

## Case Report

# Caudal Elbow Luxation in a Dog Managed by Temporary Transarticular External Skeletal Fixation

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This case report details a caudal unilateral traumatic elbow luxation in a 4-year-old male neutered Labrador following a road traffic trauma. This is a highly unusual injury in the dog. The pathogenesis and successful treatment by closed reduction followed by stabilisation with a temporary transarticular external skeletal fixator are discussed. The dog was assessed at 4 weeks and 6 months after surgery. Findings at 6 months after treatment demonstrated a normal gait with no pain or crepitation. A mild amount of soft tissue thickening around the elbow was noted. The range of motion of the elbow was limited to 45 degrees of flexion and 150 degrees of extension. This is the first case of a traumatic caudal luxation of the elbow in a dog described in the English veterinary literature and the first report of successful management of an elbow luxation in a dog by closed reduction and temporary transarticular fixation.

## 1. Introduction

The elbow consists of the humeroradial, humeroulnar, and proximal radioulnar joints. The elbow joint is regarded as a stable joint as a result of the combination of strong surrounding muscular and ligamentous structures and the presence of the anconeal process which interlocks into the olecranon fossa when the elbow is extended beyond 45 degrees [1–3]. Due to these anatomical features and the nature of the forces that the elbow is most commonly subjected to during trauma, fracture of the distal humerus or proximal radius and ulna is more common than elbow joint luxation in the dog [2–6]. The majority of luxations reported in dogs occur due to road traffic accidents [7, 8]. In over ninety percent of elbow luxations the radius and ulna dislocate laterally relative to the humerus [1–4, 6, 7].

Traumatic elbow luxation in dogs can be managed by either closed or open reduction. Early closed reduction of the elbow has a good prognosis for return to normal function [1, 2]. However, open reduction is indicated if there is marked instability following closed reduction, if there are fractures (avulsion or articular associated with the elbow joint), or if a chronic luxation is present [3]. The goals of an open

procedure, in addition to reduction of the luxation, are to assess the articular surfaces and to reconstruct or replace the collateral support structures. Joint immobilization is indicated following both open and closed elbow reduction techniques [2, 3, 9, 10].

This case report details a caudal unilateral traumatic elbow luxation which is highly unusual in a dog. The pathogenesis and successful treatment by closed reduction followed by stabilisation with a temporary transarticular external skeletal fixator are discussed.

## 2. Case Presentation

A 4-year-old male neutered Labrador weighing 28.4 kg was referred following a road traffic trauma that had occurred several hours earlier that day. First aid involving administration of analgesia and intravenous fluids had been initiated by the referring clinic. Luxation of the left elbow and multiple pelvic fractures had been identified via radiographs taken prior to referral.

On presentation the dog was quiet, alert, and responsive. He was nonambulatory. His mucous membranes were

pale and cardiopulmonary auscultation revealed slightly decreased bronchovesicular sounds. Superficial skin abrasions were noted over the right carpus, over the tarsi bilaterally, and over the craniolateral aspect of the left thigh. Marked bruising was evident over the caudal abdomen and inguinal region. Neurological assessment of the left pelvic limb was indicative of a sciatic nerve deficit; pain sensation was present and the patellar reflex was intact, but there was a reduced withdrawal response. Neurological examination of the left forelimb was unremarkable; pain sensation and a withdrawal response were within normal limits and voluntary motor function in this limb was noted. Pain was elicited on palpation and manipulation of the left elbow and pelvis. Thoracic radiographs demonstrated changes consistent with mild pulmonary contusions. A urinary catheter was placed to assist management of the dog and analgesia was provided by administration of methadone (Dechra, Sansaw Business Park, Hadnall, Shrewsbury, Shropshire, UK) 0.2 mg/kg via intravenous injection every 4 hours.

The following day the dog was premedicated with 0.02 mg/kg acepromazine (Novartis, Frimley Business Park, Frimley, Camberley, Surrey, UK) and 0.2 mg/kg methadone (Dechra, Sansaw Business park, Hadnall, Shrewsbury, Shropshire, UK) via intravenous injection. General anaesthesia was induced with propofol (Abbott Animal Health, Abbott House, Vanwall Business Park, Vanwall Road, Maidenhead, Berkshire, UK) total dose 1.4 mg/kg and maintained with isoflurane (Novartis; Frimley Business Park, Frimley, Camberley, Surrey, UK) in oxygen. Examination at that time revealed that the left thoracic limb appeared shorter than the right and it was maintained in a flexed position. The tip of the olecranon was felt to be displaced caudally relative to the distal humeral epicondyle. Marked swelling, crepitus, and instability of the left elbow joint were evident on palpation and manipulation.

