



## RESEARCH ARTICLE

### Articular Puncture Techniques and Contrast Arthrography of the Forelimb in Dromedary Camels (*Camelus dromedarius*)

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#### ABSTRACT

The purpose of this study was to establish puncture techniques of the forelimb joints in dromedary camels. Ten clinically healthy female camels, 6-9 years old, were used in this study. Two camels were euthanized, preserved with 10% formalin solution and used to determine the appropriate site/sites for puncturing the joints. In addition, barium sulfate was intra-articularly injected for contrast radiography to determine the joint capsule outlines. Joints of the forelimbs were aseptically punctured in the remaining eight camels. In general, puncturing of the interphalangeal, fetlock, intercarpal, and radiocarpal joints was very easy (grade 1) compared to the puncturing of the shoulder and elbow joints (grade 2). The approaches and puncture techniques were established for each joint as well as for contrast radiography, and are described in detail. The approaches for camels are somewhat different from those for horses and cattle. In conclusion, puncturing and contrast arthrography of the forelimb joints could be performed in adult dromedary camels and could be of clinical relevance in the diagnosis and treatment of some joint disorders.

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#### INTRODUCTION

Joint puncturing is a very useful procedure for performing intrasynovial anesthesia (Baxter and Stashak, 2011), arthrocentesis (Nuss *et al.*, 2002ab; Courtney and Doherty, 2009) and for administering intraarticular medication (Walker-Bone *et al.*, 2000; Baxter and Stashak, 2011). Joint aspiration is a valuable procedure for the diagnosis of several joint diseases in humans and animals (Ross *et al.*, 2012). Different macromolecules that can be detected in synovial fluid can provide specific information about joint structure turnover (Bani Ismail *et al.*, 2007; Francoz *et al.*, 2007). In addition, intra-articular injection is a commonly used method for administering drugs (e.g. corticosteroids and hyaluronic acid) to treat or protect joints from various types of arthritis, mainly in athletes (Leighton *et al.*, 2014; Triantafyllidou *et al.*, 2014).

Joint puncturing has been described in humans (Daley *et al.*, 2011; Heidari *et al.*, 2013), horses (Ross *et al.*, 2012; Waxman *et al.*, 2014) and cows (Nuss *et al.*, 2002ab). To our knowledge, the techniques of joint puncturing in dromedary camels had not to date been

reported in detail. Therefore, the present study was carried out to describe the optimal sites for articular puncturing of the thoracic limb of adult dromedary camels. In addition, positive contrast arthrography was performed to determine joint capsule outlines.

#### MATERIALS AND METHODS

**Experimental animals:** Ten healthy adult female dromedary camels, 6-9 yr old, were used in this study. Two of these animals were euthanized and used for contrast arthrography. They were preserved in 10% formalin and were used to determine the landmarks and appropriate site(s) for articular puncturing of the forelimb. In the remaining eight camels, the joints of the forelimbs were aseptically punctured.

**Joint puncturing:** Each camel was sedated with xylazine hydrochloride (Bomazine 10%, BOMAC Lab Ltd, New Zealand) at a dose of 0.2 mg/kg, IV. While the animal was in a sitting position, each joint region was aseptically prepared. The appropriate gauge and length of the needles used for puncturing each joint were determined. A sample

of synovial fluid (approximately 0.5-2 ml) was aspirated following joint puncturing. The joint was radiographed while the needle was inside the joint cavity. The exposure factors for radiographing each joint were set according to reported reference (Lavin, 1999). A graded scale (1 to 3) was used to determine the difficulty of puncturing each joint: 1- very easy to puncture (successful puncturing on the 1<sup>st</sup> attempt), 2- easy (successful puncturing on the 2<sup>nd</sup> or 3<sup>rd</sup> attempt), 3- difficult (successful puncturing after more than three attempts).

**Positive contrast arthrography:** Positive contrast arthrography, using barium sulfate, was performed on the dead animals before preservation with the formalin solution. After injection, the joint was flexed and extended and radiographs were then taken immediately.

