# ULTRASOUND-GUIDED INJECTIONS IN HORSES WITH CRANIOVENTRAL DISTENSION OF THE COXOFEMORAL JOINT CAPSULE: FEASIBILITY FOR A CRANIOVENTRAL APPROACH

MARY BETH WHITCOMB, BETSY VAUGHAN, SCOTT KATZMAN, JAKE HERSMAN

**Intrasynovial access to the equine coxofemoral joint (CFJ) is inherently challenging. Blind injection techniques rely upon inconsistently palpable landmarks, and ultrasound guidance requires expertise for needle placement into the coxofemoral articulation. Aspiration is recommended to confirm intrasynovial placement and avoid sciatic nerve anesthesia. The aim of this observational, descriptive, retrospective study was to evaluate the feasibility for an alternative ultrasound-guided approach in horses with cranioventral distention of the CFJ identified during pelvic ultrasound. Thirteen horses with cranioventral CFJ distention, including 12 with severe pathology, were recruited from 2009 to 2014. Seven were excluded as they were not injected or underwent ultrasound-guided injection using a dorsal approach. The remaining six horses underwent a total of nine injections into the cranioventral recess. With the exception of one foal, all were aged horses (15–29 years) of varying breeds and uses, with prominent lameness due to subluxation (three), luxation (two), and severe osteoarthritis (one). The cranioventral recess was imaged adjacent to the proximal femur using a low-frequency curvilinear transducer placed ventral to the cranial joint margins. Using aseptic technique, spinal needles were placed cranial to the transducer and advanced caudomedially into the distended cranioventral recess. Synovial fluid was retrieved in all cases with one needle placement. Findings indicated that, when distended, ultrasound-guided access to the cranioventral CFJ recess is a feasible alternative approach and may reduce the potential for extra-synovial placement. Distention in this sample of horses was accompanied by severe pathology, also supporting the use of this approach for therapeutic interventions.** 

**Key words: arthrocentesis, fracture, hip, lameness, luxation, pelvis, subluxation.**

## Introduction

INTRASYNOVIAL ACCESS TO THE EQUINE coxofemoral joint (CFJ) is notoriously challenging whether needles are placed blindly or with ultrasound guidance.[1–4] Blind techniques rely upon palpation of the cranial and caudal eminences of the greater trochanter of the femur for needle placement; anatomic landmarks that are often difficult to identify, especially in overweight or heavily muscled horses.[1–3] Furthermore, the needle path to the articulation of the femur and acetabulum is hard to assess blindly, and multiple needle repositionings may be required for joint entry. Aspiration of synovial fluid is recommended to ensure intrasynovial placement, especially when injecting anesthetic agents for diagnostic purposes. Complications of extra-synovial deposition include anesthesia of the nearby sciatic nerve and subsequent loss of motor function to the limb.[2] When performed for palliative purposes, extra-synovial placement could be erroneously interpreted as a lack of therapeutic response.

The use of ultrasound guidance to place needles into the CFJ has been shown to increase accuracy for intraarticular access.[5] Ultrasound guidance requires a low-frequency curvilinear transducer oriented in a craniodorsal to caudoventral orientation to produce a transverse view of the craniolateral joint surfaces. Needle placement is similar to that described for blind techniques. The needle is positioned ventral to the transducer and monitored ultrasonographically as it is advanced to the craniodorsal aspect of the joint. Investigators confirmed intraarticular placement in 18/18 CFJs in live horses based on contrast arthrography; however, synovial fluid was obtained in only 7/18 joints, all of which were considered normal. This is in contrast to other authors who state that synovial fluid is reliably obtained, either spontaneously or through aspiration, during

From the Department of Surgical & Radiological Sciences, School of Veterinary Medicine, University of California, Davis, CA 95616 (Whitcomb, Vaughan, Katzman) and Animal Imaging, 6112 Riverside Drive, Irving, TX, 75039 (Hersman).

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Address correspondence and reprint requests to Mary Beth Whitcomb, at the above address. E-mail: mbwhitcomb@ucdavis.edu

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coxofemoral injections.[1,2] It is possible that synovial fluid retrieval could be affected by the presence of coxofemoral pathology.

