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RESEARCH ARTICLE

Comparative evaluation of point contact fixator plate system and locking compression plate for femoral and tibial fracture repair in dogs

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This study evaluated the efficacy of Point Contact Fixator (PC-Fix) and Locking Compression Plate (LCP) systems in managing diaphyseal fractures in dogs. Twelve dogs with femoral or tibial fractures were randomly assigned to two groups and monitored for 60 days using clinical, radiographic and biochemical assessments following open reduction and internal fixation (ORIF). Group I (PC-Fix) showed slightly earlier functional recovery, with weight-bearing by day two, compared to day three to eight in group II (LCP). Radiographs revealed progressive callus formation and complete fracture gap closure by day 60 in both groups. Serum alkaline phosphatase, calcium and phosphorus levels showed no significant differences. Postoperative complications were minimal, with one revision surgery required in the PC-Fix group. Both implants effectively stabilized fractures and promoted healing, although LCP offered superior angular stability and consistent outcomes. Findings affirm the clinical viability of both systems in veterinary orthopaedic practice.

Keywords: Dog, Fracture, Locking Compression Plate, PC-Fix, ORIF

Fractures in companion animals, especially dogs, are a major orthopaedic concern, with increasing incidence due to urbanization and road traffic accidents. High-energy trauma commonly affects long bones, with the femur most frequently involved, followed by the tibia-fibula. These injuries significantly impair mobility and quality of life, and inadequate management can lead to complications such as non-union, osteomyelitis and chronic lameness (Sumiran *et al.*, 2021). Effective treatment requires anatomical reduction, stable fixation, preservation of vascular supply, and early mobilization, as emphasized in the AO/ASIF principles (Perren, 1991). Plate osteosynthesis is widely used for diaphyseal fracture repair, but traditional plates may compromise periosteal circulation because of extensive bone contact. To overcome this, the Point Contact Fixator (PC-Fix) and Locking Compression Plate (LCP) were developed (Haas *et al.*, 2001). PC-Fix reduces bone-plate contact to maintain vascularity, while LCP systems provide angular stability through locking screws, improving fixation in comminuted or complex fractures (Roberts *et al.*, 2007). Despite their clinical popularity, there is limited direct comparative evidence on their outcomes in veterinary patients. Comparing them highlights how biological versus mechanical fixation strategies perform in canine bone healing. This study addresses that gap by evaluating and comparing the clinical, radiographic and biochemical performance of PC-Fix and LCP implants in canine femoral and tibial fractures, with the aim of supporting evidence-based implant selection and enhancing surgical outcomes.

Materials and Methods

This clinical study was conducted at the Department of Veterinary Surgery and Radiology, Veterinary College, Bidar, to compare the efficacy of point contact fixator (PC-Fix) and locking compression plate (LCP) systems in the treatment of long bone fractures in dogs. Twelve dogs presented with femoral or tibial fractures were randomly assigned to two groups (n=6 each). Group I underwent fracture repair using PC-Fix plates, while group II received LCP fixation. All procedures followed open reduction and internal fixation (ORIF) protocols using either 2.7 mm or 3.5 mm implants. Ethical approval was obtained from the Institutional Animal Ethics Committee (VCB/IAEC/VSR-53/2024-25), and informed consent was secured from all the owners. Details on age, breed, sex, etiology, type of fracture and treatment are given in table I.

Clinical signs such as swelling, crepitus, pain and limb non-weight-bearing were recorded (Fossum, 2013). Radiographic evaluation included medio-lateral and cranio-caudal projections to determine fracture configuration and implant dimensions. Screw length and plate size were estimated using contralateral limb measurements (Guiot and Dejardin, 2012).

Pre-operatively, food and water were withheld for 12 hr and 6 hr, respectively. The surgical site was prepared aseptically. Inj. ceftriaxone-tazobactam (20 mg/kg body weight, i.v.) and inj. tramadol (2 mg/kg, i.v.) were administered 30 min before the induction of anaesthesia. Premedication included atropine sulphate (0.045 mg/kg, i.m.) followed by xylazine HCl (1 mg/kg, i.m.). Anaesthesia was induced with propofol (3 mg/kg, i.v.) and maintained with 2-2.5%

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Table I: Signalment, fracture details and treatment adopted in dogs.

