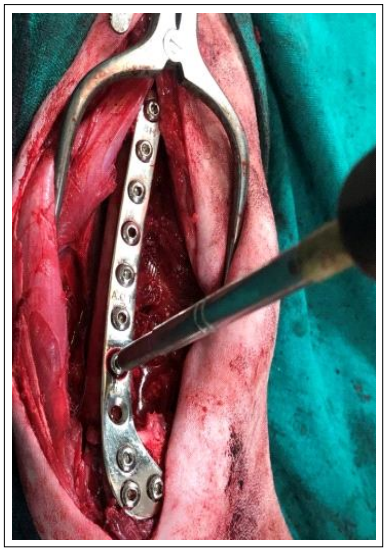


Fig 10: Tightening of screws using hexagonal orthopaedic screw driver.

Fig 11: Bone plate in-situ.

Post-pperative care and management

The suture line was covered with a thin layer of sterile gauze bandage dipped in 5% povidone iodine solution and covered with cotton padding and applied gauge bandage. The dressing was replaced on every alternate day until the sutures were removed on the 12th post-operative day. Injection ceftriaxone sodium was administered at the rate of 25 mg/kg body weight as intramuscular injection for 7 days post-operatively. Injection meloxicam was administered once a day at the rate of 0.3 mg/kg body weight by intramuscular injection for 3 days post-operatively.

RESULTS AND DISCUSSION

Clinical evaluation was carried out every alternate day to check for the presence of swelling, exudation and weight bearing in all the dogs. The post-operative day on which the dog started bearing weight was recorded and graded.

Post-operative clinical observations

None of the dogs developed post-operative swelling and suture dehiscence and the surgical wounds healed well in all the dogs without any complications (Table 3).

Implants

In the present study, use of 2.7 mm and 3.5 mm supracondylar plates and the cortical and cancellous screws provided good fracture stability. Application of supracondylar plate to the distal femur fracture followed the standard principles for internal fixation. The plate was ideal for distal femoral fractures with or without articular involvement and provided placement of more screws in the distal fragments there by achieving superior stability (Roch and Gemmil, 2008). This technique provided good apposition and alignment of fractured ends. These results are in agreement with suggestions of Roch and Gemmil (2008), Neil (2016), Senthil kumar *et al.* (2017), Smalle *et al.* (2018), Jaganmohanreddy (2020).

Lameness grading

All the dogs in the present study showed partial weight bearing from 1st post-operative day. Weight bearing was by 3rd post-operative day in one dog (Case no. 5), 5th post-operative day in one dog, 15th post-operative day in threedogs (Case no. 2) (Fig 12) and in one dog weight bearing was achieved after the plate removal on 120th post-operative day. Lameness grading based on weight bearing pre-operatively showed grade V lameness before surgical stabilization of the fracture. Post-operatively, five dogs progressed to grade I lameness on 60th post-operative day and one dog progressed to grade III lameness by the end of 60th post-operative day and later progressed to grade I lameness by 120th post-operative day. The mean lameness grades observed pre-operatively and on 1st day, 15th day,

30th day, 60th day post-operatively were found to be 5.00±0.00, 4.00±0.00, 2.00±0.25, 1.66±0.33, 1.3±0.30 and 1.00±0.00 respectively.

The details of lameness grading (Vasseur *et al*, 1995) were presented in Table 2. Post-operatively, lameness grading showed gradual improvement to normal weight bearing over the period of study. The lameness grading was carried out in accordance with the protocol developed by Vasseur *et al.* (1995). After stabilization, five dogs progressed to grade I lameness by the end of 60th post-operative day and one dog progressed to grade I by the end of 120th post-operative day. These finding was in agreement with the findings of Piermattei *et al.* 2016, Meeson, 2017, Smalle *et al.* 2018 and Jaganmohanreddy 2020.

Post-operative radiographic observations

In the present study, radiographs obtained on immediate postoperative day (Fig 13) and 15th post-operative day revealed proper apposition and alignment of the fracture fragments in all the six dogs. Indistinct fracture margins and widening of fracture was observed. On the 30th post-operative day, radiographic examination revealed good callus formation, bridging the fracture site with unstructured and patchy mineralization of bridging callus; fracture line

Case 2: 15th Post-operative day. Case 5: 3rd Post-operative day.

