The Pharma Innovation Journal 2021; SP-10(8): 156-160

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(8): 156-160

www.thepharmajournal.com
Received: 13-06-2021
Accepted: 15-07-2021

Tenzin Wangchuk
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Jasmeet Singh Khosa
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Tarunbir Singh
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Jitender Mohindroo
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Vandana Sangwan
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Opinder Singh
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Corresponding Author
Tenzin Wangchuk
Department of Veterinary Surgery and Radiology
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Evaluation of pin plate combination for surgical management of comminuted diaphyseal femur fracture in dogs

Tenzin Wangchuk, Jasmeet Singh Khosa, Tarunbir Singh, Jitender Mohindroo, Vandana Sangwan and Opinder Singh

Abstract
Femoral fractures constitute approximately 20% to 25% of all fractures in dogs and represent 45% of all long-bone fractures. Various external coaptation methods for fracture immobilization are available but these conservation techniques are ineffective and generally not suited for femur fracture fixation due to abundant quadriceps musculature. This study was aimed to evaluate the outcome of a pin plate combination for repair of a comminuted diaphyseal femur fracture in dogs. This study was carried out in ten clinical cases of dogs presented to the clinics with a comminuted diaphyseal femur fracture. We used 3.5mm (7-11 holes) stainless steel locking compression plates (LCP) in combination with Steinmann pin measuring mean diameter of 37% (32-44%) of marrow cavity at isthmus. In six cases, ancillary cerclage wires were used to proximate widely apart fragments. The initial weight bearing was recorded as early as 3 days and as late as 10 days, with the mean of 6.11±0.81 days. The mean time required for full functional limb usage was 60±12.68 days with a range of 30-120 days and similarly the mean time taken to achieve radiographic union was 70±11.18 days, which ranged from 30-120 days. Plate dislodgement was observed in one case, and it was re-operated for interlocking nailing. A case of sciatic nerve paralysis was observed in one dog but it was resolved with physiotherapy and rehabilitation. The final outcome was excellent 40% (n=4) and good 30% (n=3). Therefore, the pin plate combination can be used successfully for diaphyseal comminuted femur fracture repair with good implant stability and satisfactory bone healing.

Keywords: diaphyseal, femur, fracture, locking compression plate, pin plate combination

Introduction
Comminuted femur fractures are very common in dogs and are mainly due to high velocity injuries, usually caused by automobile accidents and falling from heights [1]. Various external coaptation methods for fracture immobilization are available, viz., Robert Jones bandage, plaster of paris, fibre-glass cast, Thomas splint, slings, Mason metasplint and external skeletal fixators. However, these conservation techniques are ineffective and generally not suited for femur fracture fixation due to abundant quadriceps musculature [2].
Proper selection of a fixation technique is a prerequisite to achieving a higher success rate [3]. Open reduction and internal fixation using suitable implants with minimal disruption to vascularity and soft tissue components is the objective of biological osteosynthesis [4]. In dogs and cats, the pin plate combination has proved to be a highly adaptable method of bridging osteosynthesis [3] and proven more versatile because it combines both the advantageous aspects of intramedullary pinning and bone plating.
In a pin plate combination, the intramedullary (IM) pin protects fractured bone from bending loads while the plate resists axial, torsional, shear and compression forces [5]. The addition of an IM pin to the bone plate reduces plate strain and hence extends the pin plate combination's fatigue life [2,3,4].
Several in vitro studies were carried out using a locking compression plate (LCP) and IM pin combination using canine cadavers or bone models, but limited studies were performed in clinical cases using this combination. So, the objective of this study was to evaluate the outcome of a pin plate combination for repair of a comminuted diaphyseal femur fracture in dogs.