Groups	Case No.	Breed of dog	Sex	Age (m)	Aetiology of fracture	Bone affected	Type of fracture	AO classification	Details of implant used	Details of screws used
Group-I PC-Fix	1	Mongrel	M	5	Automobile accident	Left femur	Comminuted mid-diaphyseal	32C3	6-hole, 2.7 mm	14 mm-2,16 mm-2 and 18 mm-1
	2	Labrador Retriever	M	4	Automobile accident	Left tibia	Long oblique mid-diaphyseal	42A2	8-hole, 3.5 mm	18 mm-3 and 20 mm-2
	3	Mongrel	F	8	Hit injury	Right tibia	Transverse mid-diaphyseal	42A3	8-hole, 3.5 mm	16 mm-5 and 18 mm-2
	4	Mongrel	F	5	Hit injury	Right femur	Transverse proximal diaphyseal	32A3	6-hole 2.7 mm	16 mm-2, 18mm-1, 20mm-1 and 22 mm-1
	5	Mongrel	M	8	Automobile accident	Right femur	Comminuted mid-diaphyseal	32C3	11-hole, 3.5 mm	20 mm-3, 22 mm-2, 24 mm-1 and 26 mm-2
	6	Mongrel	F	6	Hit injury	Right femur	Short oblique distal diaphyseal	32A2	6-hole, 2.7 mm	18 mm-3, 20 mm-1 and 22 mm-1
Group-II LCP	1	Mongrel	M	5	Hit injury	Right tibia	Transverse mid-diaphyseal	42A3	6-hole, 2.7 mm	14 mm-5
	2	Mongrel	M	4	Automobile accident	Left femur	Transverse proximal diaphyseal	32A3	6-hole, 2.7 mm	16 mm-3, 18 mm-2 and 22 mm-1
	3	German Shepherd	M	5	Fall from staircase	Right femur	Transverse mid-diaphyseal	32A3	6-hole, 2.7 mm	16 mm- 2,18 mm-1 and 20 mm-2
	4	Mongrel	F	11	Dog bite	Right tibia	Comminuted mid-diaphyseal	42C3	7-hole, 3.5 mm	18 mm-3 and 20 mm-2
	5	Pomeranian	M	8	Hit injury	Right tibia	Transverse mid-diaphyseal	42A3	6-hole, 2.7 mm	14 mm-2 and 16 mm-3
	6	Mongrel	F	7	Automobile accident	Right femur	Long oblique/spiral mid-diaphyseal	32A2	8-hole, 3.5 mm	20 mm- 2, 22 mm-2, 24 mm-1 and 26 mm-1

isoflurane in oxygen. Intubation was performed post-induction using appropriately sized endotracheal tubes.

The dogs were positioned in lateral recumbency after the hanging limb technique for surgical site preparation. Femoral fractures were approached via a cranio-lateral incision, exposing the shaft through dissection of tensor fascia lata, and separating the biceps femoris and vastus lateralis muscles. Tibial fractures were accessed medially, preserving neurovascular structures and retracting muscles to expose the shaft. Fracture fragments were anatomically reduced and stabilized using either PC-Fix or LCP with appropriate screw configurations. Closure was performed in layers using polyglycolic acid and polyamide sutures. Standard orthopaedic instruments were used for the surgical fixation. Implants included 2.7 mm and 3.5 mm PC-Fix and LCP plates with 6- to 11-hole configurations and non-locking and locking screws ranging from 14 to 26 mm.

Postoperative management included daily intravenous injection of ceftriaxone-tazobactam (20 mg/kg) for seven days and tramadol (2 mg/kg) for three days. Dressings were changed every other day and sutures were removed on day 14. Controlled leash walks and passive range-of-motion exercises were advised for four to six weeks.