## RESULTS

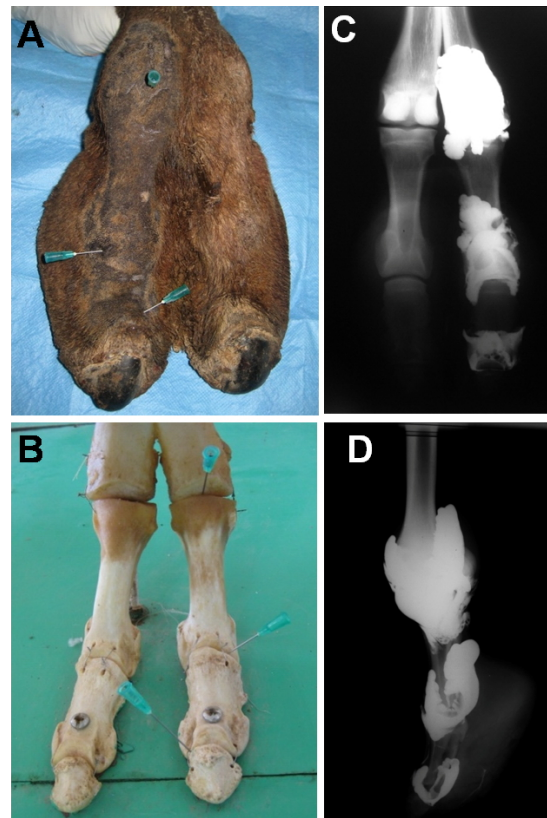
**Articular puncture:** In general, the interphalangeal and fetlock joints could be punctured very easily, grade 1 (Fig. 1A, B). A 20- or 22- gauge, 1-inch needle was found appropriate for puncturing these joints. In order to facilitate the puncturing techniques, these joints were flexed prior to injection.

**Coffin joint:** The coffin joint was punctured at either the dorsomedial or the dorsolateral aspect, about 5 cm from the midline, and the needle was directed palmarolaterally or palmaromedially, respectively (Fig. 1A, B).

**Pastern joint:** For puncturing the pastern joint, the distal condyle of the first phalanx (larger) and the articular rim of the second phalanx (smaller) were palpated. The joint space could be easily palpated just below the distal condyle of the first phalanx by exerting hard digital pressure while continually flexing and extending the joint. The needle was inserted at either the medial or lateral aspect and directed laterally or medially, respectively, in a slightly distal direction (Fig. 1A, B).

**Fetlock joint:** A dorsal approach was utilized to puncture the fetlock joint after its complete flexion. The space in the dorsal aspect of the joint between the distal end (condyle) of the metacarpus and proximal end of the first phalanx was identified. It is a relatively large space for both lateral and medial digits. The needle was inserted in the dorsal aspect and directed palmarly (Fig. 1A, B).

**Carpal joint:** Two approaches were used to puncture the radiocarpal and intercarpal joints; lateral and dorsomedial. The carpus was partially flexed and the lateral and common digital extensor tendons were identified. The sites of injection for both joints appeared laterally as depressions between the lateral digital extensor tendon and the lateral collateral ligament ventrally, and the two common digital extensor tendons dorsally. An 18-gauge, 1.5-inch needle could also be inserted dorsomedially through obvious depressions away from the tendon sheath of the extensor carpi radialis tendon, which presents dorsally (Fig. 2A, B). Puncturing the carpus was achieved in one trial (grade 1).



**Fig. 1:** Sites of articular puncture of the fetlock, pastern and coffin joints in an adult camel forelimb (A). The same sites illustrated on a bone specimen (B). Dorsopalmar (C) and lateromedial (D) radiographs of the fetlock joint and phalanges, demonstrating contrast radiography of the fetlock, pastern and coffin joints in the camel.