Materials and methods
The current study was conducted on ten clinical cases of dogs which were presented to the

Multi-Specialty Veterinary Hospital, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India. The study was conducted from April 2020 to March 2021. The dogs having diaphyseal femur fracture, weighing more than 10 kg and older than 6 months of age, and have undergone a complete radiographical examination were included in the study. A pre-operative radiograph of the affected and contralateral limbs was used to determine the size of the implants. A 3.5mm locking compression plates manufactured from 316L stainless steel metal alloy were used in combination with Steinmann's pin measuring a diameter of 32-44% of the marrow cavity at the isthmus.

The animals were made to withhold food for twelve hours and water for six hours. Dogs were premedicated with a combination of inj. BAA-Butorphanol @ 0.2 mg/kg body weight, inj. Acepromazine @ 0.05 mg/kg body weight and inj. Atropine sulphate @ 0.04 mg/kg body weight intramuscularly. The third-generation antibiotic, inj. Cefotaxime @ 20mg/kg body weight, was administered intravenously. After 15-20 minutes of preanesthesia, the induction of anesthesia was achieved by inj. Propofol (1%) @ 4mg/kg body weight intravenously. It was given slowly over a period of one minute. Maintenance of anesthesia was carried out using 1-2% Isoflurane and 100% oxygen through a cuffed endotracheal tube connected to a partial rebreathing system of the small animal anesthetic apparatus.

The fracture site was approached by making an incision along the craniolateral border of the thigh. The subcutaneous tissues were dissected bluntly with Mayo's scissors, exposing the tensor fascia lata. The attachments of the cranial border of the biceps femoris muscle with tensor fascia lata were incised to expose the vastus lateralis muscle cranially and the biceps femoris muscle caudally to exteriorize the proximal and distal fragments of fractured bone. A Steinmann pin measuring 32-44% of the diameter of the marrow cavity at the isthmus was inserted in normograde fashion from the trochanteric fossa until it sat firmly in the distal metaphysis. Before cutting the excess length of the pin protruding above the superficial gluteus muscle, the pin was withdrawn slightly and cut using a pin cutter and driven forward with the help of a hammer to prevent surrounding soft tissue injury. The IM pin helped in maintaining the length and axial alignment of bone. If required large fragments that were far apart were reduced using full cerclage wires. Final stabilization was done using 3.5mm stainless steel LCP in a bridging fashion. At least two bicortical screws were used on either side of the fracture fragment. While applying the plate, extreme caution was taken to minimize disruption of vascularity and soft tissue components by minimizing fragment manipulation. Finally, the fracture site was thoroughly irrigated with 0.9% normal saline to remove all debris before suturing the tensor facia lata with 2-0 braided coated polyglactin 910 violet and the subcuticular suture with the same material. The skin incision was closed using either a stainless steel staple suture or nylon 3-0 on a simple interrupted mattress.

Postoperatively, the animals were closely monitored until their complete recovery from anesthesia. Immediate post-operative radiographs in medio-lateral and cranio-caudal views were taken to evaluate apposition and implant alignment. A modified Robert-Jones bandage was applied on the operated limb from digits up to thigh for 3 weeks post operatively and changed periodically every 3 days. An Elizabethan collar was advised to prevent self-mutilation of sutures and wounds. Antiseptic dressing of the wound was done using povidone iodine solution. Broad spectrum antibiotics, i.e., inj. Cefotaxime @ 20 mg/kg body weight intramuscularly (IM) twice daily for 5 days and inj. Amikacin @ 10mg/kg body weight IM once daily for 3 days. Post-operative pain was controlled using inj. Meloxicam @ 0.2mg/kg body weight IM once daily for 3 days. Owners were advised to restrict movement or cage rest for at least 2 weeks, followed by limited exercise or leash walking for 4-6 weeks. The skin suture was removed after 12-14 days.