The use of ultrasound to diagnose equine pelvic and coxofemoral disorders is increasingly utilized in the hospital and ambulatory setting.[6–15] Multiple authors have reported on the ultrasonographic features of coxofemoral osteoarthritis, subluxation, luxation, and acetabular rim fractures.[6–8,10–13,15] Radiography and nuclear scintigraphy are often considered first in horses suspicious for pelvic disorders.[16–24] More recently, ultrasound has been recommended as the initial diagnostic modality in horses with suspect pelvic injury based on strong agreement between ultrasonography and standing radiography.[13] Additionally, ultrasound has no personnel exposure risks and is the only modality able to assess effusion and synovitis within the CFJ in the standing horse. Ultrasonographic detection of cranioventral distention within the CFJ was reported in 6/7 horses with coxofemoral subluxation; however, intrasynovial access at this location has not been described.[12]

The aim of this study was to evaluate the feasibility of injection of the cranioventral recess as an alternative ultrasound-guided approach to the CFJ in abnormal horses and, secondarily, and to describe the prevalence of cranioventral distention in horses presenting for pelvic ultrasound.

## Materials and Methods

The study design was observational, descriptive, and retrospective. Horses were recruited from the medical record archives at the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California, Davis during the period of January 1, 2009 to December 31, 2014. Horses were considered for inclusion if they underwent pelvic ultrasonography, and cranioventral distention of the CFJ capsule was identified on ultrasound. Horses were excluded if they did not undergo CFJ injection or if they underwent ultrasound-guided injection using a dorsal approach. Signalment, historical, clinical, and imaging features of affected horses were recorded.

Systematic ultrasound examinations were performed on the hemipelvis of the lame limb using a low-frequency (2–5 MHz) curvilinear transducer after clipping the hair with #50 clipper blades, washing the skin and application of ultrasound coupling gel. Evaluation included transcutaneous ultrasound of the ilial wing, ilial body, CFJ, tuber sacrale, tuber coxae, tuber ischii and third trochanter of the femur. Transrectal examination of the ischial body, pubis and axial surfaces of the acetabulum was performed in appropriate cases (i.e., adult horses). Cranioventral distention of the CFJ was identified by sliding the transducer ventrally from a transverse view of the cranial joint margins until the proximal femur was visualized (Fig. 1/Video 1). Distention was noted as a fluid filled recess located ventral to the coxofemoral articulation and adjacent to the cranial aspect of the femur. Longitudinal views of the recess were obtained by rotating the transducer 90°. The transducer was oriented horizontally for transverse views and nearly vertically to obtain longitudinal views of the cranioventral recess.

Prior to injection, the intended site of needle entry was marked on the skin surface with Wite Out® marks placed at appropriate distances from this site to prevent their removal during aseptic skin preparation (Fig. 2A and B). The intersection of imagined lines extending from these marks served to denote the intended location for needle placement. The region was aseptically prepared in standard fashion, and the transducer and ultrasonographer's hands were dressed with sterile surgical gloves. A transverse view of the cranioventral recess was reproduced with a low-frequency (2–5 MHz) curvilinear array transducer using the skin marks as a guide. A small subcutaneous bleb of local anesthetic (2% lidocaine HCL) was placed aseptically at the intended site of needle entry (Fig. 2C) after skin preparation to preserve bleb visibility. With the transducer oriented approximately parallel to the ground (in standing horses), a 6–8″ 16ga-18ga spinal needle was placed cranial to the transducer and advanced under ultrasound guidance in a caudomedial direction until the needle tip was visualized within the cranioventral recess (Fig. 2D). Needle selection was based on availability at the time of injection. After stylet removal, intrasynovial placement was confirmed either by visualization of joint fluid flowing from the needle hub or by aspiration of synovial fluid (Fig. 2E). The syringe for injection was attached to the needle hub. A small test injection was then performed to ensure intrasynovial placement, after which the remaining solution was injected under real-time ultrasonographic monitoring (Fig. 2F). Injections in live horses were performed in stocks under light sedation with detomidine HCL (0.004–0.008 mg/kg IV [Dormosedan; Orion Corporation, Espoo, Finland]) or xylazine HCL (0.01–0.02 mg/kg IV [Anased; Akorn, Inc., Decatur, IL]). Butorphanol tartrate (0.01–0.02 mg/kg IV [Torbugesic; Pfizer Inc., New York, NY]) was added for pain control prior to each injection.

