



Comparative evaluation of intramedullary interlocking nailing and end-threaded pinning (positive profile) for fixation of femoral fractures in dogs

HARISH KUMAR¹, S P TYAGI², AMIT KUMAR³, ADARSH KUMAR⁴ AND SUKHPREET SINGH⁵

Dr. GC Negi College of Veterinary and Animal Sciences, Palampur, Himachal Pradesh 176 062 India

Received: 02 August 2019; Accepted: 20 September 2019

ABSTRACT

The study included 14 cases of femur fracture in which two different techniques namely intramedullary interlocking nailing (IILN) (group-I; 9 cases) and end threaded pinning (ETP) (group-II; 5 cases) were used for fixation of the fracture. The mean duration of surgical procedure was higher in group I as compared to group II. The extent of manipulation/soft tissue damage was slightly more in group I than in group II. The technique of IILN was relatively more difficult than ETP. The extent of fracture reduction and fixation was relatively better in group I than in group II. The weight-bearing improved gradually in both the groups but found to be better in group I than group II. The functional outcome of the fractured limb was superior in fracture fixed by IILN as compared to other group.

Key words: Dogs, ETP, Femoral fracture, IILN

Fracture is a commonly encountered orthopaedic problem in veterinary practice. It is a major cause of discomfort and loss of function in animals of all species, age, size and breed. Eyarefe and Oyetayo (2016) reported the incidence of orthopaedic cases as 16.7% among various small animal surgery cases and incidence of fracture was 61.42% among various orthopaedic conditions. The femoral fracture cannot be managed by simpler methods of closed reduction and external coaptation such as casts or splints (Beale 2004), therefore more invasive internal methods of fracture management like intramedullary pinning, intramedullary interlocking nailing, cross-pinning and bone plating are commonly used. Whereas, auxiliary methods like orthopaedic wiring and lag screw techniques are also used sometimes in conjunction with primary fracture fixation techniques. IILN effectively neutralizes bending, rotational, and axial forces that act on fracture. The ETP used in the present study has positive profile, as it could be screwed in the distal cancellous part of bone where it's wider and deeper threads cuts in to cancellous bone to have a better hold and resist pin migration, pin breakage and all load acting on bone, i.e. compression, tension, bending, rotation. So the present communication deals with comparative evaluation of managing the femoral fractures

by intramedullary interlocking nailing (IILN) and end threaded pinning (ETP) in dogs.

MATERIALS AND METHODS

The comparative study was conducted during 2016–2018, on 14 clinical cases of femoral fractures in dogs, divided in two groups, Gr I (IILN; n=9) [Table 1] and Gr II (ETP; n=5) [Table 2]. Anamnesis/signalment, basic clinical examination, haemato-biochemical examination and orthopaedic examination (Pain at fracture site, Crepitation, level of inflammation, status of weight bearing, goniometry) was thoroughly done in all the cases. The radiographic examination was done to diagnose the type and site of femoral fracture. After the radiographic examination the fracture cases were repaired randomly with any of the technique under the study.

The comparative evaluation was done in both the groups by various preoperative, intraoperative and postoperative variables. The preoperative variables include degree of inflammation and pain at fracture site, status of lameness and weight-bearing score.

Different preoperative and postoperative observations like pain and inflammation were analyzed and recorded during the study. Pain and inflammation scored from 0–3. The number of score increased with severity of pain, inflammation and vice-versa.

Status of weight bearing was recorded on implant fixation and final reappraisal day; on the scale of 5 as: 0-test limb not touching the ground; 1-Toe of test limb touching the ground occasionally; 2-Toe of test limb touching the ground frequently; 3-The paw of test limb

Present address: ¹Veterinary Officer (Jaswalvet89@gmail.com) Veterinary hospital, Dulehar, Himachal Pradesh. ²Professor (sptyagivet@gmail.com), ³Assistant Professor (drasingla@gmail.com), ⁴Professor and Head (adarsh9kan@gmail.com), ⁵MVSc. Scholar (sukhivets@gmail.com) Dr. GC Negi College of Veterinary and Animal Sciences, CSKHPKV, Palampur, Himachal Pradesh.