Table 1: Lameness scoring system, Harari *et al.* in 1996)

Lameness Score	Clinical signs
1	No functional limb usage; limbs carried most of the time.
2	Slight functional limb usage; limb carried during running but set down when walking
3	Moderate functional limb usage and partial weight bearing; lameness evident
4	Complete normal functional limb usage

A lameness score was assigned on the basis of the severity of clinical signs on day 0, 15, 30, 45 and 60 in all animals to assess the response to treatment. Animals were scored using a lameness scoring system developed by Harari *et al.* in 1996 [6] (Table 1). Periodical radiographs were taken every two weeks or as and when a case was presented for clinical or radiographical assessment, until complete radiographic healing was observed. Radiographic evaluation was carried out based on the fracture healing score described by Hammer *et al.* in 1985 [7] (Table 2). The IM pin was removed from three patients. Functional outcome was graded as per Duhautois in 2003 [8] (Table 3).

Table 2: Fracture healing scoring from radiographs according to Hammer *et al.* in 1985

Grade	Radiological assessment		
	Callus formation	Fracture line	Stage of union
1	Homogeneous bone structure	Obliterated	Achieved
2	Massive. Bone trabeculae crossing fracture line	Barely discernible	Achieved
3	Apparent. Bridging of fracture line	Discernible	Uncertain
4	Trace. No bridging of fracture line	Distinct	Not achieved
5	No callus formation	Distinct	Not achieved

Table 3: Functional outcome grading system, Duhautois in 2003

Grade	Clinical signs
Excellent	Normal gait
Good	Gets normal after exercise
Fair	Lameness evident
Poor	No weight bearing in affected limb

Result & Discussion

Ten dogs that met the criteria were included in this study. The age of dogs ranged from 6 months to 84 months, with a mean age of 35.50±8.7 months. The average weight of the dogs was 24.08±2.12 kg, ranging from 12.5 kg to 37 kg. Out of ten dogs, eight were males and two females. Motor vehicle accidents were the major causes of femur fractures in dogs (90%, n=9), followed by falling from a height (10%, n=1). Fractures occurred equally on both the right (50%, n = 5) and left (50%, n = 5) limbs. The proximal one-third had the highest number of fractures (50%, n=5), followed by the distal one-third (30%, n=3), and fractures in the mid-shaft (20%, n=2).

The mean number of days that elapsed between the occurrence of the fracture and fracture fixation was 4.0±0.39 days. It was observed that cases that were presented to the clinics as early as two days after a fracture incident healed faster than cases presented after two days. A previous study, Dvorak *et al.* in 2000 [9] reported more complications in fracture healing when the time gap between the fracture and fracture fixation exceeds more than 4 days. The earliest weight bearing was recorded as early as 3 days and as late as 10 days, with the mean initial weight bearing at 6.11±0.81 days.

A 3.5mm locking compression plate with (7-11) number of holes was used as the primary implant along with an intramedullary Steinmann pin measuring 32-44% of the diameter of the marrow cavity. In six cases, cerclage wires were used to proximate far apart fragments. The addition of an IM pin to the bone plate reduced strain on the plate and subsequently increased the fatigue life of the pin plate combination [2-4]. Moreover, the IM pin withstands bending loads, whereas the axial and torsional support is provided by the bone plate in the pin plate combination [5].

The mean plate span width was 2.6±0.12 with a range of 2.1 to 3.24 (Table 4). The value fell within the expected range. Gautier and Sommer in 2003 [10] reported that the plate span width should be greater than 2 to 3 in comminuted fractures and greater than 8 to 10 in simple fractures. The plate screw density was 0.72±0.05, which ranged from 0.5 to 1, and the value was above the recommended value. The normal recommended value was below 0.5 to 0.4, indicating that more than half of the plate holes should remain empty [10]. The mean percentage of medullary cavity filled was 37% ±0.01, which ranged from 32% to 44%. The authors of previous studies, Reems *et al.* in 2003 and Hulse *et al.* in 1997 [3, 5] have recommended using an intramedullary pin ranging from 35% to 50% of the diameter of the medullary cavity. The mean number of screws in the proximal and distal fragments was 3.1±0.28 (2-5) and 3.4±0.43 (2-7) respectively. While the mean number of empty plate holes was 2.4±0.43 (0-4) as shown in (Table 4).

