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Lateral Approach for Distal Articular Fractures of Humerus in Canines-A Review of 4 Cases

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ABSTRACT

Background: Humeral condylar fractures have fracture lines that extend through the joint surface and through one or both epicondyles or epicondylar crests, or into the distal shaft. Addressing the distal articular Humeral fractures in dogs through lateral approach by using positional transcondylar screws.

Methods: A total of four cases of dogs with different age groups, breeds and sex with fore limb lameness caused due to trauma were included in the study. Clinical and standard radiological examination of all revealed intercondylar fractures with reduced range of motion where the fracture of the condyle extending from the articular surface. After preoperative evaluation all the animals were subjected to surgical reduction by lateral approach under general anaesthesia using positional transcondylar screws (n=2) with or without K-wires in cross fashion (n=2). This approach avoided the necessity of olecranon osteotomy and triceps tenotomy with their associated complications

Result: Excellent limb utility was obtained during postoperative period by clinical and radiographical grading system. To conclude, the use of fully threaded cortical screws was found effective for surgical management of distal humeral condylar fractures in dogs via lateral exposure.

Key words: Condylar fractures, Humerus, K-wires, Positional transcondylar screws, Range of motion.

INTRODUCTION

The humerus is a unique bone due to its shape and forms the skeleton of the arm. It is the least commonly affected long bone for fractures in canines. Low incidence of these fractures combined with the unique anatomy makes correction challenging (Denny, 1983). Almost half of the humerus fractures occur in the distal aspect and most of them are comminuted (Cardona *et al*, 2015). Fractures of the humeral condyle are common and divide into the lateral, medial and intercondylar condyles. Intra-articular fractures in young growing animals involve the distal humerus growth plate and are more commonly classified as Salter-Harris type IV (Perry *et al,* 2015). A study reported that the condylar fractures are most commonly occurring event in dogs, accounting for 41% of cases out of which majority occurs in lateral side followed by medial condyle. The intracondylar (T-Y) fractures represent 25.9% to 35% is also one among them. Reduction of condylar fractures can be challenging, especially it involves articular surface, which results in residual lameness and reduced range of elbow joint motion with osteoarthritis (Rorvik, 1993). They require immediate surgical stabilization which in turn led to medial elbow subluxation and joint deformity (Denny and Butterworth, 2000). In addition to these, the most commonly encountered complications of elbow affections are elbow arthrosis, non-union, fixation failure, seroma formation and infections (McCartney *et al,* 2007). Various surgical techniques have been recommended to address these fractures which includes transcondylar lag screws, K-wire fixation, bone plates and screws (Perry *et al,* 2015). Different approaches like olecranon osteotomy, triceps tenotomy, lateral and medial approach for better visualization and proper anatomical reduction (Anderson *et al,* 1990). The potential complications arising from the osteotomy and tenotomy were premature closure of ulnar growth plate, reduced range of motion and residual lameness (Moores, 2006). The present study was carried out to repair humeral condylar fractures by lateral approach, hence avoiding the need for more difficult procedures such as olecranon osteotomy and triceps tendon tenotomy and simplifying the fixation technique.

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MATERIALS AND METHODS

A total of 4 dogs (A1, A2, A3 and A4) of different of different age, breeds and sex were presented during the year 2021 with a history of acute forelimb lameness to the Department

of Veterinary Surgery and Radiology, College of Veterinary Sciences, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (Table 1). Clinical and radiographical examinations were done prior to surgery to assess the condition of the animal. Under general anaesthesia, surgical stabilization via lateral approach by exposing the condyles, a pointed reduction clamps or forceps were used to hold them together (Fig 2) and the glide hole for the screw fixation was drilled from lateral to medial aspects. A positional transcondylar screws alone or with ancillary fixation techniques (K-wires) were performed and the fracture fragments were reduced. Postoperatively Meloxicam (Inj. Melonex®, Intas Pharmaceuticals Ltd., Ahmedabad) @ 0.2 mg/Kg S/C was administered once a day on day 1 followed by 0.1 mg/kg for 3 days along with I/V administration of Cefotaxime @ 20 mg/kg (Inj.Taxim®; Alkem Laboratories Ltd., India) for 5 days. The surgical outcome was assessed by clinical and radiographical examinations for the functional limb usage.