Table 1. Various peri-operative observations in IILN Gr I

Case no.	ASIFCode	Implant *	Radiographic observations		Final clinical outcome
			Size of callus	Outcome in days/FRD	
IILN1	32A1	6-12-2-2-3(22)	Moderatebridging	Complete union (36)	Excellent
IILN2	32B2	8-14-2-3	Large bridging	Slight ante-curvatummal-union (42)	Excellent
IILN3	32A2	7-13-2-3	Large bridging	Complete union (21)	Excellent
IILN4	32A2	9-14-2-3-3(22)	Minimal non-bridging	Non-union(179)	Poor
IILN5	32A1	6-12-2-2	ModerateBridging	Complete union (40)	Excellent
IILN6	32A1	8-12-2-1	Large bridging	Delayed and re-curvatum mal-union (150)	Excellent
IILN7	32A2	8-14-2-2	Minimal non-bridging	Non-union(56)	Poor
IILN8	32B2	6-14-2-2-2(22)	Large bridging	Complete union(40)	Excellent
IILN9	32B2	9-12-2-2-2(22)	Large non-bridging	Non-union(68)	Excellent

*The first digit of the coding represents the diameter of IILN (mm); the second digit, the length (cm); the third digit, the number of proximal screws; the fourth digit, the number of distal screws; the fifth digit, the number of cerclage wires used, if any, and the digit in parenthesis representing the diameter of orthopaedic wire (G). For example, the code '6-12-1-2-3(22)' means stabilization of fracture by a 6 mm wide, 12 cm long IILN fixed with 1 proximal and 2 distal screws along with 3 cerclage wires of 22 G. all cases were done in static mode.

Table 2. Various peri-operative observations in ETP Gr II

Case no.	ASIFscore	Implant**	Radiographic observations		Final clinical outcome
			Size of callus	Outcome in days/FRD	
ETP1	32A3	5.5-4	Large bridging	Complete union with bone shortening (39)	Excellent
ETP2	32A1	6.5-4.5	Fixation failure (large was in progress)	Fixation failure(9)	Extremely poor
ETP3	32A3	5.5-4	Large bridging	Complete union with bone shortening (25)	Excellent
ETP4	32A2	6.5-4.5-2(22)	Remodeled already	Mal-union (122)	Fair
ETP5	32B2	6.5-4.5	Large bridging	Complete union with bone shortening (40)	Excellent

** The first digit represents the thread diameter (mm) of ETP used; the second, the diameter of the core/shaft (mm); the third, the number of cerclage wires used, if any and the last digit in parenthesis, the diameter (gauge) of the cerclage wires used. For example the ETP code '6.5-4.5-2(22)' means stabilization of fracture by using an ETP having a 6.5 mm threads over a 4.5 mm core and 2 cerclage wires of 22 G. The ETP used in this study had positive profile, i.e. the diameter of the pin at the threaded end is more than the core diameter of the pin.

Table 3. Various intraoperative observations in Gr I (IILN) and Gr II (ETP)

Mean±SE	Duration of surgery (in min.)	Extent of manipulation and soft tissue damage	Degree of technical difficulty	Status of fracture reduction	Status of fracture fixation
Group I	81.66±6.73	1.55±0.29	1.77±0.27	3.11±0.20	3.44±0.24
Group II	59±6.9	1.4±0.24	1.2±0.20	2.6±0.40	2.0±0

Table 4. Pre and postoperative observations in Gr I and Gr II

Mean±SE	Inflammation		Pain		Muscle atrophy	Weight bearing	
	IFD	FRD	IFD	FRD		IFD	FRD
Gr I	2.11±0.42	0±0	1±0.28	0.33±0.16	1±0.44	2.33±0.86	8.55±0.95
Gr II	2.4±0.40	0.11±0.11	1.2±0.58	0.2±0.20	0.8±0.58	1.6±0.92	7.6±1.60