Table 4: Mean± SE values of implant associated parameters

Particulars	Mean± SE (Range)
Plate span width	2.60±0.12 (2.1-3.24)
Plate screw density	0.72±0.05 (0.5-1)
Percentage of medullary cavity filled	37±0.01 (32-44)
Number of screws in proximal fragment	3.1±0.28 (2-5)
Number of screws in distal fragment	3.4±0.43 (2-7)
Number of empty plate holes	2.4±0.43 (0-4)

On the 30th post-operative day, fracture union was achieved in 2 cases, while on the 60th day, fracture union was achieved in 6 cases. The mean time taken to achieve radiographic union was 70±11.18 days, which ranged from 30-120 days (Fig. 1&2). A similar finding was also reported by Reems *et al.* in 2003 [3] where fracture union was achieved by 7.5±2.7 weeks. On the 30th postoperative day, 2 dogs showed full functional usage of the affected limb, while on the 60th day, 6 dogs showed full functional usage of the limb. The mean time taken for full functional usage of the limb was 60±12.68 days with a range of 30-120 days. From this finding, we infer that functional usage of the limb was achieved earlier than radiographic union. Our findings are in agreement with the finding of Gielen in 2014 [11] that radiographical healing signs appear weeks to months later than physiological healing signs. The reason being organic component of the callus accounts for roughly half of the stability of fracture.

The IM pin was removed in 3 cases. In one case, the intramedullary pin was removed on the 14th day due to post-operative pin migration. In the second case, the pin was removed after the fracture had completely healed. Whereas in the third case, both the intramedullary pin and plate were removed after noticing plate dislodgement on the 14th day of the postoperative radiograph. The fracture was refixed with interlocking nailing in an aseptic condition. It is recommended that the removal of implants is not necessary unless there is a loss of function or implant failure [12].

Minor complications like seroma formation at the point of insertion of the intramedullary pin was observed in one case and swelling of the scrotum was observed in two cases. Scrotal swelling could be due to Robert John bandaging. Migration of the intramedullary pin was noticed in one case. A similar finding was observed by Sarangom *et al.* in 2018 [13]. Dehiscence of skin sutures occurred in two cases. Lovric *et al.* in 2020 [14] also noticed similar complications after femur fracture fixation in dogs. Plate dislodgement was observed in one case and it was re-operated for interlocking nailing. It could have resulted due to short plate length because the plate span width was 2.1. Moreover, the animal was very active and it jumped while running, as per the owner's statement. Other complications, such as sciatic nerve paralysis was observed in one case but were resolved by physiotherapy and rehabilitation. Similar complications were observed by Fanton *et al.* in 1983 [15] where they recorded sciatic paralysis in 14.3% of dogs and 23.1% of cats after IM pin fixation. It could be because of the pin's proximity to the nerve [16], where authors observed that the sciatic is very close to the IM pin and the pin transmits pressure to the nerve through the surrounding tissue.