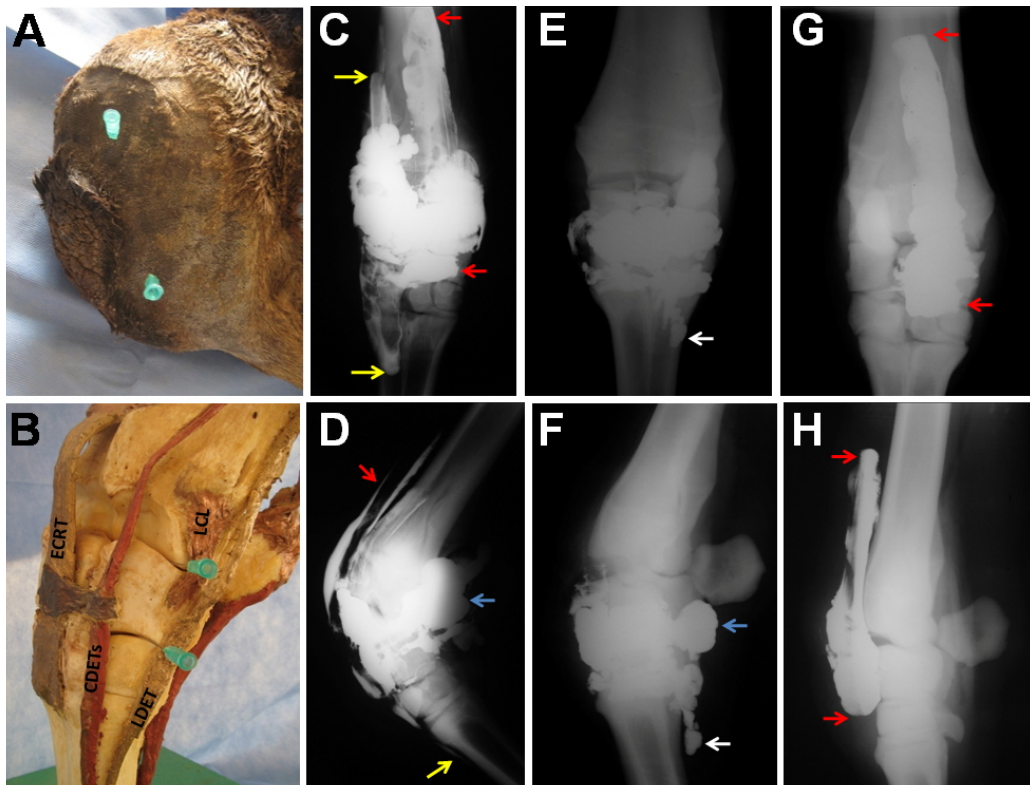
**Elbow joint:** Two easy (grade 2) techniques were used for puncturing the elbow joint (Fig. 3A, B). The first technique was performed by inserting an 18-gauge, 2.5-inch needle laterally, parallel to the olecranon tuberosity in a craniodistal direction. The other technique was carried out by inserting the same needle at the location between the lateral humeral condyle and the radial tuberosity, just cranial to the lateral collateral ligament, and directing the needle caudally.

**Shoulder joint:** The shoulder joint was punctured easily (grade 2) by inserting an 18-gauge, 2.5-inch needle in a caudal direction through the groove formed between the lateral and medial tubercles of the minor tuberosity at the proximal aspect of the humerus (Fig. 3E, F and G).

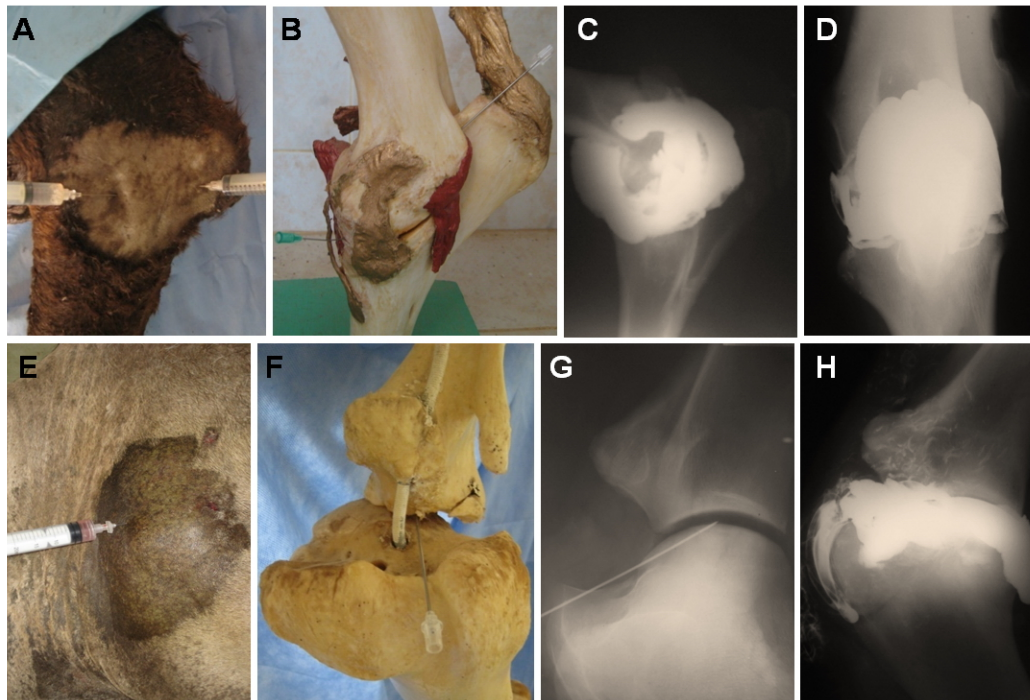
### Contrast arthrography

**Coffin joint:** The coffin joint is a large square-shaped joint with two short proximally-oriented recesses on a dorsopalmar view. In a lateral radiograph, it forms a large palmar sinus, which extends to the middle of the second phalanx. A small dorsal sinus is also found within the coffin joint (Fig. 1C, D). The volume of the contrast material suitable for the coffin joint is about  $12 \pm 4$  ml.