Fig 12: Showing first weight bearing on operated limb.

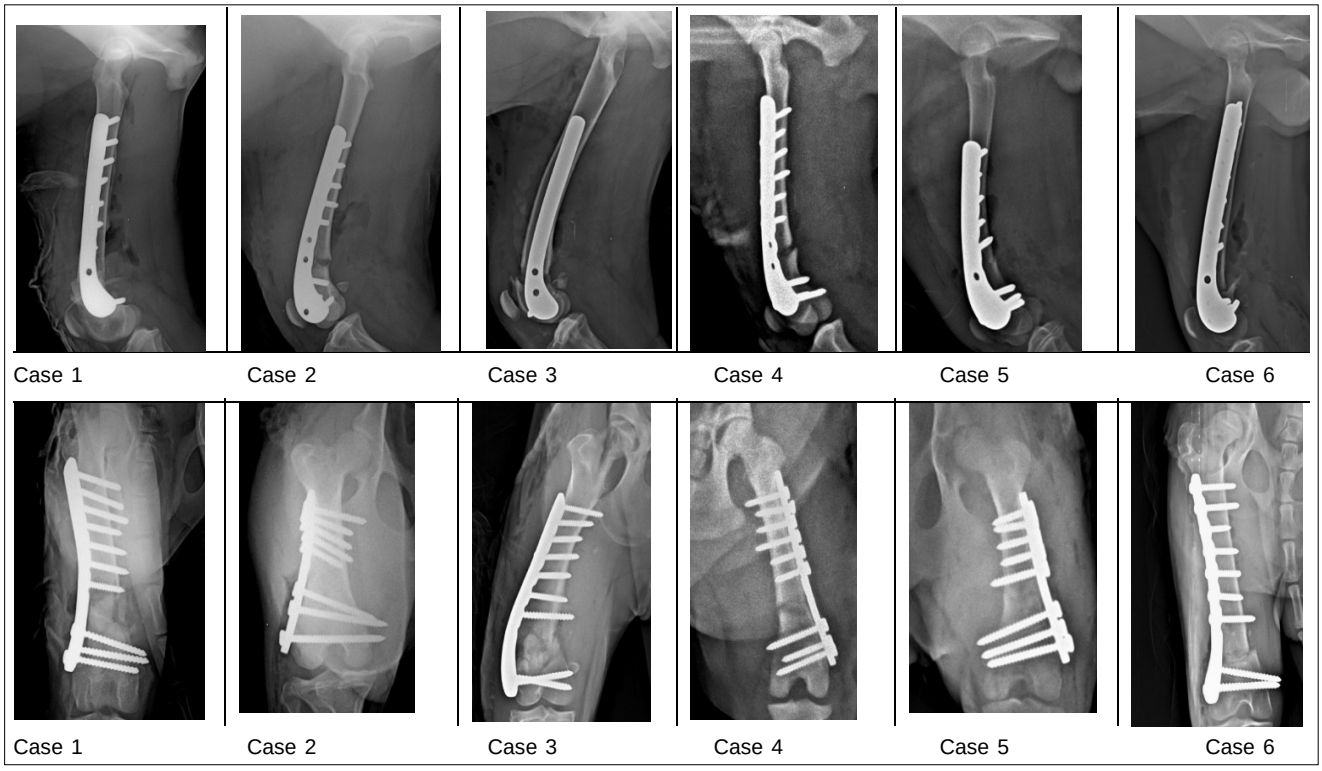


Fig 13: Skiagram showing Immediate post-operative medio-latera and cranio-caudal radiographs of dog with distal femur fractures stabilized with supracondylar plate showing good alignment of the fracture fragments.

still visible and these findings are in agreement with Hudson *et al.* (2009). Radiographs obtained on the 60th post-operative day revealed dense callus of reduced size; fracture line barely visible, early corticomedullary remodeling and these findings are in agreement with Hari Krishna *et al.* (2013). Radiographs obtained on the 90th post-operative day revealed corticomedullary continuity and fracture line not visible (Fig 14) and these findings are in agreement with Piermattei *et al.* (2016) and Jagan Mohan Reddy (2020). Primary bone healing with minimal callus formation was noticed in case five. Similar observations were made by Anderson *et al.* (2002).