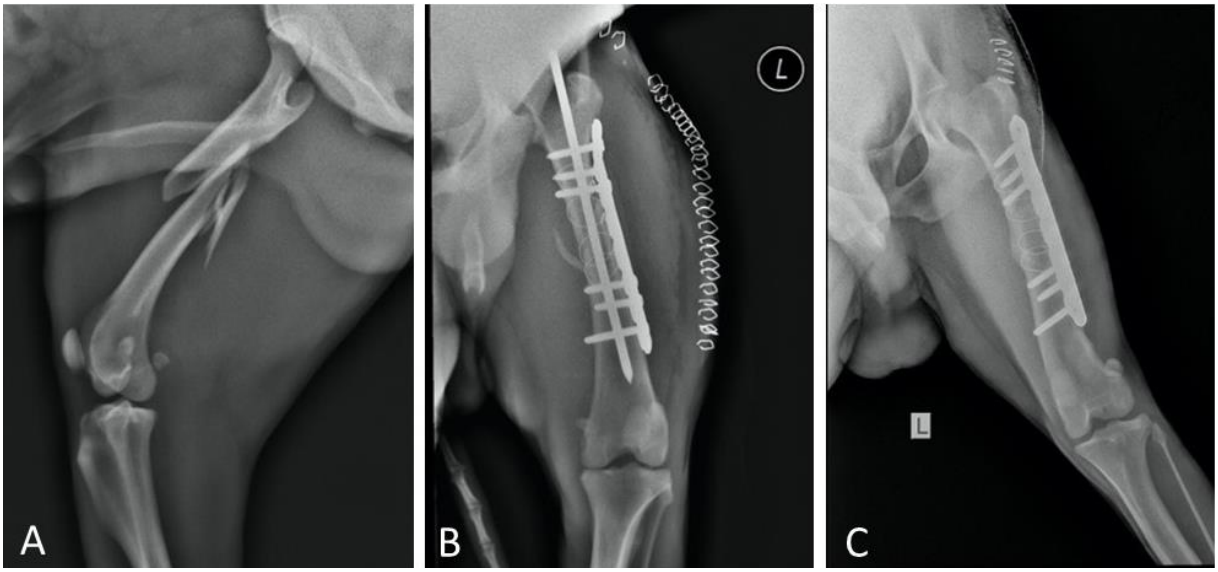

Fig 1: Preoperative and postoperative radiographs showing complete healing of bone in 2years male dogs A: Preoperative radiograph Showing proximal third comminuted femur fracture B: Immediate post-operative radiographs showing properly stabilized fracture by pin plate combination C: 90th day postoperative radiograph showing complete fracture union after IM removal.

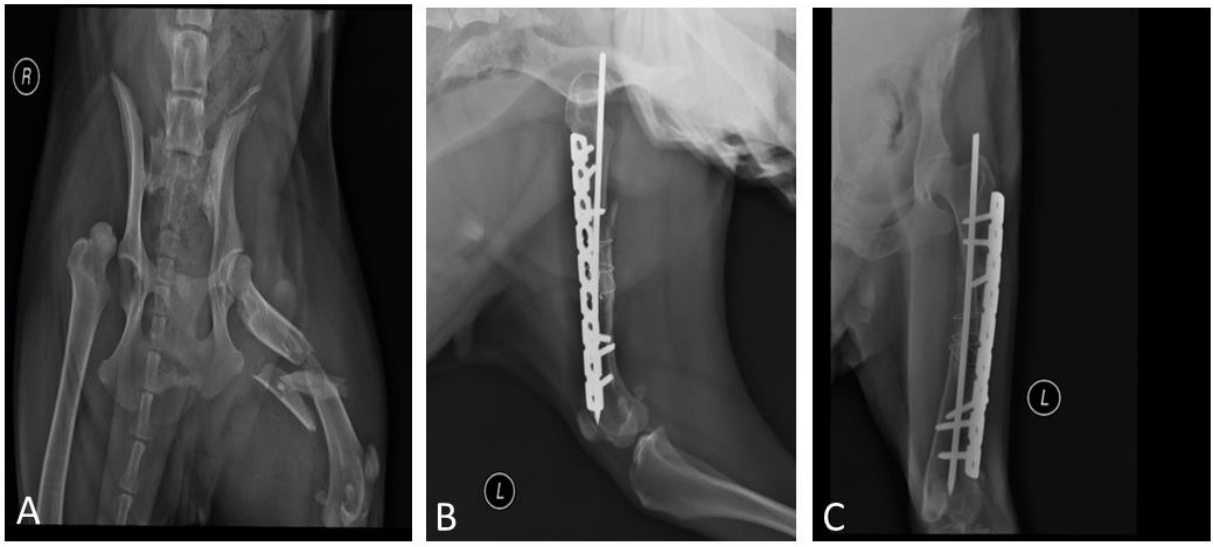

Fig 2: Preoperative and postoperative radiographs showing complete healing of bone in 3years female dog
A: Preoperative radiographs showing mid shaft comminuted femur fracture with complete luxation of femoral head of contralateral limb and fracture of ischial symphysis B: 30th day post-operative radiograph showing mild discernible fracture line C: 90th day post-operative radiograph showing complete union with obliteration of fracture line.

