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Clinical appraisal of Admit pin for management of femur fracture in canines

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ABSTRACT

The study involved 25 client-owned dogs treated for femoral fractures (27) by Admit pinning technique. The fracture types included: wedge (10), oblique (9), transverse (4), complex (3) and spiral (1). The status of fracture reduction and fixation ranged from good to excellent. All the dogs had excellent clinical outcomes, except three cases which had an axial collapse of fracture after an episode of post-operative trauma, and 2 senile cases which showed delayed union (more than 60 days). Admit pinning, when used in conjunction with orthopaedic wiring, can resist axial, bending, tension and torsional forces acting on the bone up to the level of no major complications.

Keywords: Admit pin, End-threaded pin, Femoral fracture, Internal fixation, Intramedullary pinning

Fracture primarily involves discontinuity of bone structure with loss of locomotion, associated with a plethora of soft tissue impairment of mainly associated muscles, blood circulation, nerves, fasciae, and joints (Piermattei *et al.* 2006). The autogenous healing process of the body is sufficient enough for the restoration of the structural integrity of the bone but can only seldom result in the acquirement of normal physical function and locomotion. To stabilize the fracture on its own, the body tries to immobilize the associated structures resulting in various unavoidable processes like muscle contracture and joint ankylosis. To avoid certain complications associated with autogenous healing processes like mal-union and mal-angulation, it is better to intervene surgically and fix the fractures using internal or external fixation methods. Femur fractures are best fixed using internal fixation techniques and its anatomic features do not allow adequate fixation via external coaptation techniques (Dejardin and Cabassu 2005).

Field veterinarians are adequately equipped with the skill and resources required for conventional Steinmann pinning, and it is a feasible option of fracture fixation in femur fractures. Preserving the qualities of the Steinmann pinning technique, namely, easy application, resistance to bending forces, and cost-effectiveness, Admit pin was designed to overcome the complications of the intramedullary pinning technique i.e. pin migration and dislodgement (Chanana 2014). Chanana (2014) conducted a study on fixation of long bone fractures in small animals using an in-house designed intramedullary implant to test its clinical application and concluded that the Admit pin has a superior clinical outcome when compared to the conventional Steinmann pinning technique.

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MATERIALS AND METHODS

The study involved 25 client-owned dogs which were presented to the Department of Veterinary Surgery and Radiology at the Veterinary Clinical Complex of Dr G. C. Negi College of Veterinary and Animal Sciences, Palampur. Two out of 25 dogs were treated with Admit pinning technique in both the femurs bilaterally. Out of 25 animals, 16 were male and 9 were female. Automobile accidents amid grounds of trauma were found to be the major (n=17) etiological factor followed by blunt trauma (n=3), fall from height (n=2), unknown (n=2) and mischief (n=1). The age of the animals ranged from 1.5 months to nine years. The majority of the cases were juvenile (n=19), while 4 were adults and 2 were senile. The breeds of the dogs were German shepherd (n=3), Labrador (n=3), Siberian husky (n=2), Gaddi (n=1) and the remaining were non-descript dogs (n=16). The range of fractures treated was diverse, having single or multiple wedge (n=10), simple oblique (n=9), simple transverse (n=4), complex (n=3) and spiral (n=1).

The dogs were subjected to a routine clinical examination where physiological, haematological, and biochemical parameters were recorded. The cases of femoral fractures when identified were subjected to a radiographic examination where cranio-caudal and medio-lateral projections were taken for evaluation of fracture fragments. The type of fracture, number of wedges (if any), and the size of the implant required for fixation were recorded.

Surgical technique: The exposure to the femoral shaft was achieved by a lateral skin incision along the line joining the greater trochanter and lateral distal condyle of the femur. The exposure of the bone was then achieved by incising the tensor fascia lata over the line separating biceps femoris and vastus lateralis muscles (Piermattei *et al.* 2006).

Exposure of the distal femoral fractures required a lateral stifle arthrotomy where the stifle joint was opened via a lateral incision followed by retraction of the patella and patellar ligament to the medial side (Chanana 2014, 2017, 2018).