Computed tomography (CT) was performed using a 5th generation helical multislice scanner (Somatom Emotion 16; Siemens Healthcare, Erlangen, Germany) of both elbows, the pelvis, and left femur. CT imaging of the left thoracic limb demonstrated a caudal luxation of the left humeroradial and humeroulnar joints (Figures 1 and 2). The left medial coronoid of the ulna appeared sclerotic and a small fragment was visible at the coronoid consistent with medial coronoid disease. Additionally, pelvic CT revealed comminuted fractures of the right ischium and pubis, separation of the pubic symphysis, and a comminuted left ilial fracture. The right sacroiliac joint was displaced laterally.

The left thoracic limb was suspended from a drip stand for ten minutes prior to attempting closed reduction. The dog's body weight was used to distract the joint. Reduction was achieved by applying further manual traction and gentle supination to the antebrachium (with the elbow in a moderately flexed position) to distract the coronoid process of the ulna from the olecranon fossa. Pressure was applied to the caudal aspect of the olecranon with the other hand. A clunk was felt when reduction of the joint was achieved. Manipulation of the joint after reduction demonstrated a normal range of flexion and extension. Stability was assessed with Campbell's test [11]. Pronation of greater than 60 degrees was

achievable with the elbow and carpus in 90 degrees of flexion and exceeded the angles achievable in the contralateral limb. This finding was suggestive of rupture of the medial collateral ligaments. Further manipulation of the elbow caused it to relaxate caudally. Closed reduction of the left elbow was easily repeatable.

As the left elbow was unstable after closed reduction and the dog had further orthopaedic injuries affecting other limbs, surgical stabilisation of the luxated elbow was indicated. Stabilisation was achieved with application of a type I transarticular external skeletal fixator (SK ESF System; IMEX Veterinary, Inc., Longview, TX, USA). Four, positive profile end threaded 2.5 mm pins were placed laterally into the radius and four 3.2 mm positive profile pins were placed laterally into the humerus. The holes were predrilled with a 2.0 mm drill bit prior to insertion of the 2.5 mm pins and with a 2.5 mm drill bit prior to insertion of the 3.2 mm pins. Pins were connected to a connecting bar with medium SK clamps. The connecting bars of the radial and humeral component of the external skeletal fixator were connected with an IMEX angular hinge. The hinge was locked to prevent motion. Post-operative radiographs confirmed satisfactory pin positioning. Following imaging a triangulating connecting bar was added to the construct spanning from the proximal aspect of the humeral connecting bar to the distal aspect of the radial connecting bar with two SK clamps. Analgesia was provided with topical transdermal fentanyl ("RECUVYRA", Elanco Animal Health, Eli Lilly and Company Limited, Lilly House, Priestley Road, Basingstoke, Hampshire, UK). Pin insertion sites were covered with a protective bandage that was changed daily for three days before being removed.

The dog was taken to surgery 24 hours later to reduce and stabilise the right sacroiliac luxation with a single 3.5 mm/45 mm Synthes cortical screw (Synthes Ltd., Veterinary Division, 20 Tewin Road, Welwyn Garden City, Hertfordshire, UK) sacroiliac lag screw. The left ilial shaft fracture was stabilised with two polyaxial locking cuttable plates (VetLOX reconstruction plates 3.5 mm and 2.7 mm) (VetLOX Freelance Surgical Ltd., Havyat Business Park, Havyat Road, Wrington, Somerset, UK).

Postoperatively the dog was ambulatory on all four legs with sling support. The dog received daily physiotherapy for the pelvic limb injuries. The dog was discharged from the hospital 12 days postoperatively by which time it was ambulatory on all limbs without assistance. The hinge of the transarticular external skeletal fixator was maintained in a fixed position until removal of the frame.