**Pastern joint:** The pastern joint is relatively large, rough and rectangular in shape with two short, distally-extended recesses, an axial and an apaxial recess, as seen on a dorsopalmar radiograph. On a lateral view, the pastern



**Fig. 2:** Sites of articular puncture of the radiocarpal and intercarpal joints in an adult camel (A). The same sites in relation to ligaments and tendons illustrated on a bone specimen (B). ECRT=extensor carpi radialis tendon, CDET=common digital extensor tendon, LCL=lateral collateral ligament. Dorsoventral (C) and lateromedial (D) radiographs of the carpal joint in an adult camel. Note the extensor carpi radialis tendon sheath (red arrows), the lateral and the common digital extensor tendon sheaths (yellow arrows) and the ventral pouch (blue arrow). Dorsoventral (E) and lateromedial (F) radiographs of the carpal joint in an adult camel. Note that the intercarpal and carpometacarpal joints are communicated and filled with the contrast material, with distally-oriented palmar pouches (white arrows) and a ventral pouch (blue arrow). Dorsoventral (G) and lateromedial (H) radiographs of the carpal joint in an adult camel illustrating the extensor carpi radialis tendon sheath filled with the contrast material (red arrows) during a dorsal approach of the camel carpus. Note that the contrast material does not reach the radiocarpal joint.



**Fig. 3:** Sites of articular puncture of the elbow (A) and shoulder (E) joints in an adult camel. The same sites in relation to ligaments and tendons as illustrated on a bone specimen of the elbow (B) and shoulder (F) joints. A lateromedial (C) and craniocaudal (D) contrast radiograph of the elbow joint in an adult camel. A lateromedial radiograph of the shoulder joint with a needle in the joint space (G) and a lateromedial contrast radiograph of the shoulder joint (H).

joint, as in the fetlock, has a dorsal pouch and a long palmar pouch, both extending to the middle of the first phalanx. The palmar pouch is wider than the dorsal one (Fig. 1C, D). About 18±ml of contrast material is required for pastern contrast arthrography.

**Fetlock joint:** In camels, the fetlock joint has two separate joint cavities; medial and lateral. On a dorsopalmar radiograph, it appears as a triangle with its base directed distally and an apex directed proximally. However, the fetlock joint appears as a crescent on a lateromedial view. It has a short dorsal recess and a relatively long palmar one (Fig. 1C, D). Fetlock contrast radiography requires about 23±4 ml of contrast material for each joint cavity.

**Carpal joint:** The carpal joint appears as three joints, radiocarpal, intercarpal and carpometacarpal, on dorsoventral and lateromedial radiographs. The intercarpal and carpometacarpal joints communicate, while the radiocarpal joint is a separate sac. The radiocarpal joint communicates dorsally with the extensor carpi radialis tendon sheath and the common digital extensor tendon sheath (Fig. 2C, D). The radiocarpal joint extends in a large pouch at the level of the accessory carpal bone at the ventral aspect of the joint (Fig. 2D). Moreover, the intercarpal joint has a palmar pouch, while the carpometacarpal joint extends in short palmar pouches that are distally oriented (Fig. 2E, F). A dorsal approach of the carpal joints leads to injection of the extensor carpi radialis tendon sheath (Fig. 2G, H). Contrast material up to 70±10 and 52±8ml are required for radiocarpal and intercarpal contrast arthrography, respectively.

**Elbow joint:** The elbow joint appears as an incomplete ring in the lateromedial radiograph (Fig. 3C) and as a rough circle at the dorsoventral view (Fig. 3D). The contrast material fills the interepicondylar space constructing a broad vertical radio-opaque line (Fig. 3C). An amount of 35±5ml of contrast material is required to visualize the elbow joint.

