



Advanced locking plate system (ALPS) for the management of radius and ulna fracture in dogs – Clinical and radiographic study[#]

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Abstract

The study was conducted on six dogs presented to the Teaching Veterinary Clinical Complex and University Veterinary Hospital, Mannuthy, and University Veterinary Hospital, Kokkalai, with fractures of the radius and ulna. Preoperatively, fractures were diagnosed based on orthopaedic and radiographic examinations. Fracture stabilisation with open reduction and internal fixation was performed in all the six dogs following standard AO principles, using 2.7 mm and 3.5 mm Advanced Locking Plate System (ALPS) plates with locking screws. Radiographic evaluation revealed periosteal callus formation from the second postoperative week onwards, which progressed to endosteal response and cortical bridging by the sixth to eighth postoperative weeks. Obliteration of the fracture line and radiographic union were evident by the eighth postoperative week in five cases with stable fixation. One case showed implant failure due to plate breakage at the sixth postoperative week, resulting in instability and delayed healing. The ALPS construct provided rigid stabilisation, maintained anatomical alignment, and promoted fracture healing, facilitating early functional limb use in dogs with fractures of the radius and ulna.

Keywords: Advanced locking plate system, dogs, radius and ulna fracture

Fractures of long bones are among the most frequently encountered orthopaedic injuries in dogs (Mathai et al., 2016; Joshi et al., 2022; Sriharsha et al., 2024). Proper diagnosis and appropriate application of fixation techniques greatly influence the quality of fracture healing and the restoration of early ambulation. The primary goal of fracture management is to achieve anatomical alignment and stable fixation until physiological bone healing re-establishes structural integrity (Venkateswaralu, 2006; Mathai, 2015). Open reduction and internal fixation (ORIF) remains the preferred method for achieving accurate reduction, rigid stabilisation, and early functional recovery as recommended by Ganesh et al. (2004) and Joshi et al. (2021).

The evolution of plating systems in veterinary orthopaedics has focused on improving both mechanical stability and biological preservation. Conventional plates such as the Dynamic Compression Plate (DCP) provided rigid fixation but caused excessive plate–bone contact, compromising periosteal blood supply. Subsequent developments, including

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the Limited Contact Dynamic Compression Plate (LC-DCP) and the Locking Compression Plate (LCP), reducing bone contact and introduced fixed-angle stability between the screw and plate, functioning as an internal fixator (Barnhart & Maritato, 2019). Despite these advancements, limitations such as increased stiffness, implant bulk and restricted contour adaptability persisted in small-animal orthopaedics.

The Advanced Locking Plate System (ALPS) represents a refinement of locking plate technology specifically designed for veterinary use. The system incorporates a low-profile plate, purely locking holes and a point-contact plate to bone interface, thereby minimising periosteal disruption while maintaining angular stability (Guerrero, 2018). These design features reduce implant stiffness, enhance fatigue resistance and allow minimally invasive application. The concept promotes biological osteosynthesis by preserving vascular integrity and optimising the mechanical environment for bone healing (Beierer & Glyde, 2013).

Previous clinical reports have documented favourable outcomes following the use of ALPS for the stabilisation of long bone fractures in dogs and cats, demonstrating reliable fixation, minimal complications and satisfactory radiographic union (Guerrero et al., 2014). However, literature on the clinical evaluation of ALPS in dogs remains limited. The clinical, radiographical, and functional outcomes of radius and ulna fracture repair using the Advanced Locking Plate System (ALPS) have been placed on record in detail.

Materials and methods

The study was conducted in six clinical cases of fracture of radius and ulna in dogs presented to University Veterinary Hospital with the objective of evaluating the efficacy of advanced locking plate system (ALPS) for the repair of radius and ulna fractures. All the dogs presented with symptoms like swelling, pain on manipulation, non-weight bearing, abnormal angulation, lameness and crepitation of the affected limb were subjected to detailed clinical and orthopaedic evaluation including grading of lameness (Sumner-Smith, 1993) grades of weight bearing (Vasseur et al., 1995) functional outcome (Fox et al., 1995) and radiological examination. Six dogs confirmed with fractures of radius and ulna were included in the study. These dogs were subjected to open reduction and internal fixation using advanced locking plate system.