RESULTS AND DISCUSSION

Mean age of the dogs was 1.2±0.9 (from 0.3 to 4 years) belonging to different breeds Pointer cross, Non-Descriptive, Pomeranian and Labrador Retriever one each. Majority of the animals were males (75%, n=3) while one animal was female. Higher population distribution, aggressive temperament and owners' preference have been attributed to the greater number of male dogs affected (Thilager and Balasubramanium, 1988). The body weights of the animals ranged from 9.3 to 22 kgs (14.9±3.1) and all of them were ideal in their body condition as no visible ribs but palpable with only a slight fat covering, tucked abdominal viewed from laterally and waist present from dorsally along with smooth contour over tail base (Jones, 2006). The major etiological cause for the fracture was road traffic accident (n=2) followed by dog bite (n=1) and fall from height (n=1). Similar incidence was found by Jain *et al*, (2018) in their study. Bardet *et al*, (1983) stated that right humerus was more commonly affected limb which differed from the present study as the left (n=2) and right (n=2) side of the limbs were equally affected. However, all the animals were apparently healthy upon clinical evaluation without any concurrent injuries. Time lapse of the trauma to the day of presentation ranged from 1 to 20 days. The delay was due to the attempt of conservative treatment at local hospitals. In case of articular fractures, delayed fixation and prolonged immobilization resulted in osteoarthritis. This may have directly affected the joint to cause post traumatic osteoarthritis with delay in early stabilization especially the condylar fractures of humerus (Gordon *et al*, 2003).

Clinical evaluation in all the animals showed lameness, pain, crepitus, dropped elbow, dorsally resting paw (neuropraxia) and abnormal angulation of the affected limb with poor limb usage on the day of presentation. A painful soft tissue swelling was noticed in all animals. Proprioception was present in two animals and absent in other two. Olaifa (2018) was of view that the neuropraxia was due to the

Table 1: Signalment, anamnesis, clinical, radiographical, implant details and postoperative assessment.

Sl. No	Age (Years)	Breed	Gender	B.wt. (Kgs)	Etiology	Limb affected	Proprioception	Type of fracture	Screw placements L (mm)	Screw placements W (mm)	Screw placements Total (no's)	Ancillary technique	Regaining proprioception (days)	Regaining Initial weight bearing (day)	Lameness score Grade	Lameness score Day 15	Lameness score Day 30
A1	4	Pointer cross	Male	22	RTA	Left	Absent	13C1	40	4.0	1	Cross pinning	15	15		Poor	
A2	0.4	Non-Descriptive	Female	9.3	Fall	Right	Present	SH type IV	22	2.5	1	-	1	2	Fair	Good	Excellent
A3	0.3	Pomeranian	Male	10	Dog Bite	Left	Absent	SH type III	28	2.7	1	Cross pinning	1				
A4	0.4	Labrador Retriever	Male	18.4	RTA	Right	Present	SH type IV	45	3.5	2	-	2				
	1.2± 0.9			14.9 ±3.1					33.75± 5.29	3.17± 0.34			4.75± 3.42	5.25± 3.25			

A- Animal; B.Wt.- Body weight; (Kgs)- Kilograms; RTA- Road traffic accident; L- Length; W- Width; (mm)- Millimetres; (no's)- Numbers.

compression of the peripheral nerve endings causing neurological deficits by temporary interruption in the transmission of electrical impulses and generally was associated with the humeral and elbow traumas. The muscle trauma and soft tissue swelling from the trauma might have diminished the proprioception reflex (Fossum, 2013). The present study also emphasized the importance in palpation of the elbow swellings, which helped to differentiate joint effusions (fluctuating swelling) from degenerative joint disease (firm and generalized swelling). These signs were most commonly encountered clinical presentation in humerus fractures and elbow joint affections (Simpson, 2004).

The passive range of motion (ROM) included the flexion (62.25±8.29), extension (164.0±6.49) and range of motion (101.75±3.90) of the affected limb and the contralateral limb (Flexion: 33.7±0.85; Extension: 168±0.70; ROM: 134.25±1.54) on the day of presentation (Table 2). There was a highly significant difference noticed between the affected limb and contralateral limb in flexion ($P<0.001$) and range of motion ($P<0.001$). Millis and Levine (2014) found the average flexion between 20° to 40° and extension in between 160° to 170° in healthy canines with no musculoskeletal affections. In the present study, the ROM was reduced preoperatively in the affected limb which might be due to the obvious pain, neuropraxia and the surrounding soft tissue swelling from the trauma. However, the contralateral limb had normal values as there was no concurrent injuries which further used to evaluate the postoperative clinical assessment.