Horses received one intravenous dose of nonsteroidal anti-inflammatory medication (phenylbutazone 4 mg/kg; MWI, Boise, ID) following each joint injection. Stall rest was recommended for 3 days after which horses were allowed to return to their normal housing environment.

## Results

Pelvic ultrasound was performed in 139 horses from 2009 to 2014 during which time cranioventral distention of the

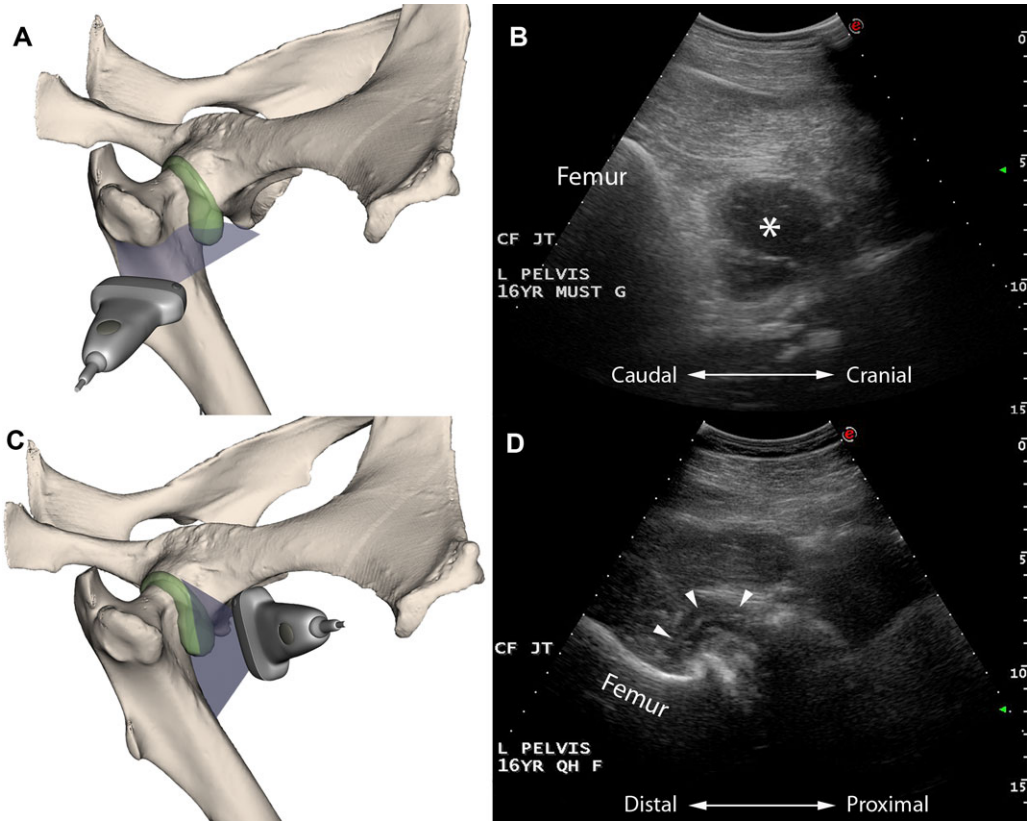


FIG. 1. /Video 1. Ultrasonographic technique to identify distention of the cranioventral recess of the coxofemoral joint. (A) Transducer position to obtain a transverse image of a distended cranioventral recess. Beginning with a transverse view of the cranial margin of the coxofemoral joint, the transducer is moved distally along the craniolateral margin of the femur. (B) Corresponding transverse ultrasound image of a severely distended cranioventral recess (asterisk) in a horse with coxofemoral subluxation. (C) Transducer position to obtain a longitudinal image of the cranioventral recess. (D) Corresponding longitudinal ultrasound image showing distention and synovial thickening of the cranioventral recess (arrowheads) in a horse with coxofemoral luxation.

CFJ was identified in 13 horses (prevalence = 9%). Distention was attributed to severe coxofemoral pathology in 12/13 horses and ultrasonographic evidence of mild osteoarthritis in the remaining horse. Seven horses were excluded from analysis because coxofemoral injections were not performed or ultrasound-guided injection was performed using a traditional dorsal approach. Of the remaining six horses, nine injections were performed into the cranioventral recess of the CFJ and these are included for analysis. Eight injections were performed at the University of California, Davis Veterinary Medical Teaching Hospital; and one horse was injected at Animal Imaging in Irving, TX. Five horses underwent one injection each, and one horse underwent a total of four injections.