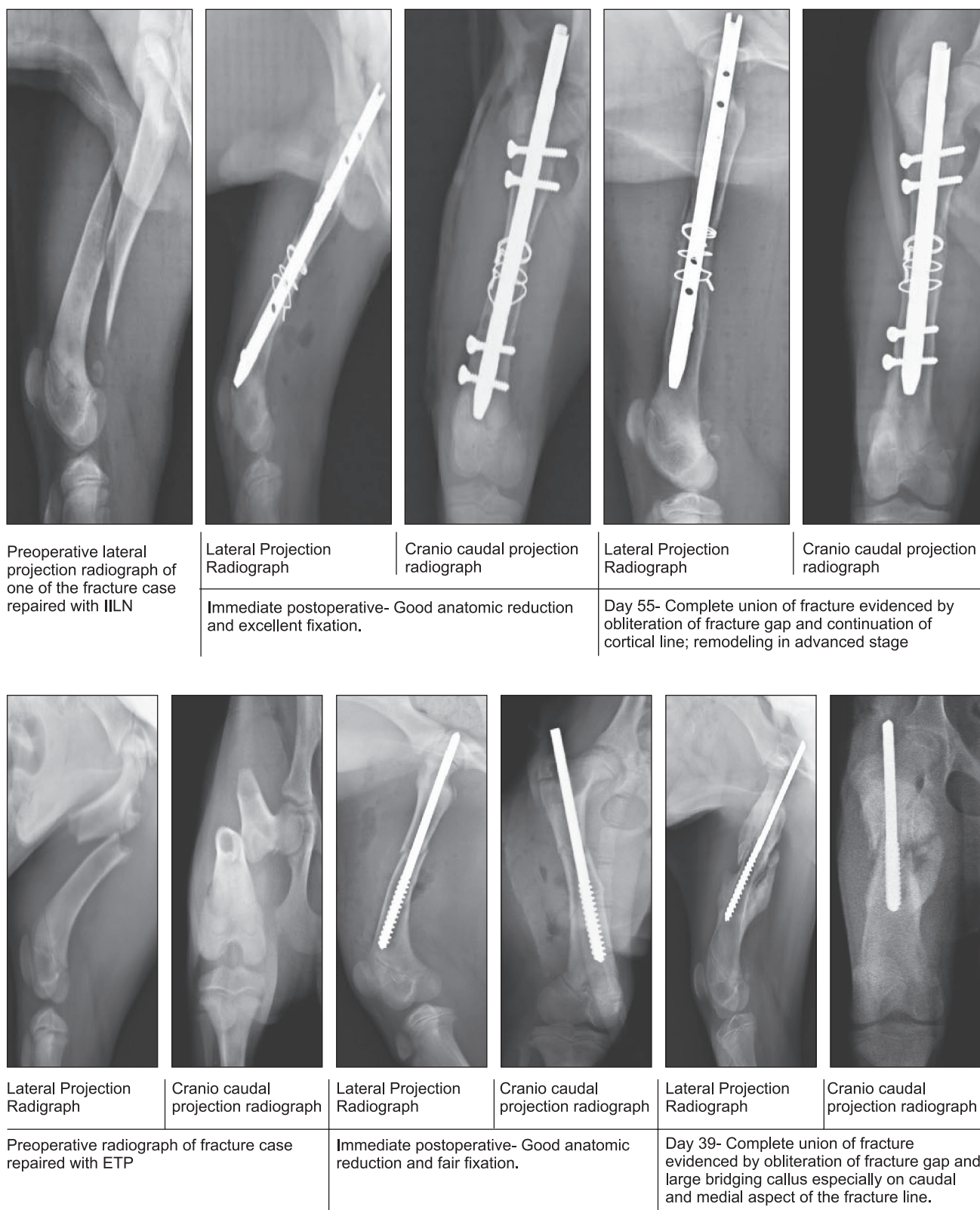


Fig. 1. Representative of pre- and post-operative radiographs of group I and II.

touching the ground occasionally; 4-The paw of test limb touching the ground frequently and 5-The paw of test limb touching the ground regularly. Net weight-bearing score (max. 10) was calculated by adding individual score of

standing and walking phases (max. 5 in each) for a particular patient. During fixation of fracture various intraoperative parameter were recorded. Extent of manipulation/soft tissue damage and degree of technical difficulty were recorded

on scale of 1–3; in which 1 means slight, 2 means moderate and 3 means high extent of manipulation/soft tissue damage and degree of technical difficulty. Whereas the status of fracture reduction and status of fracture fixation were recorded on scale of 1–4; here 1 means poor and 4 means excellent reduction and fixation. During fracture fixation intra-operative observations like duration of surgery (min.), extent of manipulation/soft tissue damage, degree of technical difficulty, status of fracture reduction and fixation, complications and any other remarkable observations were also recorded.