The implant was introduced in a retrograde fashion when fixation of diaphyseal fractures was done, whereas a normograde pinning technique was used for distal supracondylar fractures, as described by Chanana (2014). Femoral diaphyseal fractures were exposed and the pin was passed via its trocar end through the medullary cavity of the proximal fragment to exit from the trochanteric fossa. Jacob's chuck was then placed on the trocar end and the pin was retracted proximally using an anti-clockwise rotary motion. The fracture was thereafter reduced and the pin was advanced into the distal fragment using clockwise rotary motion until the adequate purchase of distal cancellous bone was achieved by the threads of the Admit pin. In distal supracondylar fractures, the pin was introduced from the intercondylar region by its trocar end and then passed across the fracture line to exit from the trochanteric fossa at the proximal end of the femur. The pin was then retracted in an anti-clockwise manner until the screw end was seated in the distal end of the bone and could not be visualized from the joint surface.

When placed properly, the Admit pin had three anchorage points with respect to the bone: Proximally at the entry point, laterally with the cortical bone of the diaphysis, and distally interdigitated with the cancellous bone (Chanana 2014).

Intra-operative observation: Recording of the parameters like time taken for the surgery, degree of soft tissue damage and manipulation, degree of technical difficulty, degree of reduction, and fixation was done. The scoring system is elaborated in Table 1.

Table 1. Scoring for intra-operative observations

Score Observation	1	2	3	4
Extent of manipulation and soft tissue injury Degree of technical difficulty	Low	Moderate	High	Very high
Status of fracture reduction Status of fracture fixation	Poor	Fair	Good	Excellent

Clinical observation: Recording of the status of wound healing, fracture healing, weight-bearing status, degree of movement of the limb, post-operative complications like implant failure, wound dehiscence, fracture collapse, mal-angulation, limb shortening, delayed-union, non-union if any, etc. The pain and inflammation were accessed and graded on a 4 point scale ranging from 0 to 3, which increased with increasing severity of inflammation and pain, as described by Kumar (2016), Kaur (2017) and Sakshi (2019).

Weight-bearing: The weight-bearing of the animals was recorded pre-operatively and post-operatively on every reappraisal according to the methods described by Kumar (2016), Kaur (2017) and Sakshi (2019). The scoring ranged from 0 to 5, where 0 being non-touching of the fractured limb on the ground and 5 being near-normal status of weight-bearing, in the walking and standing phase of assessment. The total weight-bearing score was then calculated by adding the standing and walking phase scores.

Goniometric observations: The flexion and extension angles of stifle and hock joints were recorded pre-operatively and post-operatively to compare the outcome of fracture fixation in terms of the range of joint movement in comparison to that of the normal contralateral limb.

Radiographic observations: Radiography was employed to diagnose the type of fracture and degree of comminution etc. in pre-operative radiographs. Medio-lateral and cranio-caudal projections of the affected femur were taken and analysed. Radiography was performed to evaluate the 'six As' of orthopaedic radiographic evaluation described by Langley-Hobbs (2003). The modality was also used to grade the amount of callus formation at the fracture site as described in Table 2.

RESULTS AND DISCUSSION

The Mean±SE for duration of the surgery was 22.81±2.48 min. The mean score of soft tissue injury and manipulation, which inadvertently reflected on the degree of technical difficulty, was 1.96±0.19 and 1.93±0.16 respectively. This implies that the technique is easier to master and poses minimal disruption of musculoskeletal adnexa. However, Sakshi (2019) reported the technical difficulty and degree of manipulation to be 1 while Kumar (2016) reported it to be 1.4±0.24 which is significantly lower than this study attributing to the fact that these studies included simpler fractures that did not always require any other ancillary method of fixation. The mean score of fracture reduction and fracture fixation was 3.41±0.16 and 3.56±0.13 respectively. The degree of reduction and fixation was reported to be 2.6±0.14 and 3±0.19 respectively by Sakshi (2019). Kumar (2016) reported the status of reduction to be 2.6±0.40 and the status of fixation to be 2.0±0. This could be attributed to errors arising from small sample sizes in their studies.