Conclusion

We evaluated all animals at 90th day post-operation for functional outcome. Among 10 animals, the functional outcome was excellent in 40% (n=4), good 20% (n=2), fair 20% (n=3) and poor in 20% (n=1). Therefore, the Pin plate combination can be used successfully for diaphyseal comminuted femur fracture repair with good implant stability and satisfactory bone healing. The pin diameter of 32-44% of the medullary cavity allows for the placement of bicortical screws without causing post-operative implant failure.

Acknowledgements

The authors are thankful to Indian Council of Agriculture Research for funding the study under "All India Network Program on Diagnostic Imaging and Management of Surgical Conditions in Animal".

References

1. Fossum TW. Femoral diaphyseal fraxtures-management of specific fractures. In: Small Animal Surgery. 2nd Edn. Mosby Elsevier, St. Louis, Missouri 2002, 981-994.
2. Beale B. Orthopedic clinical techniques femur fracture repair. Clinical Techniques in Small Animal Practice. 2004;19(3):134-150.
3. Reems MR, Beale BS, Hulse DA. Use of a plate-rod construct and principles of biological osteosynthesis for repair of diaphyseal fractures in dogs and cats : 47 cases (1994 – 2001). Journal of the American Veterinary Medical Association 2003;223(3):330-335.
4. Stiffler KS. Internal fracture fixation. Clinical Techniques in Small Animal Practice 2004;19(3):105-113.
5. Hulse D, Hyman W, Nori M, Slater M. Reduction in plate strain by addition of an intramedullary pin. Veterinary Surgery 1997;6(26):451-459.
6. Harari J, Seguin B, Bebchuk T, Lincoln J. Closed repair of tibial and radial fractures with external skeletal fixation. The Compendium on continuing education for the practicing veterinarian (USA) 1996;18(6):651-654.

7. Hammer RR, Hammerby S, Lindholm B. Accuracy of radiologic assessment of tibial shaft fracture union in humans. Clinical Orthopaedics and Related Research. 1985;199:233-238.
8. Duhautois B. Use of veterinary interlocking nails for diaphyseal fractures in dogs and cats: 121 Cases. Veterinary Surgery 2003;32(1):8-20.
9. Dvorak M, Neaas A, Zatloukal J. Complications of long bone fracture healing in dogs: Functional and Radiological Criteria for Their Assessment. Acta Veterinaria Brno 2000;69(2):107-114.
10. Gautier E, Sommer C. Guidelines for the clinical application of the LCP. Injury 2003;34:63-76.
11. Gielen I. Radiology of Fractures-Classification, Healing, Complications World Small Animal Veterinary Association World Congress Proceedings 2014.
12. Singh T, Mohindroo J, Verma P, Udheiya R, Umeshwori N. Evaluation of intramedullary pinning technique for management of tibia fractures in dogs. The Pharma Innovation Journal 2019;8(2):291-297.
13. Sarangom SB, Singh K, Gopinathan A, Mohammed K, Basha A, Surendra DS *et al.* Plate-rod technique for the repair of comminuted diaphyseal femoral fractures in young dogs. In Indian Journal of Advace Biological Research 2018;8(4):451-453.
14. Lovric L, Kreszinger M, Pecin M. Surgical treatment of canine femoral fractures-A review. World's Veterinary Journal 2020;10(2):137-145.
15. Fanton JW, Blass CE, Withrow SJ. Sciatic nerve injury as a complication of intramedullary pin fixation of femoral fractures. The Journal of the American Animal Hospital Association (USA) 1983;19(5):687-694.
16. Forterre F, Tomek A, Rytz U, Brunnberg L, Jaggy A, Spreng D. Iatrogenic sciatic nerve injury in eighteen dogs and nine cats (1997-2006). Veterinary Surgery 2007;36(5):464-471.