Clinical evaluations were performed on days 0, 15, 30, 45 and 60 postoperatively to assess weight-bearing and implant stability. Functional limb usage was graded using the scoring system described by Fox *et al.* (1995) and lameness was scored as per Vasseur *et al.* (1995). Radiographic healing was assessed based on callus formation, fracture line visibility and union status (Pozzi *et al.,* 2012). Biochemical parameters (alkaline phosphatase, calcium and phosphorus) were measured preoperatively and on postoperative days 0, 15, 30, 45 and 60 using standard diagnostic kits. Intra-operative and postoperative complications were recorded for all dogs. Student's *t*-test was used to analyze biochemical data (Snedecor and Cochran, 1994). Qualitative variables were evaluated using a scorecard method. A P-value < 0.05 was considered statistically significant.

Results and Discussion

Among the 12 dogs, mongrels constituted 75%, followed by Labrador Retriever, German Shepherd and Pomeranian breeds (each 8.33%). This breed distribution aligns with findings of Radha *et al.* (2023), who reported higher fracture incidence in mongrels due to their semi-domesticated lifestyle. Male dogs (58.33%) were more frequently affected than females (41.67%), consistent with the findings of El-shaffey *et al.* (2022). The age range was 4–11 months, with 58.33%

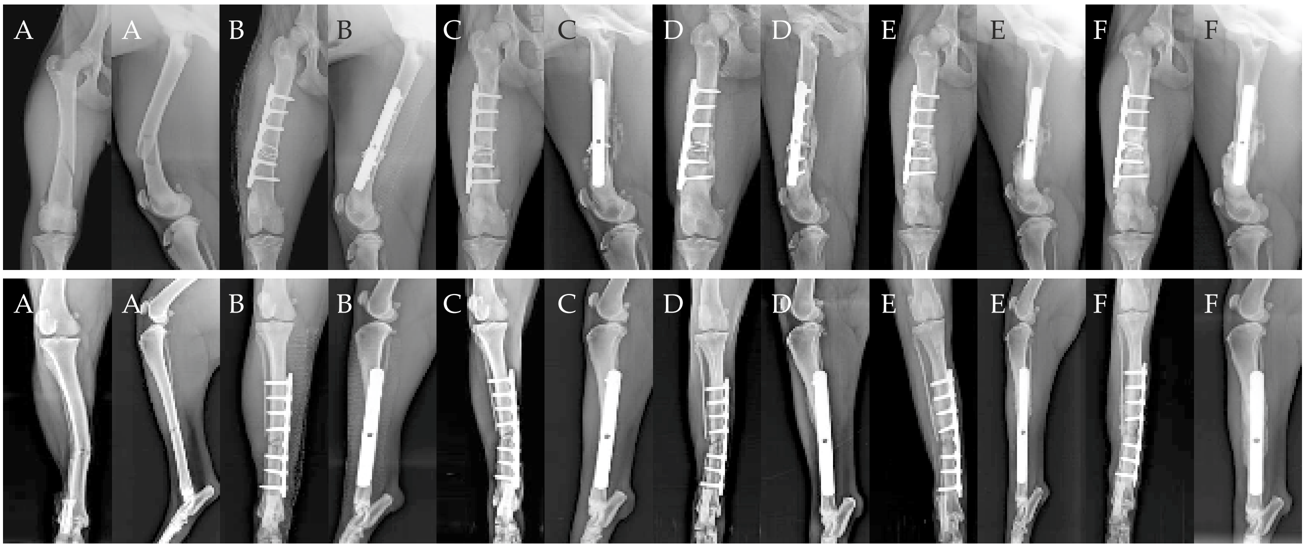

Fig. 1: Cranio-caudal and medio-lateral radiographs of group I (PC-Fix; Case 6 with femur fracture and Case 3 with tibial fracture) with before surgery (A), immediately after surgical fixation (B), and on postoperative days 15 (C), 30 (D), 45 (E) and 60 (F), showing progressive healing with bridging callus formation.