Table 2. The scoring system used for radiographic assessment of callus formation

Grade	0	1	2	3
Parameter	None (No visible callus)	Small (<10% of bone diameter increase)	Moderate (10-20% increase)	Large (>20% increase)

The mean score of pain and inflammation on implant fixation day (IFD) was 2.28±0.16 and 2.56±0.12 respectively, which was later found to be 0.22±0.10 and 0.11±0.08 respectively at the final reappraisal day (FRD). Kumar (2016) reported the mean pain and inflammation score at IFD to be 1.2±0.11 and 2.4±0.40 respectively and that at FRD to be 0.2±0.20 and 0.11±0.11 respectively. The findings of this study are in accordance to the findings of Kumar (2016) which show significant reduction in degrees of pain and inflammation at the FRD when clinical union can be appreciated. The mean muscle atrophy score at FRD was 0.44±0.20, translating as no to a mild degree of atrophy. It implies to faster return to normal ambulation of limb without any significant loss of muscle tissue. The mean score of weight-bearing at IFD was 1.5±0.25 and at FRD was 9.17±0.57. The weight-bearing improved gradually from 16.73±1.53 days showing signs of partial weight-bearing and full weight-bearing were achieved at 37.68±3.51 days. This clearly shows that the status of weight bearing improves quite early in the fracture healing process, leading to early ambulation of the affected limb.

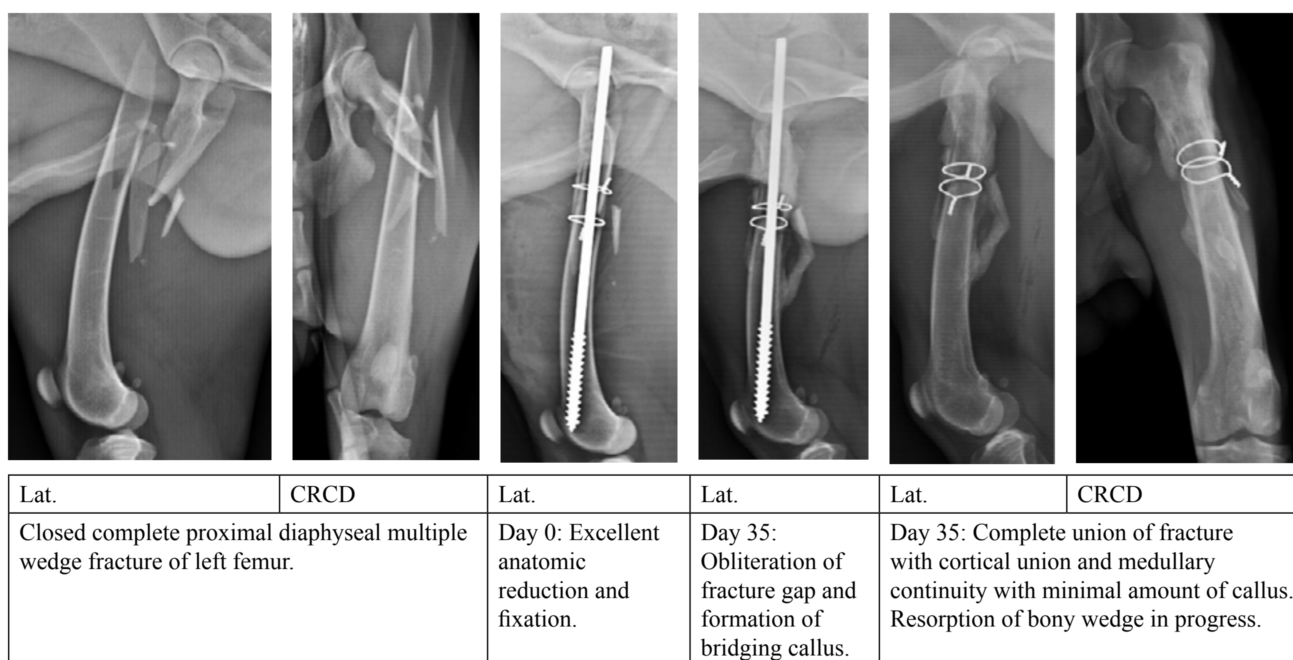
Radiographic evaluation showed complete clinical union in all the cases presented for final reappraisal, except two senile cases where delayed union (FRD>60 days) was seen. The mean callus gradation score came out to be 2.06±0.19 which translates to a mild to moderate amount of callus around the fracture site. This could be attributed to the fact that the implant was not so rigid in fixation of fragments and allowed certain degree of movement, up to the level of causing cortical union and medullary continuity by means of bridging osteosynthesis, without any major complications. On the contrary to static osteosynthesis achieved with compression techniques, it has been demonstrated that some instability was always present with intramedullary pinning techniques (Olmstead *et al.* 1995, Dean 1998, Hach 2000). Out of 27 cases, only 18 were available for FRD radiographic evaluation and the rest 9 were lost to reappraisal.