Pre-operatively all the dogs were administered with tramadol hydrochloride at the dose rate of 2.0 mg/kg body weight intramuscularly and the limb was temporarily immobilised with Robert Jones bandage to reduce soft tissue oedema resulting from the injury and maintained until the day of surgery. Food and water were withheld for 12 hours prior to surgery. General anaesthesia was

induced with atropine at the dose rate of 0.045 mg/kg bodyweight and xylazine at the dose rate of 1.0 mg/kg body weight given intramuscularly as pre-anaesthetic medication, induction with ketamine at the dose rate of 5.0 mg/kg bodyweight intramuscularly and midazolam at the dose rate of 0.1 mg/kg bodyweight intramuscularly and anaesthesia was maintained with isoflurane at 2 to 3 per cent in oxygen (Prabhukumar et al., 2019; Prabhukumar et al., 2020). Ceftriaxone was administered at the dose rate of 30 mg/kg body weight intravenously, 30 minutes prior to the skin incision.

Surgical site was prepared in routine manner and hanging limb technique was employed for 15 minutes to effect traction and counter traction. After exposing the fracture site, reduction of fracture fragments and stabilisation were done with advanced locking plate system. The plates were applied along the cranial surface of the stabilised bone fragments of radius, a locking drill sleeve was then inserted and the holes were drilled with battery operated drill using a 2.0 mm drill bit for 2.7 mm screws or a 3 mm drill bit for 3.5 mm screws. The length of the screws were determined by measuring the thickness of the bone from the pre-operative radiographs and were confirmed during the surgical procedure using a depth gauge. A minimum of three self-tapping locking screws of suitable size (2.7 mm or 3.5 mm), appropriate for the selected plate, were inserted into each bone fragment

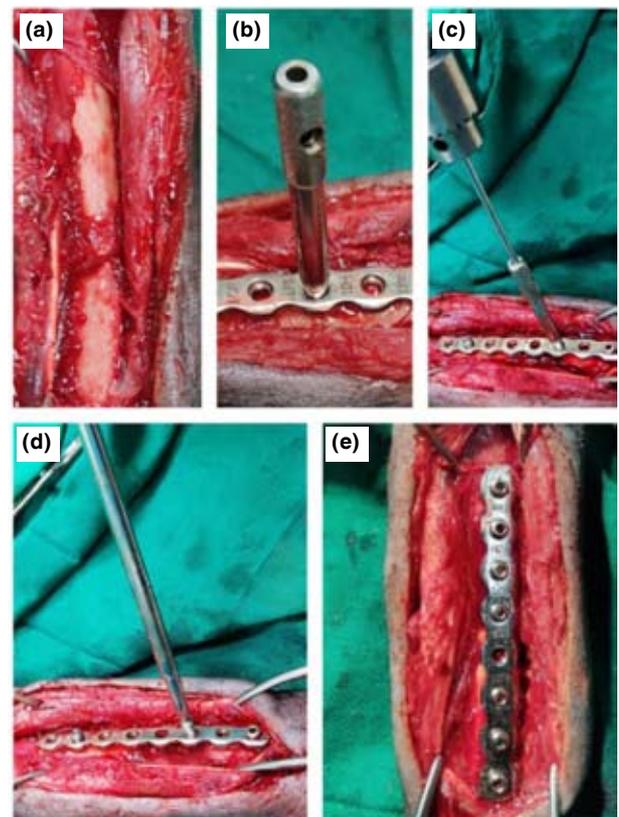


Fig. 1: Surgical procedure— Exposure and reduction of fracture (a), Application of drill sleeve (b), Drilling of holes (c), Fixation of screws (d), Cranial application of

(proximal and distal) on either side of the fracture without encroaching on the fracture line. Screw lengths ranged from 12 mm to 18 mm, based on the measured bone thickness at each screw site. Finally, all screws were tightened to ensure rigid fixation of the plate to the fractured bone. The muscle and fascia were closed with polyglactin 910 (size-0) sutures in simple continuous suture pattern and skin was apposed using skin staples (Fig. 1).

Antiseptic dressing of surgical wound was done with 5% povidone iodine solution and the limb was immobilised with plaster of Paris cast for a period of two weeks as recommended by Syam et al. (1997). Antibiotic therapy with cephalexin at the dose rate of 30 mg/kg body weight was given twice daily orally for seven consecutive days and carprofen was given at the dose rate of 4.0 mg/kg body weight once daily orally for three days. Skin staples were removed on 14th post-operative day. The clinical, orthopaedic and radiographic observations were recorded pre-operatively, on day of surgery after recovery from anaesthesia and on second, fourth, sixth and eighth post operative weeks.

Results and discussion

The age of the dogs ranged from 1-9 years and the body weight of the dogs ranged from 13 to 34 kilogram. Four of them were male and two were female. The breeds of dogs studied were Labrador retriever (2), Chippiparai (1), non-descript (1), Tibetan terrier (1) and Siberian husky (1). The exciting causes of fracture were automobile accident (3), jumping from a height (2) and dog bite (1). The interval between the fracture inducing trauma and the presentation for treatment varied from one to five days (Table 1).