The dog was reexamined four weeks after application of the transarticular external fixator for the luxated left elbow. At this time the dog was bearing weight well on both forelimbs. Some circumduction of the left forelimb was evident during limb protraction, enabling limb usage with immobilisation of the elbow. A moderate amount of serous discharge was noted to be associated with the most proximal pin tract in the humerus. The frame remained stable. A sciatic neuropraxia was still apparent in the left hind limb, with postural deficits and a reduced withdrawal reflex still evident associated with this limb. Pain sensation and motor function, however, remained intact. The radiographs taken

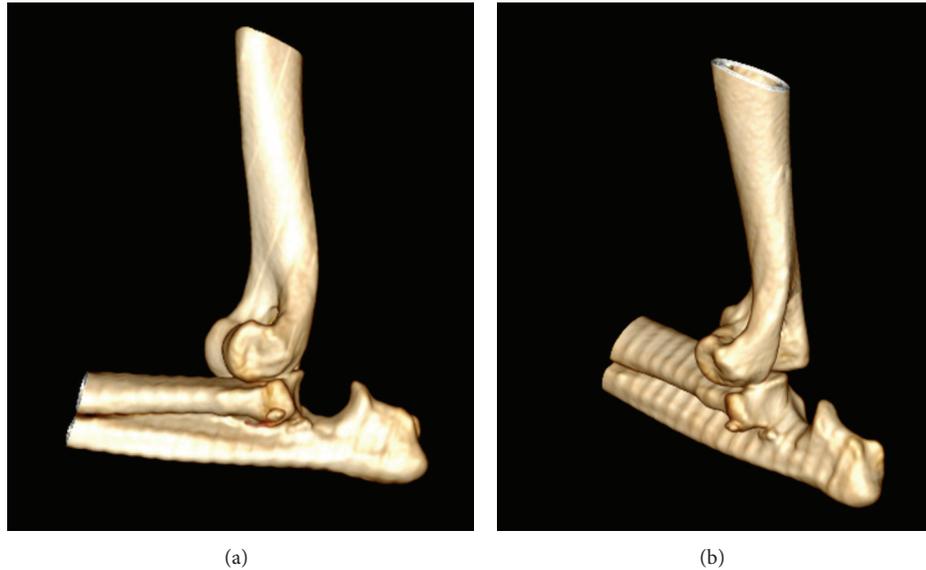


FIGURE 1: (a) CT 3D reconstruction of left elbow viewed from lateral aspect demonstrating caudal luxation of the humeroradial and humeroulnar joint. (b) CT 3D reconstruction of left elbow viewed from caudolateral aspect demonstrating caudal luxation of the humeroradial and humeroulnar joint.



FIGURE 2: Transverse bone algorithm [B60] image of left elbow at the level of the coronoid before reduction demonstrating caudal luxation of the humeroradial and humeroulnar joint. Two well-defined smoothly margined mineral opacities were also noted; measuring approximately 3 mm and 1 mm, respectively, on the caudal lateral aspect of the radius at the level of the medial coronoid process of the ulna. The medial coronoid appears sclerotic and irregularly defined.

at this time confirmed continued successful reduction of the luxated elbow and appropriate alignment (Figure 3) and the frame was removed. At that time the elbow joint range of movement was measured with an orthopaedic goniometer. The range of motion of the elbow was severely reduced. A limit of 90 degrees of flexion and 115 degrees of extension

was present. No crepitus or instability was felt and Campbell's test demonstrated stability of the medial and lateral collateral support. Radiographs of the femoral and pelvic fractures showed that there were no complications associated with the implants and there was evidence of fracture healing. Following removal of the external skeletal fixator, the dog continued to bear weight well on the left thoracic limb despite mild discomfort being elicited on palpation and manipulation of the left elbow. Left elbow passive range of motion exercises were commenced immediately following external skeletal fixator removal. These involved slow flexion and extension of the joint beyond the pain-free range of motion of the elbow to enable stretching of the tissue. The stretch was held for 10 seconds and repeated 10 times per session. The owners were instructed to perform three to four sessions daily. The owners were also advised to continue to rest the dog for a further four weeks (crate rest with ten minutes of short lead exercise three times daily). Following the four weeks of restricted activity the dog's exercise was gradually increased over a further six-week period. At repeat assessment six months after trauma the dog was not lame. Exercise was well tolerated with no requirement for medication. Range of motion of the left elbow was still slightly reduced compared to the other limb but with no pain or crepitation. A mild amount of soft tissue thickening around the elbow was noted. The range of motion of the elbow was limited to 45 degrees of flexion and 150 degrees of extension. Despite identification of medial coronoid disease from the CT imaging at the time of injury, no further treatment was specifically advised relating to this finding as the dog had been asymptomatic prior to the trauma and the pathology identified was subtle. However, if symptoms developed, further assessment would be appropriate.