Table 3. Pre-and post-operative goniometric observations (in degree angle) in dogs with femoral fractures repaired with Admit pin

	Stifle (Extension angle)	Stifle (Flexion angle)	Hock (Extension angle)	Hock (Flexion angle)
IFD	135.95±2.28	60.26±2.15	149.53±2.05	67.89±2.46
FRD	146.00±2.06	55.89±1.56	157.17±1.42	61.62±2.49
Contra-lateral limb at IFD	142.16±2.47	53.47±2.13	154.79±1.97	58.79±2.42

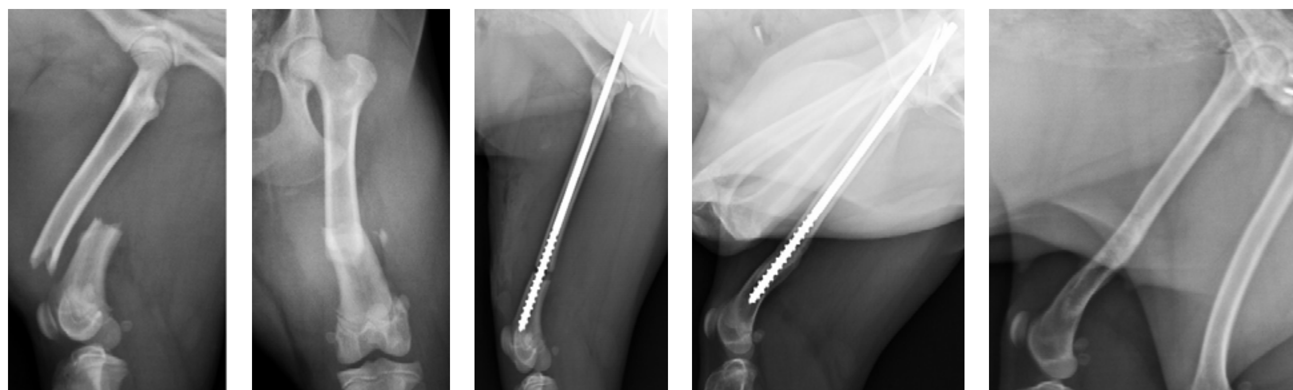
There was an episode of axial collapse of fracture as a result of violent trauma to the animal after jumping from a height 8-10 days post-operation in 2 dogs (n=3; Case 14, 19 and 20, where cases 19 and 20 were bilateral fractures of the same dog). The resultant collapse of fracture led to the migration of Admit pin proximally, without major implant failure leading to a complete clinical union of the fracture. One incidence of piercing of the cranial cortex of the distal fragment of the femur occurred (Case 27), in which pin migration was observed proximally and cortical union along with medullary continuity was achieved in 36 days after the surgery. A collapse of distal fracture fragment in a 1.5 month old female dog occurred during the surgery while cutting the pin to its length (Case 11).

The mean pre-operative and post-operative goniometric observations are given in Table 3. The mean FRD



Lat.	CRCD	Lat.	Lat.	Lat.	CRCD
Closed complete proximal diaphyseal multiple wedge fracture of left femur.		Day 0: Excellent anatomic reduction and fixation.	Day 35: Obliteration of fracture gap and formation of bridging callus.	Day 35: Complete union of fracture with cortical union and medullary continuity with minimal amount of callus. Resorption of bony wedge in progress.	

Fig. 1. Representative radiographic projections of a proximal diaphyseal multiple wedge fracture fixed using Admit pinning technique and Cerclage wiring.