Under general anaesthesia the animal was positioned on lateral recumbency with the fractured limb facing upwards. In the present study rather than olecranon osteotomy and triceps tendon tenotomy a separate lateral approach was employed for the fixation of intercondylar fractures (Fig 1) Mckee *et al*, (2005). Two animals (A2 and A4) with Salter-Harris type IV fractures (Fig 3) in which the fractured lateral condyles were stabilized using a full threaded self-tapping cortical screw alone from lateral epicondyle to medial condyle (Fig 2) as a sole method of fixation to reduce the intercondylar fractures (Fig 6). The soft tissue damage was moderate (50%, n = 2) in these two animals. The other two animals (A1 and A3) with 13C1 (Fig 4) and Salter-Harris type III fractures were stabilized using positional transcondylar screw and augmented with placement of Kirschner wires from the medial and lateral

Table 2: Passive range of motion.

Passive ROM (Degrees)	Contralateral limb	Affected limb	
		Preoperative	Postoperative
Flexion	33.7±0.85^{b}	62.25±8.29^{**a}	40.75±3.19^{b}
Extension	168±0.70	164.0±6.49	157.0±7.03
ROM	134.25±1.54^{a}	101.75±3.90^{**b}	116.25±6.04^{*b}

*Significantly different from contralateral limb values ($P<0.05$); **($P<0.01$); Values with different superscripts differ significantly in a row.

Fig 1: Photograph showing Lateral Skin incision for the exposure of elbow joint.

Fig 2: Application of positional transcondylar Screw from lateral approach.

Fig 3: Preoperative Radiographs showing Salter-Harris type IV fracture.

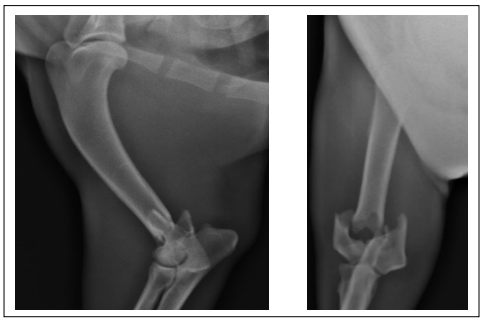

Fig 4: Preoperative radiographs showing 13C1 type fracture.

aspects (Fig 5) of the respective humeral condyles to neutralize the rotational forces. There was a marked soft tissue damage noticed in these two animals. Cook *et al,* (1999) and Guille *et al*, (2004) studied the lateral humeral condyle fractures and managed using antirotational Kirschner wires from the lateral condyle through the lateral epicondylar crest and through the medial cortex of the humeral diaphysis. They also stated that the positional transcondylar screws help to stabilize the intercondylar fractures and provide good interfragmentary compression.

Langley-Hobbs (2012) achieved rigid fixation of the condylar component with a transcondylar screw which creates compression between the fragments. The use of fully threaded cortical screw in the present study was a proposed treatment modality to repair Salter-Harris type IV fractures to reduce the risk of implant-related growth plate trauma (Lewis *et al*., 1991: Lefebvre *et al*., 2008). Screw length was (33.75±5.29 mm) ranged from 22-45 mm and width (3.17±0.34 mm) ranged between 2.5-4.0 mm. The facia and subcutaneous tissues were closed separately with polyglactin 910 of size 2/0 and skin with disposable skin staples. Postoperatively a light padded modified Robert-Jones bandage was applied up to the suture removal which helped to reduce the postoperative swelling of the limb and also protected the surgical site. Similar statement was given by Mckee *et al*, (2005) and which helped to protect the wound. Turner (2005) suggested that the bandage should not be continued more than 2 weeks of postoperative period. DeCamp *et al*, (2016) were of view that postoperative Robert-Jones Bandage could help in preventing seroma formation and postoperative wound dehiscence.

Radiographic healing was evaluated by Hammer *et al*, (1985) grading system in all the animals by recording the callus and stage of union from 2 weeks to 180 days (Fig 9) after surgery. Animals stabilized with transcondylar screws (A2 and A3) showed apparent bridging callus of the fracture line on 15th day (Fig 7) and homogenous bone structure after 30-60 days (Fig 8). Whereas in animals with transcondylar screws along with K-wire (A1 and A4) showed a massive bone trabecula crossing the fracture line on 20th day and homogenous bone structure after 30 days.