Post-operatively routine clinical, haemato-biochemical, orthopaedic and radiological examinations as described in pre-operative observations part above were done at the time of reappraisal of the patient. Additionally, the surgical site was examined for its gross appearance and healing status. The muscle atrophy in the affected limb was noted down on the final day of reappraisal and compared with contralateral limb. It was recorded on a scale of 0–4; where 0 means no atrophy and 4 means high muscular atrophy. Various data were analyzed using SPSS ver. 21 software.

RESULTS AND DISCUSSION

The mean $\pm$ SE duration of surgical procedure in minutes in Gr I was 81.66 $\pm$ 6.73 min and in Gr II it was 59 $\pm$ 6.9 min. The mean score of manipulation/soft tissue damage and degree of technical difficulty was 1.5 $\pm$ 0.29 and 1.7 $\pm$ 0.27 respectively in Gr I whereas; it was 1.4 $\pm$ 0.24 and 1.2 $\pm$ 0.20 in Gr II. The mean score of status fracture reduction and fixation was 3.11 $\pm$ 0.2 and 3.44 $\pm$ 0.24 in group I and 2.6 $\pm$ 0.4 and 2.0 $\pm$ 0.00 in Gr II (Table 3).

In Gr I, the inflammation score at implant fixation day (IFD) was 2.11 $\pm$ 0.42 and 2.4 $\pm$ 0.40 in Gr II. The individual score of inflammation at the time of final reappraisal day (FRD) were zero in all the cases of the both groups except in one case of Gr II (Table 4).

The preoperative pain score was 1 $\pm$ 0.28 in Gr I and 1.2 $\pm$ 0.58 in Gr II. At the day of final reappraisal, the mean of pain score was 0.33 $\pm$ 0.16 in Gr I and 0.2 $\pm$ 0.20 in Gr II. Mild pain was evidenced by 3 dogs of IILN group on final reappraisal day and all these were found to have developed non-union. This may be attributed to instability of the bone implant construct. Whereas one case in Gr II exhibited mild pain at the same observation interval.

The muscle atrophy was recorded in 4 out of 9 cases of Gr I, 2 out of 5 cases of Gr II. In Gr I, it was 1 $\pm$ 0.44 and in Gr II, it was 0.8 $\pm$ 0.58. The three dogs of Gr I having muscle atrophy at final reappraisal day, showed non-union whereas the remaining dog showed normal fracture healing. In two non-union cases, the muscle atrophy was significant. Among these two, in one case, the muscle atrophy was pre-existing due to mal-union of fracture initially repaired by end-threaded intramedullary pinning.

The weight score at IFD in Gr I and Gr II was 2.3 $\pm$ 0.86 and 1.6 $\pm$ 0.92 respectively. The weight-bearing improved gradually in both the groups post-operatively. On final reappraisal day the weight-bearing score ranged from 3

to 10 (8.5 $\pm$ 0.95) in Gr I and 2 to 10 (7.6 $\pm$ 1.6) in Gr II. On comparative basis, it was found to be better in IILN group. In Gr I, three animals showed complete weight-bearing as early as on first post-operative day. One dog showed good weight-bearing even in cases of non-union of fracture; whereas the other two showed reduced weight-bearing.

Radiographically, in Gr I, evidence of initiation of fracture healing was seen in seven cases but eventually complete union was observed only in 5 out of 9 patients. One case showed delayed-union and the 3 cases non-union of fracture by the time of last post-operative reappraisal. The sizes of callus during healing were moderate in two and large in three cases. The bony response with moderate to large sized callus indicated that the fixation was not rigid and the fracture healing was occurring by second intention.