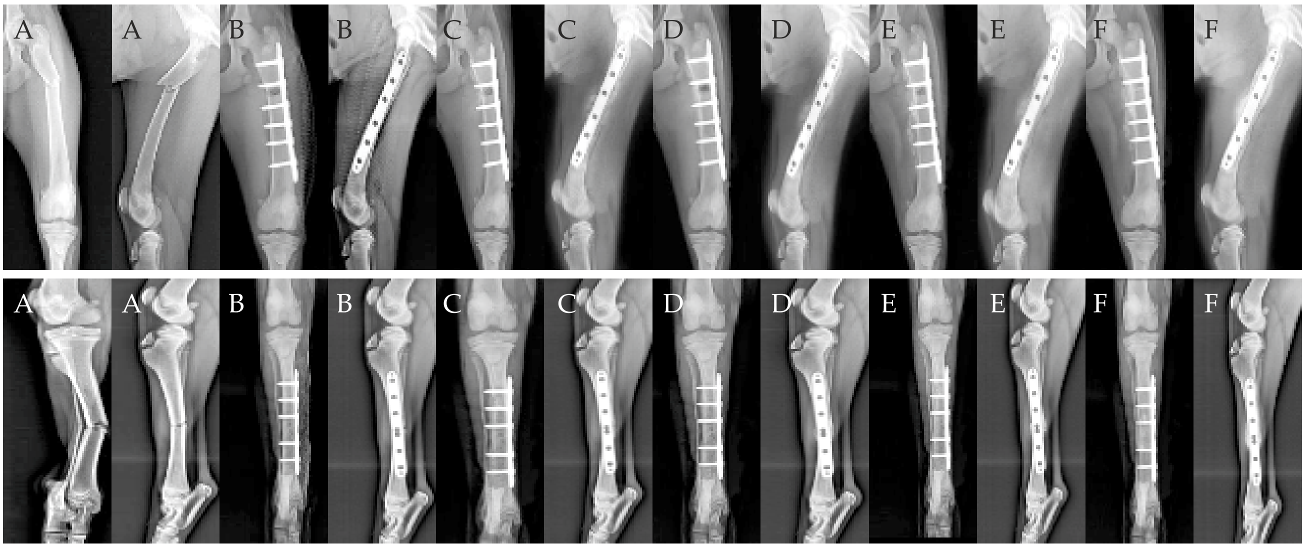

Fig. 2: Cranio-caudal and medio-lateral radiographs of group II (LCP; Case 2 with femur fracture and Case 1 with tibial fracture, before surgery (A), immediately after surgical fixation (B), and on postoperative days 15 (C), 30 (D), 45 (E) and 60 (F), showing progressive healing with bridging callus formation.

of fractures occurring in puppies under 6 months, validate the vulnerability of younger dogs for fractures as noted by El-Shafey *et al.* (2022). Automobile accidents and hit injuries were the leading causes (41.67% each), as also reported by Singh *et al.* (2015).

Clinical signs included acute pain, swelling, crepitus and non-weight-bearing lameness. Radiographic evaluation revealed transverse (50%), comminuted (25%) and oblique (25%) fractures. AO classification guided implant selection. These findings are consistent with Pozzi *et al.* (2012), who emphasized the importance of orthogonal imaging in fracture planning.

In group I, PC-Fix plates (2.7 mm and 3.5 mm) provided effective stabilization, with five out of six dogs showing uneventful healing. One case (Case No. 5) experienced plate bending, requiring revision surgery. The undercut design of PC-Fix plates, which preserves periosteal blood flow, may have contributed to early healing (Tepic and Perren, 1995). In group II, LCPs demonstrated consistent implant stability across all dogs, with no complications. The fixed-angle construct of LCPs enhanced stress distribution and angular stability, supporting the findings by Zhao *et al.* (2021).

