OPEN REDUCTION AND INTERNAL FIXATION WITH LINEAR LOCKING COMPRESSION PLATES FOR THE STABILISATION OF UNSTABLE DIAPHYSEAL FRACTURE OF FEMUR IN DOGS*

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ABSTRACT

Six dogs with unstable diaphyseal fracture of femur of different breeds of either sex and bodyweight ranging from 10 to 30 kg presented to the Small Animal Orthopedic Unit of the Madras Veterinary College Teaching Hospital, over a period of two years underwent fracture fixation with latest technique of linear locking compression plates. Different sizes and length of new generation locking plate system were used for different configuration of unstable fracture of femur. The post operative assessment of fracture healing was evaluated by radiographs at different intervals and estimation of bone specific serum alkaline phosphatase enzyme by fluorimetric methods.

In the present study, the locking compression plating technique provided adequate apposition, stable fixation and promoted early weight bearing of traumatized limb. The locking plate system had a unique combi hole design in a single implant and enabled to select the function best suited for the fracture configuration to achieve the most stable fixation. The locking plate system acted as a single beam construct which increased the stiffness of the implant and was found appropriate in management of unstable or comminuted diaphyseal fracture of femur in dogs.

Key words: Linear locking compression plate – Unstable diaphyseal fracture – femur - dog

INTRODUCTION

Open reduction and internal fixation with suitable implants is the procedure of choice for management of unstable fracture of long bones. The common goal of any fracture fixation device is to achieve bony union. Conventional methods allow direct healing across the fracture and generally work well for simple fracture. However, these methods are less advantageous in comminuted, metaphyseal, and/or osteoporotic fracture. Conventional plating using AO/ASIF guidelines involves the use of anatomical reduction and rigid fixation with interfragmentary compression. Locking compression plating system is a recent concept...
of fracture fixation for the management of unstable diaphyseal fracture. Locking internal fixators allow for callus formation through increased flexibility in stabilization (Egol et al. 2004). The Linear Locking Compression Plate (LCP) offers the possibility of inserting conventional and locking head screws into specially designed combination of holes called “Combi holes”. This new plate hole design permitted the use of both of standard screws and locking head screws (LHS) resulting in fixed-angle stability.

MATERIALS AND METHOD

Design of the study: The study was carried out in 6 dogs of different breeds of either sex or bodyweight ranging from 10 to 30 kg presented to the Small Animal Orthopedic Unit of the Madras Veterinary College Teaching Hospital, over a period of two years. Clinical cases presented with the history of lameness and clinical symptoms suggestive of unstable diaphyseal fracture involving the femur were considered for the study. These dogs were subjected to detailed physical, orthopaedic and radiographic examination in two orthogonal views to confirm the diagnosis. Of the animals screened, 6 animals with unstable diaphyseal fracture of femur, free from other concurrent neurological, metabolic or infectious diseases were considered for the study. These cases were subjected to detailed orthopaedic examination to determine a tentative diagnosis.

Pre-operative plan: A pre-operative plan was prepared using a small animal preoperative planning guide developed by the AO/ASIF (Small animal group) using plain radiographs. A Pre-operative radiographic evaluation of the fracture was carried out in both lateral (Fig 1) and craniocaudal views. Pre-operative lateral radiograph of the contralateral limb was used to determine the diameter and length of the plates and the craniocaudal view was used to determine the diameter and length of the screws.

Premedication and anaesthesia: The dogs were premedicated using atropine sulphate at the dose rate of 0.04 mg/kg body weight intramuscularly followed by xylazine hydrochloride at a dose rate of 1 mg/kg body weight intramuscularly. General anesthesia was induced using ketamine hydrochloride at a dose rate of 5 mg/kg bodyweight intravenously and diazepam at a dose rate of 0.2 mg/kg body weight intravenously. Anaesthesia was maintained with administration of required concentration (2%-3%) of Isoflurane using a Boyle’s anesthetic machine. Intraoperatively, cefotaxime and meloxicam were administered intravenously at a dose rate of 20 mg/kg body weight and 0.2 mg/kg body weight intravenously respectively 30 minutes prior to induction.

Operative procedure: The surgical site was clipped and scrubbed with Povidone Iodine scrub solution. In the operating room, the dog was positioned in lateral recumbency with the affected limb above and a sterile surgical scrub with chlorhexidine solution was carried out. The operating site was draped using standard sterile four towel draping system and impermeable drapes.