Complications

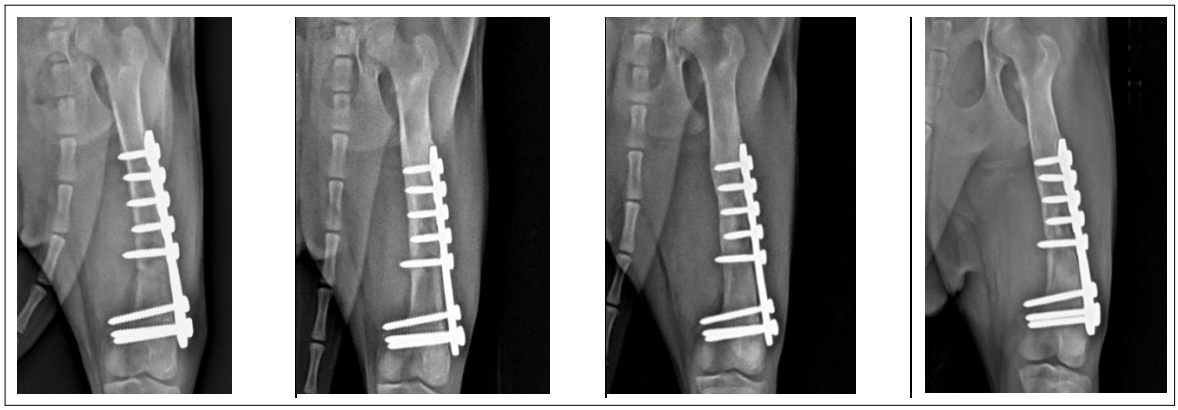
Major complications such as implant failure, osteomyelitis or osteopenia etc as reported by Denny (1991), Lidbetter and glyde (2000), Harasen (2001) and Saravanan *et al.* (2004) were not reported in the present study, which might be due to implant stability and biocompatibility of supracondylar plate. Absence of minor complications such as seroma formation or suture dehiscence might be due good post-operative care and management.

Table 2: Post operative details of lameness grading.

Case no.	Plate size	Pre operative grading	Post-operative grading			
			Day 1	Day 15	Day 30	Day 60
1	3.5 mm	V	IV	III	III	III
2	2.7 mm	V	IV	II	I	I
3	3.5 mm	V	IV	II	II	I
4	2.7 mm	V	IV	II	II	I
5	2.7 mm	V	IV	I	I	I
6	3.5 mm	V	IV	II	I	I
	Mean±SE	5.00±00	4.00±00	2.0±0.25	1.66±0.33	1.30±0.30

Table 3: Post-operative clinical observations.

Case No.	Breed	Swelling	Infection or exudation	Suture dehiscence	Pain perception	Complications
1	Mongrel	Not observed	Not observed	Not observed	Present in first 3 days, later diminshed	Nil
2	Beagle	Not observed	Not observed	Not observed	Present in first 5 days, later diminshed	Nil
3	Mongrel	Not observed	Not observed	Not observed	Present in first 5 days, later diminshed	Nil
4	Lhasa Apso	Not observed	Not observed	Not observed	Present in first 2 days, later diminshed	Nil
5	Mongrel	Not observed	Not observed	Not observed	Present in first 5 days, later diminshed	Nil
6	Siberian Husky	Not observed	Not observed	Not observed	Present in first 7 days, later diminshed	Nil



15th post-operative day | 30th post-operative day | 60th post-operative day | 90th post-operative day

Fig 14: Skiagram showing progressive radiographic fracture healing of distal left femur fracture in dog (case 5).

CONCLUSION

Based on present study,it was concluded that supracondylar plate was used successfully in the treatment of distal femur fractures and offered good recompense and remarkable improvement in limb function in five out of six dogs. The supracondylar plate was found to facilitate a more precise fit and function with enhanced conformation to bone. Its configuration permitted placement of more number of screws in the distal fragment which provided early return to function of dogs affected with distal femur fractures.

Conflict of interest: None.

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