All were mature to geriatric horses, ranging in age from 15 to 29 years (median = 20 years), with the exception of an 8-month-old foal. The age of one horse was not listed, but was estimated at 15–20 years based on dentition. There were two Quarter Horses, one used for light trail riding and one retired ranch horse, one Warmblood jumper, one Tennessee Walking horse (unknown use), one Mustang that had been used for driving, and one Friesian colt. All adults were geldings. Reported duration of lameness was from 1 to 12 months (median = 6 months). Lameness onset was insidious in three horses and acute in three horses, including one horse that slipped while running, one that developed lameness after jumping, and one that became severely lame while being ridden uphill.

On presentation, five horses were lame at the walk (Grade 4/5; American Association of Equine Practitioners grading scale 0–5) and one horse showed prominent lameness at the trot (Grade 3+/5). The left hindlimb was affected in five horses and the right hindlimb in one horse. Localizing signs of pelvic lameness included four horses with severe gluteal and quadriceps atrophy, one horse with severe gluteal atrophy, and one with mild gluteal atrophy. One horse had palpable crepitus in the region of the CFJ. Lower limb perineural anesthesia of the affected limb had been performed in all adult horses, but this either did not improve or only minimally improved the severity of lameness. Intraarticular anesthesia of the stifle of the affected limb resulted in no improvement in three of four horses and