The fracture site was approached by making a cranialateral incision. A linear skin incision was made along a line extending from the trochanter major to the lateral surface of the patella. The subcutaneous tissues were divided by blunt dissection and tensor fascia lata was exposed. The attachments of the cranial border of the biceps femoris muscle with tensor fascia lata was severed to expose the vastus lateralis muscle cranially and biceps
femoris muscle caudally. The belly of the biceps femoris muscle was reflected caudally and vastus lateralis and fascia lata were reflected cranially. The intermuscular septum between the two muscles was divided to expose the fractured fragments (Piermattei and Greely, 1993b).

The vastus lateralis and biceps femoris muscle were apposed with interrupted sutures using No 1-0 PGA. The tensor fascia lata was apposed with No 1-0 PGA in a simple continuous pattern. Subcuticular sutures were applied in continuous pattern using No 1-0 PGA. Skin was apposed with 2-0 braided silk in a cross mattress pattern.

The animals were kept under observation on the floor in a well-ventilated room with its neck in extended position until complete recovery from anaesthesia. The animal’s movements were restricted until complete recovery. The surgical wound was dressed on alternate days with povidone iodine using sterile gauze. An Elizabethan collar was applied to prevent disturbance of the bandage and protect the surgical site. Ice packs were applied over the surgical site for 10 minutes four times daily immediately after surgery for the first 24 hours followed by warm packs for the next 24 hours.

Post operatively, a combination of Cefotoxime, Tramadol and Carprofen were administered at a dose rate of 22mg/kg, 3 mg/kg and 2.2 mg/Kg body weight twice daily orally for five days respectively.

Linear locking compression plates: Linear locking compression plates manufactured from 316L stainless steel metal alloy with thickness 4.5 mm, 3.5 mm and 2.7 mm were used in this study. Plate selection was done based on the bodyweight of the dog, configuration of fracture and size of the bone involved. The 4.5mm linear locking compression plates had 12 combi holes and were 20mm width and 140mm in length. The 3.5mm plate with 10 combi holes had 15 mm wide and 140 mm in length and the 3.5mm plate with 12 combi holes had 15mm width and 160 mm length. The 2.7mm plate had a 15 mm width and 120 mm length for 8 hole plate and 15mm width and 140 mm length for 10 hole plate. All plates had a ventral flat surface and were scalloped. The diameters of the locking and non-locking side of the combi hole were manufactured based on standard AO recommendation (Wagner and Frigg, 2006). The 2.7mm linear locking compression plate was used in dogs weighing between 10 and 15 kg and 3.5 mm linear locking compression plate was used in dogs weighing between 15 and 30 kg and a 4.5mm plate was used in dogs weighing greater than 40kg. A 2.0 mm drill bit for 2.7 linear locking compression plate and a 2.7mm drill bit for 3.5mm linear locking compression plate and a 3.2mm drill bit was used for a 4.5mm linear locking compression plate. The appropriate sized drill bit was placed through the corresponding locking drill sleeve and drilled on the threaded hole of the plate when locking screws were used. The locking side of the linear locking compression plate was fixed to the bone at the proximal and distal fragments with 4.5mm locking screws for 4.5mm linear locking compression plate, 3.5 mm locking screws for 3.5mm linear locking compression plate or 2.7mm locking screws for 2.7mm linear locking compression plate, 1 to 2 mm longer than the measured length using appropriate hexagonal screw driver. AO/ASIF principles were followed for plate fixation (Brinker, 1984).

Based on fracture configuration, non-locking side of the plate was used to facilitate compression in transverse fracture (n= 3)
whereas locking screws as a sole method of fixation was used in comminuted fracture as a buttress (n=3).

Bone specific serum alkaline phosphatase was estimated using SenoLyte FDP Alkaline Phosphatase Assay Kit by fluorimetric method.

All the cases were evaluated periodically for functional outcome, surgical approach, technique and radiographic and biochemical changes.

RESULT AND DISCUSSION

Fracture patient assessment score: Fracture patient assessment score in animals with unstable diaphyseal fractures of femur in the present study considered more than 7 and measured a lower scale (<4), a middle range (5-6) and a higher scale (>7) indicating an unfavorable, guarded and favourable prognosis respectively.

