Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 5 Issue 5 May 2023

Research Article

Plate-Rod Technique for Femur Fracture Repair in Dogs: A Report of 31 Cases

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DOI:10.31080/ASVS.2023.05.0647

Received: March 31, 2023

Published: April 17, 2023

Abstract

Study was conducted on 31 femur fractures repaired with plate rod technique in dogs. Both simple and comminuted diaphyseal fractures of young and adult dogs of age ranging from 5 months to 72 months and weighing between above 10kgs to 35kgs were included in the study. Locking plates with the intramedullary rods (IMR) of 30-40% diameter of medullary cavity were used for plate-rod construct (PRC). Suitable sizes of the LCPs were selected based on preoperative orthogonal radiographs and body weight of the dogs. Minimum two bicortical screws were applied in each fracture fragment. Most of the animals showed weight bearing on 10-15 days post surgery and visible callus formation was also observed radio-graphically at 4-5th postoperative weeks. Complications like pin migration (4), seroma formation (5), plastic deformation of implant (2) and soft tissue irritation (9) were observed. From results we concluded that plate rod technique yield excellent results for the management of femoral fracture repair in dogs.

Keywords: Plate-Rod Constructs; Locking Compression Plate; Femur; Humerus; Dogs

Introduction

Long bone fractures are commonly encountered in canine veterinary practice and the usual etiology of these fractures are road accidents, fall from height and trauma [1]. Simple transverse and short oblique fractures of femur often undergo repair by anatomical reduction and rigid fixation using bone plates quiet often and also by inter locking nails (ILNs) [2]. To reduce the plate stress and the risk of catastrophic plate failure, and to increase the fatigue life of the plate, a combination of bone plate with an intramedullary rod (IMR), the so called plate-rod construct (PRC) has been recommended [3]. The addition of an IMR also assists in facilitating reduction and reestablishment of the spatial alignment of fractured segments [4]. Clinical use of PRC with broad dynamic compression plates (DCPs) and limited contact dynamic compression plates (LC-DCPs) has been associated with a high success rate ranging from 90 to 98% [5]. The locking compression plate (LCP) has been found to be four times higher in strength compared to conventional plating [6] and unlike the conventional plate which converts an axial load to a shear stress, LCP convert an axial load to a compressive force [7]. Limited plate-to-bone contact minimizes disruption of periosteum and soft tissues, preserves the periosteal and extra osseous blood supply and reduces consequent osteoporosis underneath a plate [8,9]. PRC with LCP for the repair of comminuted diaphyseal femoral fractures in young dogs has been reported [10]. The literatures on use of locking plates in PRCs in large number of long bone fracture cases are scarce. Therefore present study was undertaken to determine the success rate and various complications encountered with PRC using locking plates for the reaper of long bone fractures in dogs.

Materials and Methods

Study was conducted on 31 femoral fracture cases presented at referral veterinary polyclinic of ICAR-IVRI, Izatanagar, repaired with plate rod technique. Risk notes were taken from reach dog before surgery. Preoperative data including signalment, aetiology, prior treatment given (if any) and time elapsed between occurrence to presentation were recorded. Orthogonal radiographs were taken to determine the dimensions of the implants to be used. Operative records such as time of repair, duration of repair and damage on soft tissue structures were also noted. For animals weighing less

than 20 kg 2.7mm and for weighing more than 20 kg 3.5mm LCPs with 8-10 holes were used. For PRCs, IMRs of 35-40% of diameter of medullary cavity were used. Food for 12 hours and water for 6 hours was withheld in all the dogs, preoperatively.Dogs were premedicated with atropine sulphate (0.04 mg/kg body weight) subcutaneous injection. After 15 minutes diazepam was given @ of 0.5 mg/kg body weight followed by butorphanol @ 0.2 mg/kg body weight intravenously. General anesthesia was induced with thiopentone sodium, @ 12.5 mg/kg body weight intravenously. Endotracheal intubation was done and the anesthesia was maintained with isoflurane. Standard surgical approaches for femur [11] and humerus [12] for application of PRC were followed.