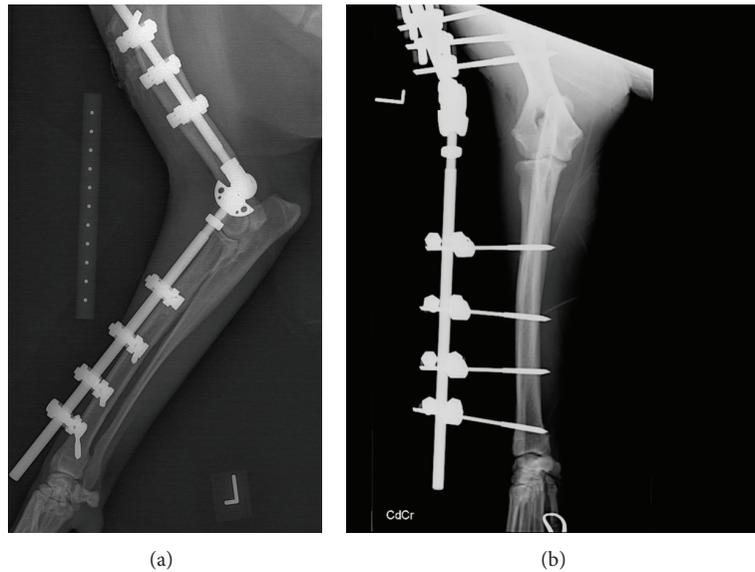


FIGURE 3: (a) Mediolateral radiograph of the left forelimb after reduction and stabilisation of left elbow. (b) Caudocranial radiograph of the left forelimb after reduction and stabilisation of left elbow.

### 3. Discussion

This report describes a polytrauma case in a dog with multiple injuries including a unilateral, caudal elbow luxation. This caudal elbow luxation was successfully stabilised by closed reduction and placement of a temporary transarticular external skeletal fixator. To the authors' knowledge, this is the first case of a caudal luxation of the elbow in a dog described in the English veterinary literature and the first report of management of an elbow luxation in a dog by closed reduction and temporary transarticular fixation.

Caudal luxation accounts for 90% of all elbow luxations in man [12, 13]. It is also extremely common in rabbits and is reported in cats, although lateral luxation is most common in this species [3, 14–16]. Elbow luxation in man, rabbits, and cats is usually the result of a fall or jump from a height (direct trauma) [14, 17, 18]. In man, luxation usually results from a fall onto an extended elbow resulting in compressive forces being directed onto the outstretched hand, the radius, and ulna, along with a valgus force at the elbow, resulting in the common caudolateral or caudal dislocation [14, 19–22]. In cats it is thought that the manner in which the cat lands on its paws determines the direction of luxation [18]. In rabbits, however, it is not clear whether dislocation occurs with the elbow flexed or when it is overextended during impact [23]. Rabbits have good lateral and medial stability of the elbow due to the presence of a well-developed central sagittal ridge of the humeral condyle. This anatomical feature protects the joint from lateral and medial luxation.

Traumatic elbow luxation in dogs is usually the result of road traffic accidents [7, 8]. It is hypothesised that the forces necessary to luxate the elbow in dogs occur when the body of the animal pivots around the flexed elbow during the traumatic event resulting in indirect rotational forces usually contributing to lateral elbow luxation [2, 3, 11].

There is limited lateral elbow joint stability in the flexed position because the anconeal process is not anchored in the olecranon fossa, which allows the humeral condyle to slide craniomedially over the head of the radius. In addition, the articular surface of the medial epicondyle slopes distally and the relatively large size of the trochlea of the humerus prevents medial displacement of the radius and ulna [1–4, 6, 24]. It is hypothesised in this case that at the time of trauma the forces acting through the elbow of this Labrador must have more closely resembled the forces of a fall or a jump and it is also likely that the elbow was in an extended position with the anconeal process engaged within the olecranon, increasing stability in the mediolateral plane. Best clinical results in cases of elbow luxation in dogs are obtained with an acute closed stable reduction [2–5, 7, 11]. Initial attempts of closed reduction were successful in this case; however, further manipulation and assessment identified marked instability and relaxation occurred. Use of a splint to maintain the elbow in extension was felt unlikely to provide adequate stability due to the orientation of the luxation and the dog's multiple orthopaedic injuries. Maintaining extension of the elbow is advantageous in cases of lateral and medial luxation as this optimises lateral stability by enabling interlocking of the anconeal process into the olecranon fossa. This does not however improve caudal stability, which was necessary to prevent relaxation in this case.