Lat.	CRCD	Lat.	Lat.	Lat.
Closed complete mid diaphyseal transverse fracture of the left femur.		Day 0: Excellent anatomic reduction and fixation.	Day 54: Obliteration of fracture gap and formation of minimal amount of bridging callus.	Day 54: Complete union of fracture with cortical union and medullary continuity, without disruption of the callus.

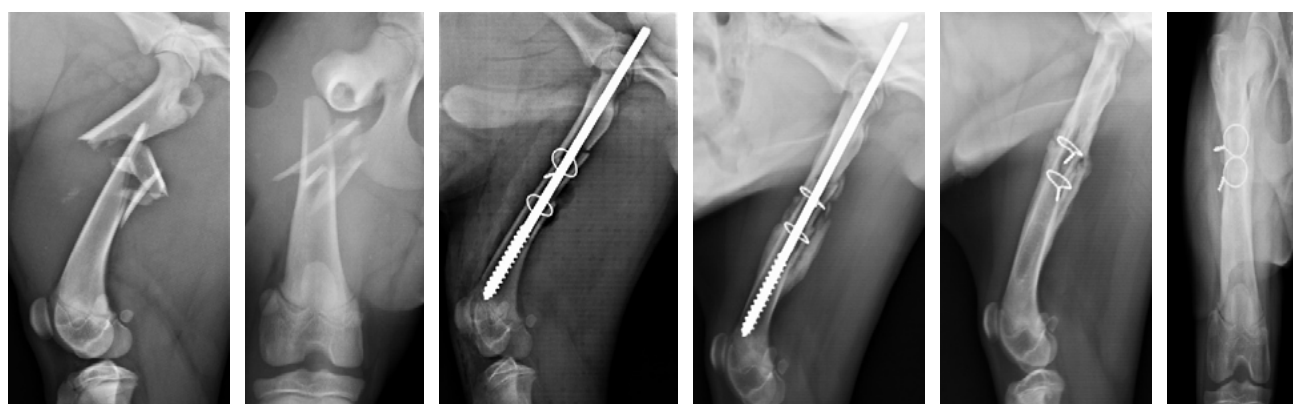
Fig. 2. Representative radiographic projections of a mid-diaphyseal simple transverse fracture fixed using Admit pinning technique.

goniometric values came in concordance with those of the contralateral limb, suggesting the restoration of the near-normal range of motion of the associated joints at the FRD.

The Admit pin firmly engages the distal fragment and thus provides stable fixation, and resists pin migration and pin bending. In nearly all the cases, partial weight-bearing was noticed on 16.73±1.53 days post-op and complete weight bearing on 37.68±3.51 days post-op with near-normal limb function. The technique poses minimal technical difficulty with lesser soft tissue manipulation and damage. It is a cost-effective orthopaedic implant with simple application technique using an affordable basic orthopaedic pack. The possibility of trauma caused by the Steinmann pin end is precluded and axial strength is increased through the gripping of cancellous bone in the distal fragment. No radiological or clinical problem was recorded during the healing period of fractures belonging to skeletally immature patients, pertaining to impairment of epiphyseal growth plate.

Representative radiographs of varying degrees of complexity of fractures fixed using Admit pinning technique and cerclage wiring are depicted in radiographic images (Figs 1, 2 and 3).

Admit pin can be used effectively to treat femoral diaphyseal fractures of varying complexity, ranging from simple transverse to complex fractures. It has a simple application technique with minimal soft tissue manipulation and damage. In conjunction with orthopaedic wiring, it can counteract bending, shearing, torsional and compressive forces to the extent of providing fracture healing with no major complications.



Lat.	CRCD	Lat.	Lat.	Lat.	CRCD
Closed complete mid to proximal diaphyseal multiple wedge fracture.		Day 0: Excellent anatomic reduction and fixation.	Day 15: Formation of bridging callus with fracture healing in progress.	Day 35: Complete cortical union and medullary continuity with minimal amount of callus without any signs of bone shortening.	

Fig. 3. Representative radiographic projections of a mid-diaphyseal multiple wedge fracture fixed using Admit pinning technique and Cerclage wiring.

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