**Shoulder joint:** In a lateromedial radiograph, the shoulder joint appears as a short cylinder with two distally extended pouches, one extending cranially at the cranial humeral tuberosity and the other extending caudally distal to the humeral head (Fig. 3H). A volume of 32±5 ml of contrast material is used for shoulder contrast arthrography.

## DISCUSSION

This study has shown that flexion of the interphalangeal (coffin and pastern) and fetlock joints significantly facilitates their puncturing. The coffin joint could be easily punctured at either the dorsomedial or the dorsolateral aspect. In camels, the joint space increased when the joint was flexed. This was obvious at the dorsomedial and dorsolateral aspects. Therefore, puncturing of the flexed coffin joint was relatively easy from the dorsomedial or dorsolateral aspects. It has been cited that the dorsal aspect is the proper approach for surgery (Badawy, 2011) and for arthrocentesis (Mostafa *et*

*al.*, 1993; Harper *et al.*, 2007) of the interphalangeal joints in camels, conclusions which differ from those of the current study. Moreover, the lateral approach has been described for arthrocentesis of the distal interphalangeal joint in a horse (Vazquez de Mercado *et al.*, 1998). In cattle and horses, the preferable site for puncturing the distal interphalangeal joint is just lateral to the common/long digital extensor tendon and proximal to the coronary band, directing the needle to the extensor process (Van Amstel and Shearer, 2006). In horses, the proximal epicondyle of the second phalanx can easily be palpated (Alrtib *et al.*, 2013) and the pastern joint can be punctured by inserting the needle at a line just proximal to that epicondyle and directing it vertically toward the midline beneath the common/long digital extensor tendon (Baxter and Stashak, 2011). In camels, the distal axial and abaxial prominences of the first phalanx are more prominent than those of the proximal end of the second phalanx (Badawy, 2011). Therefore, the landmark when injecting the pastern joint in camels was the ability to palpate the projected distal prominences of the first phalanx.

This study has shown that the puncturing of the fetlock joint was very easy from the dorsal aspect, especially if it was flexed to widen the joint space and to retract the common digital extensor tendon. Different technique has been used in young dromedary camel (Bani Ismail and Al-Rukaibat, 2006). In horses, it is preferable to puncture the fetlock joint at a site just above the lateral proximal sesamoid bone, between the third metacarpal bone and the suspensory ligament (Baxter and Stashak, 2011). Palmar/plantar and dorsal approaches have been used for fetlock joint arthroscopy in horses (Vanderperren *et al.*, 2009) and dairy cattle (Blaser *et al.*, 2012).

Although camel carpus is anatomically similar to other large animals (Kassab, 2008), the sites of puncturing are different from that of other domestic animals (Nuss *et al.*, 2002a), which usually utilize a dorsal approach. The presence of two large tendon sheaths at the dorsal aspect of the camel carpus renders the dorsal approach difficult and confusing. A false intrasynovial (intravaginal) puncturing, rather than intra-articular injection, is common with the dorsal approach. The lateral and dorsomedial approaches to the camel carpus avoid the confusion of intrasynovial injection of the extensor carpi radialis and the common digital extensor tendon sheaths, respectively.

Landmark palpation of the humeral and radial tuberosities is sometimes difficult in camels, especially when these joints are covered with a heavy musculature. The same techniques for puncturing shoulder and elbow joints have been reported in horses (Baxter and Stashak, 2011) and cattle (Nuss *et al.*, 2002a). It has been reported that caudal arthrocentesis of the equine elbow joint through the ulnaris lateralis bursa was unreliable (Baxter and Stashak, 2011).

The present study presents a detailed description of the joint capsule outlines of the forelimbs of camels. Similar results for the phalangeal joints have been reported (Mostafa *et al.*, 1993; Fahmy *et al.*, 1996). The present study has revealed that there are communications between the radiocarpal joint and the extensor carpi radialis laterally with the common digital extensor tendon

sheaths. The presence of such communications renders the sheaths visible after intraarticular injection of the contrast material. However, the injection of the contrast material in the sheath at the dorsal aspect of the carpus does not render the radiocarpal joint visible. Arthrography has been cited to provide additional information about the soft-tissue components of joints and to serve as a valuable aid in the diagnosis of synovial masses, such as villonodular synovitis, and osteochondrosis (Lamb, 1991).

**Conclusion:** The articular puncturing of the forelimbs in adult dromedary camels is a valuable technique that could be performed without requiring outside assistance. Puncturing the camel carpus utilizes a different approach than with other domestic animals. Contrast arthrography of the forelimbs is described in detail.

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