Four dogs (66.7 per cent) were affected in the right forelimb and two dogs (33.3 per cent) in the left forelimb. Transverse fractures (midshaft) were the most common configuration observed along with comminuted fractures, consistent with previous reports identifying this pattern as the predominant type in canine radius and ulna fractures (Bidari et al., 2023).

The symptoms like non-weight bearing lameness, unable to place the foot on the ground, abnormal mobility of the limb, oedema, pain and crepitation on palpation of the affected limb were observed on the day of presentation. Preoperative orthogonal radiographs were used to

classify the fractures, plan the treatment approach and assess prognosis. Contralateral limb radiographs were obtained to determine bone length, implant size and screw requirements. Dinesh et al. (2008), Shales (2008) and Padmanabhan et al., (2025) emphasised the importance of obtaining radiographs promptly after stabilisation using orthogonal projections, while comparative imaging of the opposite limb aided in accurate surgical planning. Langley-Hobbs (2003) recommended radiographs of the contralateral limb for comparison, providing valuable information on bone shape, size and alignment. Orthogonal projections, including mediolateral and craniocaudal views, were preferred for accurate diagnosis of fracture configuration and for preoperative planning, as suggested by Suresh et al. (2017).

All the six dogs weighed more than 12 kg, and consequently a 3.5 mm ALPS plate was used in five cases. In one dog, a 2.7 mm ALPS plate was selected due to the relatively smaller bone diameter observed on preoperative radiographs, which ensured a more accurate anatomical fit. The weight of the animal and the bone length measured from preoperative radiographs were the principal criteria for selecting the appropriate plate size. Previous studies on other locking plate systems, such as the Locking Compression Plate (LCP), have applied similar selection criteria based on bone size, length and body weight (Gopinathan et al., 2021).

Postoperative radiographic imaging confirmed satisfactory anatomical alignment and fracture apposition in all the dogs, with stable fixation maintained throughout the study period, except in one dog, where plate breakage at the sixth postoperative week disrupted healing progression. The ALPS constructs permitted early radiographic evidence of biological activity, with periosteal callus formation apparent by the second postoperative week in most dogs and progressing to endosteal response and cortical bridging by weeks six to eight (Fig. 2) as described by Inauen et al., 2009, Syam et al., 2012, Guerrero et al., 2014, Antabak et al., 2015 and Nojiri et al., 2015.

All the dogs were severely lame at the time of presentation. Immediately after surgery, the lameness scores remained similar due to postoperative discomfort. Progressive improvement was observed from the second postoperative week onwards, with five dogs showing

Table 1: Signalment of the selected cases

| Case | Age | Sex | Body weight | Breed | Exciting cause |
|---------|------|--------|-------------|--------------------|-----------------------|
| Dog-I | 9yrs | Male | 34 kg | Labrador Retriever | Fall/Jump |
| Dog-II | 1yr | Female | 13 kg | Chippiparai | Fall/Jump |
| Dog-III | 2yrs | Male | 13.5 kg | Non-Descript | Road Traffic Accident |
| Dog-IV | 6yrs | Female | 15 kg | Tibetan Terrier | Road Traffic Accident |
| Dog-V | 3yrs | Female | 16 kg | Siberian Husky | Dog bite |
| Dog-VI | 4yrs | Male | 24 kg | Labrador Retriever | Road Traffic Accident |