Steinmann pins were inserted in a normograde manner for axial realignment and to re-established length of the fractured bones. Cerclage wiring was done in few cases where it was required to proximate displaced bone fragments. Locking plates placed on the craniolateral surface of femur without engaging the epiphyseal growth plates in all young case. Minimal handling of fracture fragments was ensured to preserve the periosteal attachments and fracture hematoma. Minimum two bicortical screws were placed in each fracture fragment. Once the plate was fixed, muscles, subcutaneous tissue were opposed separately using no 1-0 polyglycolic acid sutures. Postoperatively antibiotics (ceftriaxone sodium, 20 mg/kg, IM BID for 5 days) and analgesic (meloxicam, 0.5 mg/kg, OID for 3 days) were given. Restricted movement along with immobilization of affected limb by Robert-Jones bandage was advised to owners.

Surgical wound healing was evaluated on 15th postoperative day and was graded as satisfactory or not. Postoperative evaluation of pain [13], posture and lameness [14] was done at 15, 30,60 and 90 postoperative days and scored. Orthogonal cranio-caudal and medio-lateral radiographs of the operated limb were taken preoperatively, just after surgery, 15, 30, 60 and 90 days post surgery to evaluate to assess the radiographic healing, callus formation, status and position of implant and complications if any. Complications were graded major or minor as described Dvorak., *et al.* [15]. Functional recovery was evaluated and graded on 60 day postoperatively and scored as: 'very good' (fracture healed with normal leg usage); 'good' (fracture healed with persisted slight lameness); 'satisfactory' (Delayed union with apparent lameness); and 'unsatisfactory' (fracture failed to heal due to fixation failure or infection). The data of parametric and non-parametric variables were expressed as mean and standard error, and median and range, respectively

Results and Discussion

The data on breeds, age, sex, limb involved, body weight, etiology, type of fracture, plate size, IMR size, complication if any and functional outcome of each case of the study have been shown in table 1. The mean age (Mean ± SE) of the dogs was 15.41 ± 1.25months (range from 8 to 36 months) and the mean body weight (Mean ± SE) was 19.48 ± 1.20 (range from 9 to 37Kg). Maximum numbers of dogs were of Non-descript (16) breed followed by, Labrador retriever (6), German shepherd (4), Pit bull (2), Saint Bernard (one), Doberman (1) and Rottweiler (one) breeds. Higher number of cases was observed in males (20) than females (1). Road traffic accident was cause of factures in 23 cases and fall from height in 8 cases. First aid treatment was provided by local veterinarian in 20 cases prior to presentation at our clinic.

S No	Breed	Age (months)	Sex	Limb (R/L)	Body weight (Kg)	Etiology of fracture	Type of Fracture	Plate size	IM Diameter (mm)	Complications	Functional outcome
1	Labrador Retriever	18	M	R	26	RTA	Short oblique	10 hole,3.5mm × 11mm	-	-	Excellent
2	Labrador Retriever	19	F	R	29	RTA	Short Oblique	9 hole, 3.5mm × 11mm	-	-	Excellent
3	ND	9	M	L	14	RTA	Transverse overriding	8 hole, 2.7mm × 11mm	-	-	Excellent
4	GSD	11	F	R	20	FFH	Short oblique	9 hole, 3.5mm × 11mm	-	-	Excellent
5	Labrador Retriever	8	M	R	12	RTA	Transverse	8 hole, 2.7mm × 11mm	-	-	Excellent
6	ND	32	F	L	15	RTA	Several reducible wedges	8 hole, 2.7 × 11mm		Seroma formation	Excellent
7	German Shepherd	19	F	L	26	RTA	Transverse overriding	9 hole, 3.5 mm × 8mm			Excellent
8	ND	12	F	R	15	RTA	Several reducible wedges	8 hole, 2.7mm × 11mm			Excellent
9	Labrador Retriever	11	M	L	15	FFH	One reducible wedge	8 hole, 2.7mm × 8mm			Excellent