Treatment recommendations in man following reduction of simple caudal luxation of the elbow are immobilization with a caudal plaster cast in 90-degree flexion or an initial plaster cast followed by functional treatment in a hinged brace, sling, or pressure bandage, regardless of the degree of ligamentous and muscular damage to the elbow [25, 26]. Similarly, in rabbits use of a Velpau sling after reduction is recommended [14]. The flexed forearm maintains the humerus in a reduced position and relieves tension on

the cranial soft tissues. This was not considered in this case due to the instability identified from Campbell's test; pronation of the elbow was greater than 60 degrees, with the elbow and carpus in 90 degrees of flexion, consistent with complete transection of the medial collateral ligament. In addition fixing the elbow in a flexed position would not be optimal in this polytrauma case with multiple limb injuries as it was felt that the dog would need to bear weight on this leg following surgery due to its compromised pelvic limbs. In dogs when elbow instability remains after closed reduction and/or there is significant instability of either the medial or lateral collateral ligaments, surgical stabilisation is recommended followed by immobilisation [1, 2, 4, 24]. Reported surgical techniques in dogs include reconstruction of the collateral support structures with suture repair or humeral transcondylar and proximal radial and ulnar bone tunnels in combination with adjunct joint immobilisation to allow healing [1, 2, 4, 24]. Described methods of secondary immobilisation to protect the ligamentous repair include splints, transarticular pinning, or use of a modified external skeletal fixator [1–3, 10, 24, 27, 28]. However, application of an external skeletal fixator alone following closed elbow reduction, without primary repair of collateral ligaments or placement of prosthetic ligaments, has not been reported in dogs to the authors' knowledge. In the authors' clinical experience closed reduction and stabilisation with a transarticular external skeletal fixator can be used as a successful treatment where collateral ligament injury is evident on Campbell's test, without the need for internal stabilisation in cases of lateral elbow luxation. The duration of joint immobilisation is critical to enable enough time for soft tissue repair without promoting joint stiffness and adverse effects on joint health. Optimal periods of joint immobilisation for dogs are currently not described. However, the degree of degenerative and destructive cartilage changes increases with greater periods of immobilization. With the reintroduction of mobilization, reparative processes do occur [29, 30].

The fixator applied in this case included a hinge over the elbow joint. Rigid joint immobilisation can have adverse effects on connective tissue and can result in decreased range of motion, muscle atrophy, joint contracture, and cartilage degeneration [10, 31–35]. Consequently controlled motion after surgical repair is considered beneficial. Because the motion of the elbow joint approximates that of a simple hinge, rigid fixation of an unstable elbow with a constrained hinge aligned along the best-fit axis is possible and should be a consideration for the future. However, appropriate hinge alignment would be essential as off-axis positioning imposes abnormal joint kinematics, with resultant incongruous articulation and/or joint instability. In addition, as healing progresses to create a more constrained situation, increases in stress would be transferred to the pins and the pin-bone interface. This may account for the clinical problems of pin loosening, pin breakage, and persistent instability [36, 37]. Controlled motion across the joint was not considered at the time of frame application in this case due to the lack of published research to describe an accurate intraoperative axis detection procedure for hinge placement and the lack of availability of a fixator hardware

system that allows flexible hinge positioning, independent of the fixator pin. Consequently the fixator design did not accommodate hinge motion and the benefits of maintaining joint motion were lost. Despite maintaining the hinge in the locked position, the clinical outcome was excellent in this case and closed reduction and stabilisation of a caudal elbow luxation with a type I transarticular external skeletal fixator provided a successful outcome with a good clinical recovery.

We did not make any recommendations for further investigations or treatment of the medial coronoid disease identified associated with the left elbow while it remained asymptomatic. Multiple studies have made recommendations relating to the optimum treatment for medial coronoid disease, including fragment retrieval [38–40], subtotal coronoidectomy [41], cartilage debridement [40], proximal ulna osteotomy [42, 43], biceps/brachialis muscle release [44], and medical management [38, 39]. It is difficult to make a definitive treatment recommendation in a previously asymptomatic dog recovering from a major orthopaedic injury, when the majority of treatment options currently have the potential for some degree of morbidity.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

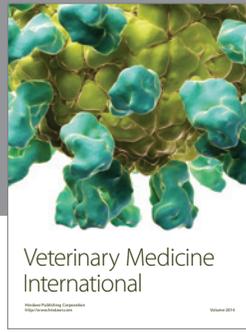
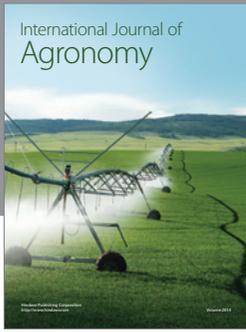
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