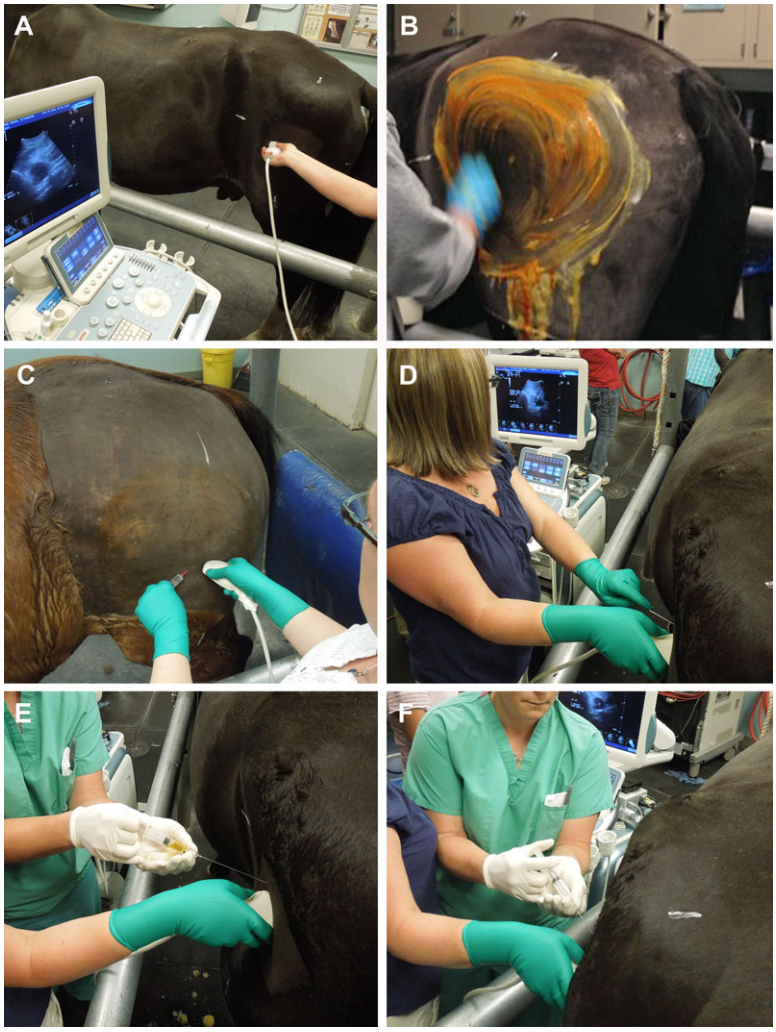


FIG. 2. Ultrasound-guided injection into a distended cranioventral recess of the coxofemoral joint. (A) Transducer position to visualize distention of the cranioventral recess. Wite-Out marks are placed on the horse to denote the intended site of needle entry at the intersection of imagined lines that extend from these marks. (B) Marks are also used to ensure sufficient skin preparation and are placed at sufficient distance to prevent their removal during skin preparation. (C) After donning sterile gloves and sterilely dressing the ultrasound transducer, a local skin block is placed after skin preparation to preserve bleb visibility and to ensure placement at the intended site of needle entry. (D) A transverse view of the cranioventral recess is obtained as shown, and a spinal needle is advanced cranial to the transducer until its tip is seen within the cranioventral recess. An in-plane technique is used to visualize the entire length of the needle from skin to target. (E) Synovial fluid aspiration confirms intrasynovial placement. (F) The syringe for injection is attached and injection monitored in real-time to confirm intrasynovial deposition.

resulted in partial improvement in the remaining horse. The latter horse underwent CFJ anesthesia at another clinic which yielded partial improvement in the degree of lameness.

Ultrasound of the affected hemi-pelvis showed evidence of severe coxofemoral pathology in all horses (Fig. 3). Coxofemoral subluxation was identified in three horses, and complete luxation of the femoral head was found in one horse and the foal, all of which showed ultrasonographic evidence of secondary osteoarthritis. Severe osteoarthritis without evidence of subluxation or luxation was noted in the remaining horse. Discrete fragments of the acetabular rim were suspected in several cases but were difficult to differentiate from irregular joint margins created by osteoarthritic changes.

Nuclear scintigraphy performed in two horses revealed increased radiopharmaceutical uptake (IRU) of the CFJ. Moderate IRU prompted subsequent ultrasonographic examination in one horse. In the other horse, scintigraphy was performed following ultrasound to evaluate for additional sources of lameness despite improving twice after CFJ intraarticular anesthesia. Mild IRU of the CFJ was identified in this horse. Standing radiography performed in three cases revealed incongruity of the coxofemoral articulation consistent with subluxation or luxation of the femoral head in the foal and one adult horse. Marked sclerosis and new

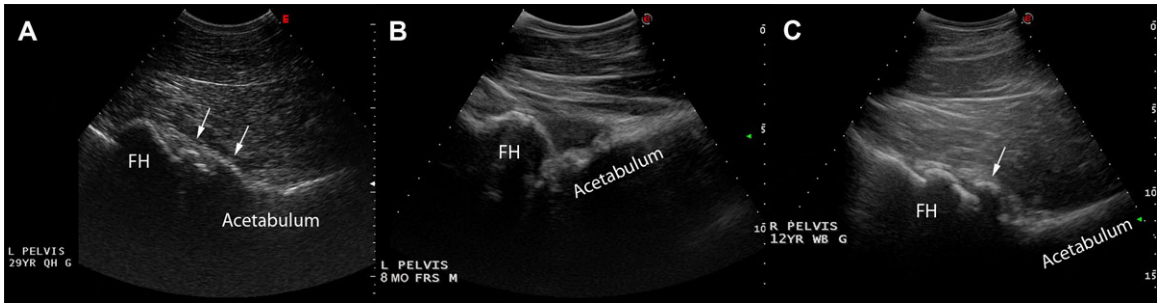


FIG. 3. Ultrasound images from three horses with coxofemoral abnormalities and concurrent distention of the cranioventral recess (not visible in these images). (A) Craniodorsal displacement of the femoral head (FH) is apparent upon full weight bearing in this 29-year-old Quarter Horse gelding with coxofemoral subluxation and secondary remodeling of the acetabular rim and femoral head (arrows). (B) Marked dorsal displacement of the femoral head in an 8-month-old Friesian colt with a 4-week history of acute onset left hind lameness. (C) Acetabular rim fragment (arrow), subluxation and femoral head remodeling in a 12-year-old Warmblood jumper with a 1-year history of lameness.

bone production consistent with severe chronic osteoarthritis was seen in the remaining horse.