10	ND	8	M	L	12	RTA	Long oblique	8 hole, 2.7mm × 11mm			Excellent
11	Rottweiler	13	F	R	27	FFH	Short Oblique	8 hole, 3.5mm × 11mm			Excellent
12	ND	36	F	R	19	RTA	Several reducible wedges	8 hole, 3.5mm × 11mm		Seroma formation (2^{nd} week)	Excellent
13	ND	8	M	R	11	FFH	Spiral	8 hole, 2.7mm × 8mm		Slight mal-alignment	Excellent
14	Pitbull	8	M	R	14	RTA	Comminuted	8 hole, 2.7mm × 11mm		Partial IMR migration, screw loosening (2^{nd} week), Plastic deformation and implant failure	Fair
15	German Shepherd	19	F	L	24	RTA	Comminuted	10 hole, 3.5mm × 11mm		Plastic deformation of plate and inward angling of screws and limb shortening	Good
16	ND	12	M	R	13	RTA	Short Oblique	8 hole, 2.7mm × 8mm			Excellent
17	Pitbull	15	M	R	21	FFH	Transverse	8 hole, 3.5mm × 11mm			Excellent
18	ND	14	F	R	24	RTA	Transverse overriding	8 hole, 3.5mm × 11mm			Excellent
19	German Shepherd	18	M	L	29	RTA	Several reducible wedges	8 hole, 3.5mm × 11mm		Hypertrophic callus (8^{th} week)	Excellent
20	Spitz	10	M	R	10	FFH	Short oblique	8 hole, 2.7mm × 11mm		-	Excellent
21	ND	17	M	R	13	RTA	Transverse	8 hole, 2.7mm × 11mm		Periosteal reaction	Good
22	ND	12	M	L	19	RTA	Transverse	8 hole, 3.5mm × 11mm		Seroma formation	Excellent
23	Doberman	13	M	L	25	RTA	Non-reducible wedges	10 hole, 3.5mm × 11mm		Osteolytic changes at pin insertion point, muscle atrophy	Good
24	Labrador	11	M	R	25	FFH	Non-reducible wedges	10 hole, 3.5mm × 11mm		Hypertrophic callus (9^{th} week)	Excellent
25	ND	24	M	L	16	RTA	Transverse	8 hole, 3.5mm × 11mm	3.5		Excellent
25	Saint Bernard	14	F	L	37	RTA	Segmental	8 hole, 3.5mm × 14mm	4		Excellent
27	Labrador Retriever	13	M	R	9	RTA	Non-reducible wedges	8 hole, 2.7mm × 8mm	3	IMR migration Seroma formation	Good
28	ND	30	M	R	24	FFH	Non-reducible wedges	9 hole, 3.5mm × 11mm	4		Excellent
29	ND	17	M	R	19	FFH	Long oblique	8 hole, 3.5mm × 11mm	3.5	Pin migration Seroma formation	Good
30	ND	12	F	R	21	RTA	One reducible wedge	10 hole, 3.5mm × 11mm	3.5		Excellent
31	ND	15	M	L	20	RTA	Non-reducible wedges	10 hole, 3.5mm × 11mm	4		Excellent
		15.41, 1.25,			19.48 1.20						

Table 1: Case details of dogs with femur fracture repaired.

ND- Non-descriptive: M: Male-20, F: Female-11, FFH: Fall from height--8, RTA: Road traffic accident-23, R: Right -19 and L: Left-12

The mean time lapsed (Mean ± SE) during presentation of dogs was 2.91 ± 0.58 (range from one to six days). All the animals had good general body condition on the day of presentation. The right side femur was fractured in more cases (19) than left (12). All the fractures were closed in nature and fracture associated injuries were not observed in any of the case. A similar clinical representation of canine fracture patients was reported previously by Reems., *et al.* [4] and Shiju., *et al*. [5]. Severe weight bearing lameness was observed in 15 dogs, intermittent non-weight bearing lameness was observed in 10 dogs and continuous non-weight bearing lameness was observed in six dogs on the day of presentation. It is reported that lameness does not directly evaluate pain but may be used as an indicator of pain [16] (Hudson *et al.*, 2004).