In Gr II, 3 out of 5 cases showed complete union with shortening of bone. In these cases, the proximal fracture fragment collapsed during the healing period. This might be attributed to poor axial resistance of ETP and inadequate restriction of animal's activity in the post-operative period. However, fracture union occurred and clinically limb function was not affected much. 4 out of 5 dogs showed large external callus responses and the callus response in remaining one dog could not be ascertained due to late presentation of case. In one case there was fixation failure on the ninth day though large callus formation was in progress.

In Gr I, 4 out of 9 cases showed inadvertent penetration of distal cortex of different degrees while intramedullary reaming which could not be seen intra-operatively but clearly evident in the immediate postoperative radiograph (Fig. 1). Abnormal angulation of the distal femur in respect to the proximal segment (n=2), one or more screws were longer than of required length (n=6), loosening of screw in the postoperative radiographs (n=2) and screw-bending during post-operative period (n=1) was observed. All these complications can be result of inadequate fixation of implant and relatively uncontrolled activity of the patient along with constant or sudden stress occurring on the intramedullary nail construct during the early phase of postoperative healing. These types of complications were also reported by Raghunath *et al.* 2012 and Saravanan *et al.* 2004.

Inadequate resistance to compressive forces leading to partial collapse of fracture fragments (n=3) and difficulty in implant removal (n=2) were the most common complications associated with ETP technique. Similar observation was observed by the Chanana *et al.* (2018).

The duration of surgery, mean extent of manipulation/soft tissue damage and degree of technical difficulty were more in IILN group as compared to the ETP group. The IILN provided more rigid fixation of fracture and size of callus was also smaller than fracture fixed by the ETP. The ETP technique was simpler and less time consuming than IILN whereas the weight bearing status was relatively better in IILN than ETP group. The functional outcome of the fractured limb was superior in fracture fixed by IILN

indicating better fracture healing in the group as compared to other group.

REFERENCES

- Beale B. 2004. Orthopedic clinical techniques femur fracture repair. *Clinical Techniques in Small Animal Practice* **19**: 134–150.
- Brinker O, Piermattei L D and Flo G L. 2015. *Handbook of Small Animal Orthopedics and Fracture Repair*. 5th Edition. Elsevier, Inc.
- Chanana M, Kumar A, Tyagi S P, Singla A K, Sharma A and Farooq U B. 2018. End threaded intramedullary positive profile screw ended self-tapping pin (Admit pin)-A cost effective novel implant for fixing canine long bone fractures. *Veterinary World* **11**: 181–85.
- Eyarefe O D and Oyetayo S N. 2016. Prevalence and pattern of small animal orthopaedic conditions at the veterinary teaching hospital, University of Ibadan. *Sokoto Journal of Veterinary Sciences* **14**: 8–15.
- Harasen G. 2011. Orthopedic hardware and equipment for the beginner: Part 1. Pins and wires. *Canadian Veterinary Journal* **52**: 1025–26.
- Newton and Nunamaker D M. 1985. Methods of Internal Fixation. *Textbook of Small Animal Orthopaedics*. (1st Eds) C D Newton and D M Nunamaker. International Veterinary Information Service, Ithaca, New York, USA.
- Raghunath M. 2002. ‘Studies on intramedullary interlocking nailing and dynamic compression plating on long bone fracture fixation in dogs’. PhD Thesis. Department of Veterinary Surgery and Radiology, Punjab Agricultural University, Ludhiana, India.
- Raghunath M, Bishnoi A K, Singh S S, Singh M, Sharma A and Atri K. 2012. Management of segmental fractures of tibia and femur by static intramedullary interlocking nailing in twelve dogs. *International Journal of Applied Research in Veterinary Medicine* **10**: 264–72.
- Saravanan K B, Maiti S K, Singh G R, Hoque M, Kumar N and Setia H C. 2004. Complication associated with different internal fixation techniques in the management of comminuted femoral fracture in dog. *Indian Journal of Animal Sciences* **74**: 1128–29.
- Wheeler J L, Lewis D D, Cross A R, Stubbs W P and Parker R B. 2004. Intramedullary interlocking nail fixation in dogs and cats: clinical applications. *Compendium on Continuing Education for the Practicing Veterinarian* **26**: 531–44.