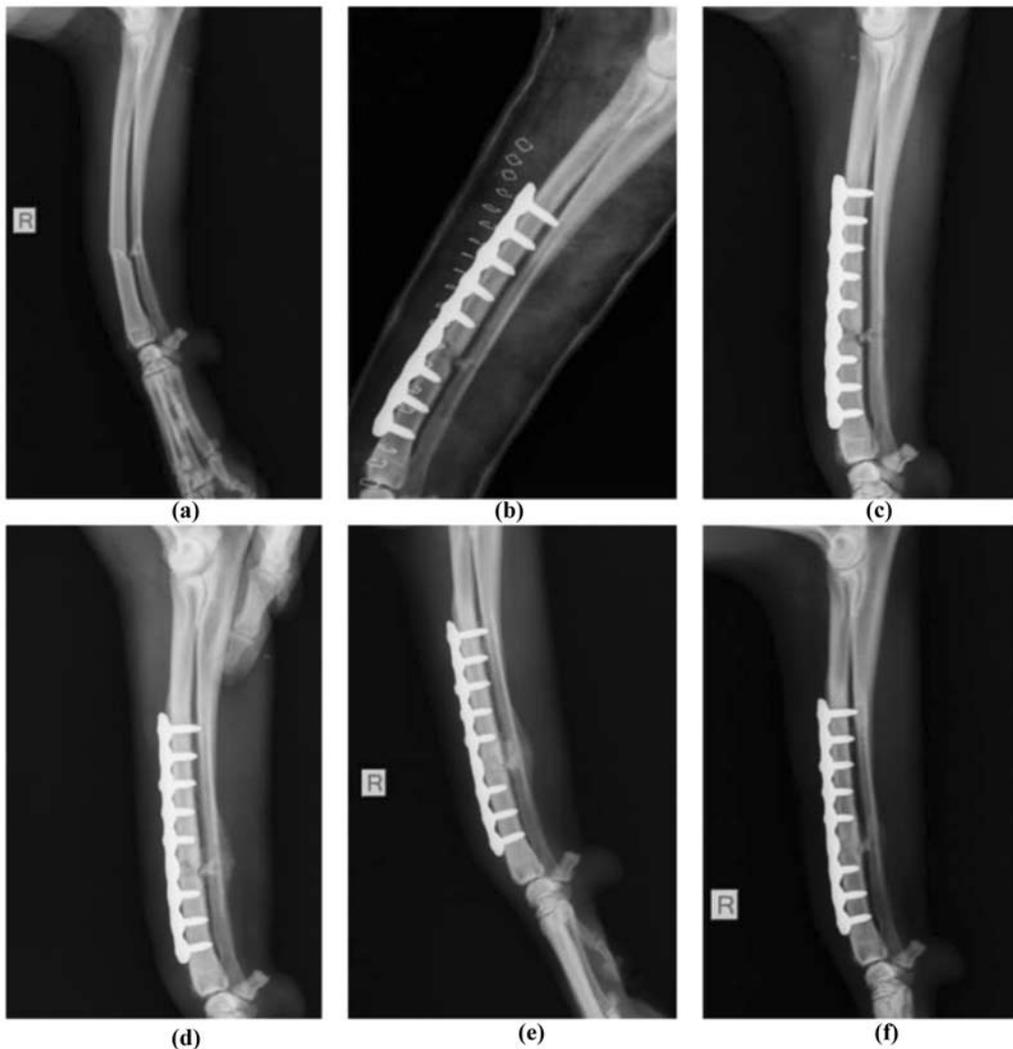


Fig. 2: Radiographs of dog-I taken preoperatively (a), post-fracture fixation (b), 2nd (c), 4th (d), 6th (e), and 8th (f) postoperative week showing stable fixation and progressive healing

mild lameness while walking and one dog showed mild lameness only at a slow trot. By the fourth postoperative week, all dogs demonstrated further improvement, and by the sixth week, five dogs had attained near-normal gait, except one dog (Dog-IV), which sustained a fall and suffered implant failure. By the eighth postoperative week, all dogs had achieved a normal gait, except one dog (Dog-IV), which was excluded from further evaluation due to the accidental fall.

All the dogs were unable to bear weight on presentation and immediately after surgery. By the second postoperative week, all the animals showed improvement in the grades. Further progress was evident by the fourth postoperative week, when all the animals regained normal weight bearing. At the sixth postoperative week, all the dogs improved, except one which had sustained a fall during this period. By the eighth postoperative week, all the remaining dogs had regained normal weight bearing, while the dog which had a fall was excluded from further assessment due to implant failure.

Functional outcome was categorised according to Fox et al. (1995). In the present study, most dogs demonstrated progressive improvement in the limb function following stabilisation with ALPS, with outcomes ranging from fair to good during the early postoperative period and reaching excellent by the eighth week. The consistent improvement observed reflected the ability of ALPS constructs to provide rigid fixation, angular stability and preservation of periosteal vascularity, which together promoted early limb use and restoration of function. Comparable findings of progressive recovery and excellent functional outcome have been reported in dogs managed with ALPS fixation (Pooja et al., 2025).

Conclusion

The ALPS system provided stable fixation and satisfactory healing in all the dogs with radius and ulna fractures except one dog. The 3.5 mm plates maintained proper alignment and promoted progressive callus formation with cortical bridging, demonstrating rigid

stabilisation while supporting biological osteosynthesis irrespective of the fracture pattern and fracture site in radius and ulna. The design advantages of the ALPS system, including fixed angle screw and plate locking, reduced plate to bone contact, and a low-profile configuration, contributed to angular stability, preservation of periosteal vascularity, and early limb function.

Conflict of interest

The authors declare that they have no conflict of interest.

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