In the present study, all the dogs were evaluated for functional outcome at 60th postoperative day and categorized as excellent good, fair and poor based on the classification suggested by (Roush and McLaughlin, 1999). The functional outcome was graded excellent in 4 (66.8%), good in one (16.6%) and poor in one (16.6%) out of 6 cases of fracture of femur considered in the study. The lameness grade was 5 on pre-operative day in all cases except in one which had lameness grade of 4.

Surgical Approach to the Femur: A craniolateral incision provided adequate exposure of the bone with minimal soft tissue disturbance and facilitated open reduction and internal fixation of the fractured diaphyseal fragments using linear locking compression plating technique. Maneuverability of surgical instruments was enabled without hindrance for the fixation of fragments.

Linear locking compression plate: A 3.5mm linear locking compression plate were used in three cases (9 hole 3.5mm plate in 1 case, 10 hole 3.5mm plate in 2 cases). The plates were stabilized with three 3.5mm locking head screws in proximal fragment and five 3.5 locking head screws in distal fragment. The fragments were stabilized further with 3mm intramedullary Steinmann pin. The 8 hole 2.7mm linear locking compression plate was used in two cases. The 12 hole 4.5mm linear locking compression plate was used in one case. The 4.5mm plate was stabilized with three 4.5mm locking head screws in the proximal fragment and seven 4.5mm locking head screws in distal fragment. One hole was left empty at the fracture site without fixing the screw. Fixing the plate to the bone by applying the most proximal and most distal locking screws initially and later filling all the remaining screws hole was found to be technically suited for plate fixation. A minimum of three screws in the proximal and distal fracture fragments provided adequate stability. Compressing unstable transverse and oblique fracture using the gliding hole of the plate ensured rigid stability of the fracture fragments. In all the cases, screws were applied bicortically except in one case where the distal screw was applied unicortically. The fracture was further stabilized with 3mm intramedullary Steinmann pin and 20G cerclage wires. The size of the screws ranged from 14mm to 24mm for dogs with bodyweight ranging from 10 – 15 kg and 16mm to 30mm for dogs with bodyweight ranging from 15-30 kg and 28mm to 36mm with bodyweight ranging from 40-50kg. Plates were applied as a buttress for comminuted fractures (n=3 cases) and as a compression for transverse fractures (n=3 cases).
Radiographic evaluation of fracture fixation in lateral and craniocaudal views was carried out periodically to judge the healing progress. This evaluation was in accordance with Haaland et al., (2009) who reported that radiographic assessment at immediate postoperative day and subsequent postoperative radiographic evaluation on every three weeks in a retrospective study on appendicular fracture repair in dogs using the locking compression plate system in 47 cases. The fracture was observed as healed when a visible callus bridging at least one cortex or disappearance of fracture line in both the lateral and craniocaudal radiographic views, as suggested by Dernanz et al. (2007). It is revealed from the observations by 45th postoperative day (Fig 2) that linear locking compression plate could successfully be used for repair of unstable diaphyseal fracture of femur in dogs.

The bone specific serum alkaline phosphatase was estimated using SenoLyte FDP Alkaline Phosphatase Assay Kit by fluorimetric method for peak absorbance on pre and 45th post-operative day. It was observed that fluorimetric reading on the 45th post operative day showed increased intensity as compared to pre-operative values indicating osteogenic activity and progressive fracture healing.

The locking compression plating technique could provide stable fracture fixation for unstable diaphyseal fracture of femur in dogs. This plating system with combi hole for the use of locking and nonlocking screws could be used both as a compression plate or a buttress plate to achieve a stable fixation. Locked plates extended a single beam construct by controlling the axial orientation of the screw to the plate and provided angular stability. It did not interfere with the vascularity to the injured bone, promoted bone healing with least risk of infection, prevented bone resorption and non-union. The surgical procedure did not involve the contouring of plate and hence probable reduction in surgical time was possible. The new generation LCP system could be successfully used for treating unstable or comminuted diaphyseal fracture of long bone as it provided a definitive clinical and mechanical advantage in terms of functionality as a buttress or compression plating system in small animal practice.

**Fig 2. 45th Postoperative craniocaudal radiograph**
- Implants in position with evidence of primary healing
Open reduction and internal fixation with linear locking compression plates

REFERENCE