The positive proprioception reflex was regained in 4.75±3.42 days and with initial weight bearing at 5.25±3.25 days which ranged from 2 (A2 to A4) to 15 days (A1). The functional limb usage and owner satisfaction were classified into four types which included; Poor- lameness with no weight bearing; Fair-consistent weight bearing with lameness; Good-normal weight bearing with mild lameness upon heavy exercise and Excellent-normal functional limb (Fox *et al*, 1995). Three animals (A2 to A4; 75%) showed fair and one (A1; 25%) animal showed poor limb usage on the day of weight bearing. After 15 to 20 days, good limb usage was noticed in 3 animals (A2 to A4; 75%) and poor in one (A1; 25%). Finally at 25 to 30 days, excellent limb

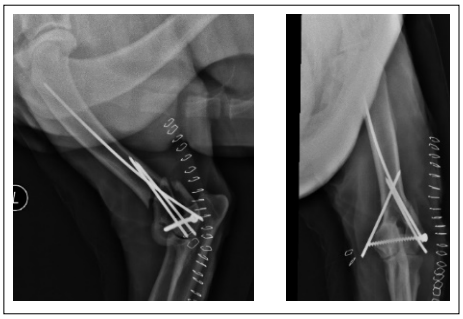

Fig 5: Postoperative Radiographs showing Full threaded Self-tapping cortical screw with cross pinning.

Fig 6: Radiographs showing Full threaded Self-tapping cortical screw for stabilization of transcondylar fracture.

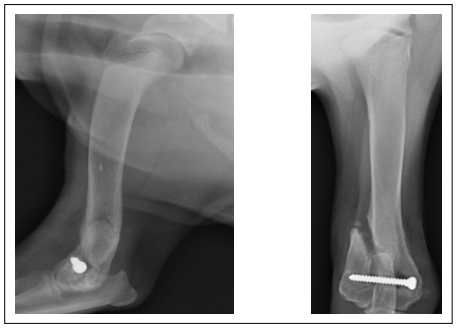

Fig 7: Postoperative radiographs showing the transcondylar screw in position on day 15.

Fig 8: Homogenous bone structure on 60th postoperative day - radiographs.

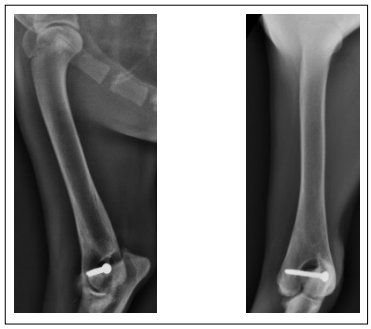

Fig 9: Complete radiographic union after 180 days.

function was seen in 75% (n = 3) and poor in 25% (n = 1) animal. Similar results were reported by Morgan *et al*, (2008) in which more than 70% of the dogs showed excellent functional outcome and 22% having poor outcome. On the contrary, Langley-Hobbs (2012); Vannini *et al*., (1988) stated that majority of dogs with intercondylar fractures involving the articular surface had good functional outcome than excellent recovery along with long term pain and lameness. In present study, positional transcondylar screw placement resulted in better interfragmentary compression and a greater bone screw contact area augmented with K-wires helped an excellent functional outcome which was in agreement with Perry *et al*, (2015) who reported an excellent success rate of intercondylar fractures. Radial nerve paralysis was observed in one animal as a complication in which the animal did not regain the functional outcome of the affected limb even after 30 days of surgery. Perry and Woods (2017) concluded that the vital neurological structures around the bone and joint make its repair very difficult and might have led to permanent radial nerve damage.

The preoperative and postoperative flexion, extension and range of motion values were compared on day 30 within the affected and contralateral limbs (Table 2). Significant ($P<0.05$) reduction was observed between preoperative and postoperative flexion of the affected limb with no significant change in between contralateral and affected limb postoperatively which indicated the normal flexion. The extension angle was 157.0±7.03 with no difference. Preoperative to postoperative ROM values of affected limb was non-significant. However, there was a significant decrease ($P<0.05$) in compared with contralateral limb postoperatively. Vannini *et al*, (1988) also observed an increase in range of motion in condylar fractures after 4 weeks postoperatively. Simpson (2004) observed the full range of motion in intercondylar fractures repaired with positional transcondylar screws and K-wires after 3 weeks postoperatively.

CONCLUSION

Lateral approach without opening the joint was found to be convenient in managing the intercondylar fractures with improving the range of motion and early limb mobility. The use of fully threaded cortical screws was found effective for surgical management of distal articular humeral condylar fractures in dogs with radial nerve paralysis was one of the complications.

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Conflict of interest: None.

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