Functional recovery was assessed using Fox *et al.* (1995) criteria. By day 60, all dogs in both groups achieved excellent limb usage. In group I, recovery was slightly delayed in Case 5 due to implant failure, while group II showed uniform progression. Mean functional scores improved significantly over time, with group I reaching excellent status by day 45 and group II by day 30 itself. These outcomes align with Khan *et al.* (2022) who reported similar recovery timelines with rigid fixation systems. Group I demonstrated slightly earlier functional recovery, with weight-bearing initiated by day two, compared to day three to eight in group II.

Lameness graded as per Vasseur *et al.* (1995) showed that preoperatively, five dogs in group I and all dogs in group II exhibited grade V lameness. By day 60, all dogs in both groups reached grade I. Group I showed a mean lameness score reduction from 4.67±0.33 to 1.00±0.00, while group II improved from 5.00±0.00 to 1.00±0.00. These improvements reflect effective fracture stabilization (Schwandt and Montavon , 2005).

Radiographic healing

Radiographs revealed progressive callus formation and fracture line obliteration. Radiographs made immediately after surgery revealed accurate placement of plates and screws with satisfactory alignment of fracture fragments. No callus formation was observed, fracture lines remained sharply defined. Implant and bone segment stability were evident in all dogs.

On day 15, bridging periosteal callus was evident in 4 dogs, 2 showed trace callus in both groups. Fracture margins became less distinct, periosteal reaction was observed indicating early healing. Similar findings were reported by Pedrotti *et al*. (2006), early callus formation suggested active osteoblastic response.

By day 30, five dogs exhibited clear bridging callus, one showed early trabeculae formation in group I. Fracture gaps reduced, implant stability remained intact. In group II, bridging callus had formed in five dogs, and implant stability along with fracture fragment positioning was satisfactory in all six dogs.

Radiographic assessment on the 45th postoperative day revealed, bone trabeculae spanned fracture sites in four dogs, bi-cortical callus in two. Three dogs showed complete obliteration of the fracture line, earning a radiographic grade of one in group I, in line with findings by Jeon *et al.* (2020). In group II, trabecular bone bridging the fracture line was observed in four of the dogs, indicating progressive healing. In five dogs fracture line was barely appreciable.

Radiographic assessment on the 60th postoperative day revealed, the absence of radiolucent line suggesting obliteration of fracture line in four dogs of group I. Additionally, bone trabeculae were observed traversing the fracture site in two dogs. Radiographic examination in group II revealed ongoing callus development indicative of bone healing in all six dogs. Four cases showed a uniform bone structure with no visible fracture line, while trabecular bone formation crossing the fracture site was evident in remaining subjects. These findings correspond with earlier reports by Pedrotti *et al.* (2006) and Raidurg (2016).

Group I demonstrated earlier periosteal reaction and trabeculae formation, possibly due to reduced bone contact with PC-Fix plates. These findings are consistent with Pedrotti *et al.* (2006) who emphasized the role of biological osteosynthesis in early healing.

Biochemical parameters

Serum alkaline phosphatase peaked preoperatively and declined by day 30, with a slight rise on day 60, remaining within physiological limits in both groups. This trend supports the observations of Patil *et al.*(2017), indicating active osteoblastic activity during healing. Serum calcium and phosphorus levels followed similar patterns in both groups, peaking on day 30 and declining thereafter, consistent with Bidari et al. (2023).

Complications

No intra-operative complications were observed. One postoperative complication of plate bending (Case 5, group I) was probably attributed to excessive activity and inadequate post-surgical care. Revision surgery with a plate-rod construct restored stability. Group II had no complications, highlighting the reliability of LCP systems.

In conclusion, PC-Fix implants, with their reduced bone contact and preservation of periosteal blood flow, facilitated slightly earlier functional recovery. In contrast, LCP systems provided superior angular stability and consistent healing outcomes. The results advocate for a tailored approach to implant selection based on fracture characteristics, patient size and biological considerations, thereby contributing to evidence-based advancements in small animal fracture management.

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