The mean duration (Mean ± SE) of 52.33 ± 3.35 minutes (range from 47 to 70 minutes) for completion of operative procedures following Open but Do Not Touch (OBDNT) approach was recorded. Repair of comminuted /wedge fractures took long time to repair. Similar type of association among these variables has been reported by Reems., *et al.* [4]. Intramedullary rods (IMR) of 30-40% diameter of medullary cavity were used for plate-rod construct (PRC) as suggested by Hulse., *et al.* [17]. However, reports on larger diameter IMR engaging up to 50% of medullary cavity are available to reduce the chances of plate failure. Application of at least two bicortical screws was practiced in each fracture fragment and a screw density was kept 0.62 ± 0.03 (range from 0.5 to 0.77). Gautier and Sommer [18] and Niederhauser., *et al*. [19] suggested screw densities <0.5 or 0.4 for bridging a comminuted fracture. It was observed that insertion of an IMR shares the plate load and precludes the need for meticulous considerations regarding the number of screws or the configuration of screws to be used. Bicortical locking screws were used in all the cases as enough space in diaphysis and metaphysis areas were available to bypass an IMR.

LCP plates of 3.5mm and 2.7mm were used in 19 and 12 cases, respectively, for PRC application. In ten dogs aging a year or less, screws were fixed without engaging the epiphyseal growth plates to avoid future developmental abnormalities. Full cerclage wiring was done for stabilization of long oblique, segmental, non-reducible wedge fractures. Postoperatively bone alignments were excellent in 28 cases. The dimensions of LCPs used in the present study were as reported by Sarangom., *et al.* [10]. Proper placement of IMR into the distal condyle of femur was ensured in every possible case to achieve stable fixation. Even then, in few cases IMR failed to engage the distal condyle properly. Penetration of IMR into opposite cortex and slight mal-alignment between bone fragments was also noticed in three cases. The locking compression plate (LCP), in contrast to conventional plates, is provided with special screws that lock the plate at fixed angle that precludes the need for the bone plate to be compressed to the bone and hence has a minimal plate-to-bone contact. The plate provides nearly uniform bending stiffness along the entire plate length [18]. The LCP has been found to be four times higher in strength compared to conventional plating [6] and unlike the conventional plate which converts an axial load to a shear stress, LCP convert an axial load to a compressive force [7]. Limited plate-to-bone contact minimizes disruption of periosteum and soft tissues, preserves the periosteal and extra osseous blood supply and reduces consequent osteoporosis underneath a plate [9].

Primary gap healing in simple transverse fractures and endosteal callus formation in comminuted fractures was observed radiographically. Excellent outcome was observed in most of the cases and no implant related major post operative complications were observed (Figure 1). The functional outcome of repair was excellent in 25 dogs at 14th week post operatively can be attributed to the perfect alignment and apposition (Figure 2), early resolution of pain and early callus formation are in agreement with earlier findings [20]. Similar outcomes, ranging from poor to excellent, with PRCs were reported previously by many researchers [21].

Figure 1: Representative cranio-caudal or mediao-lateral radiographs views taken preoperatively (A) immediate post operative status of implants (B) cortical continuity and apparent disappearance of the fracture line at 14 week post-surgery (C and D) in two dogs.

Figure 2: Representative photographs taken on the day of presentation animals are not putting weight on the fractured limbs (A) and complete weight bearing at 14 week post-surgery (B) in two dogs.

Conclusion

It is concluded that clinical application of LCP with IMR occupying 30-40% of medullary cavity for femur fracture repair is highly successful in dogs.

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