Six injections were performed for therapeutic or palliative purposes using varying doses of corticosteroids (80–200 mg methyl prednisolone acetate [Depo-Medrol; Zoetis, Inc., Kalamazoo, MI]). Amikacin (125–500 mg) was added to all injected preparations for prophylactic purposes. Hyaluronic acid 20–22 mg (Hyvisc, Anika Therapeutics, Inc., Bedford, MA; Hylartin, Advanced Medical Optics, Uppsala, Sweden) was also included in five of six injections. All therapeutic injections were performed per owner request or clinician recommendation to improve the horse's comfort level rather than a means to allow the horse to return to riding purposes. One injection was performed for diagnostic purposes in the horse with lameness only visible at the trot. Carbocaine (18 cc) with 500 mg amikacin was used, and significant improvement in the lameness was noted 1 h later. Two injections were performed after euthanasia in two horses for study purposes; both with the horse in lateral recumbency. This included the foal where dissection along the needle path confirmed intrasynovial needle placement within the cranioventral recess. The second was an adult horse that had undergone three previous therapeutic injections at 6- and 5-month intervals, respectively. Immediately after euthanasia in this horse, ultrasound-guided injection with 100 cc of a 50:50 solution of iodinated contrast material (Isovue®-370; Bracco Diagnostics, Inc., Monroe Twp, NJ) and saline was performed into the affected (left) CFJ. A lateral radiograph was immediately taken with the horse in right lateral recumbency to illustrate the size and extent of the joint capsule (Fig. 4A). In an effort to improve contrast visibility, the horse was rolled into left lateral recumbency to place the injected hip closer to the plate. A second lateral radiograph was obtained; however, significant leakage of contrast material from the joint occurred while rolling and as a result of the increased weight on the joint capsule. Necropsy confirmed the severity of joint disease and the location and size of the cranioventral recess in both horses (Fig. 4B).

All injections required only one needle placement, and needles were easily visualized within the cranioventral recess in all cases (Fig. 5A). Distance to the joint capsule was measured at 8–10 cm in adult horses. Synovial fluid readily flowed from the needle upon stylet removal in 9/9 injections. Quantity of aspirated synovial fluid was recorded in four injections and ranged from 6–40 cc. Approximately 50 cc of synovial fluid flowed from the foal dissected at necropsy. Real-time ultrasonographic monitoring of intrasynovial deposition was achieved in 100% of injections (Fig. 5B/Video 2). There was no evidence of needle bending during any injection.

The horse that underwent three ante-mortem and one postmortem injections was a 15-year-old Mustang with unilateral coxofemoral luxation. Improvement in comfort level was reported by the owner after the first two injections; however, he remained lame at the walk in the interim and the duration of therapeutic effect was reduced with each injection. There was minimal improvement after the third injection, and the horse was euthanized 60 days later. No additional horses returned for necropsy examination. A 29-year-old Quarter Horse gelding underwent seven additional injections (specific technique not recorded) at another clinic over a 3-year period until the horse was euthanized due to progressively debilitating hip lameness. Injections were beneficial in this horse but therapeutic effect was reported as short-lived. A 22-year-old Quarter Horse gelding also became more comfortable after a single injection. He was kept at pasture until he died suddenly for unrelated reasons seven months later. The adult Warmblood show jumper injected for diagnostic purposes was retired due to worsening lameness. The owner reports that he continues to receive regular anti-inflammatory medication and has been comfortable at pasture for 2.5 years since diagnosis. One horse was lost to follow-up.

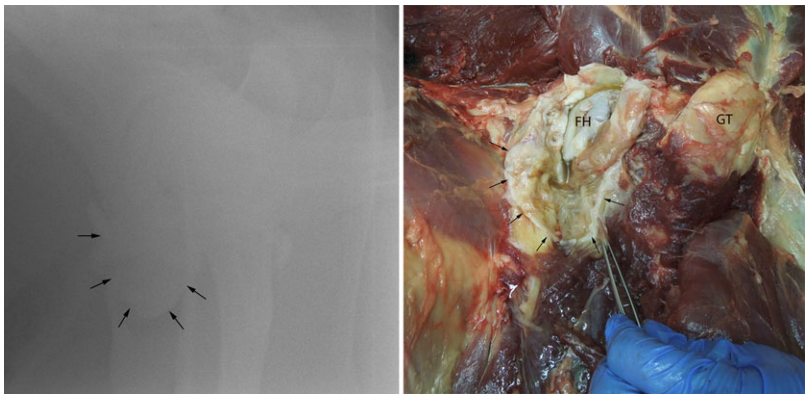


FIG. 4. Postmortem contrast arthrogram and dissection photograph showing the cranioventral recess (arrows) of the coxofemoral joint in a 15-year-old Mustang gelding with craniodorsal displacement of the femoral head (FH). Cranial is to the left on both images. GT = greater tubercle.

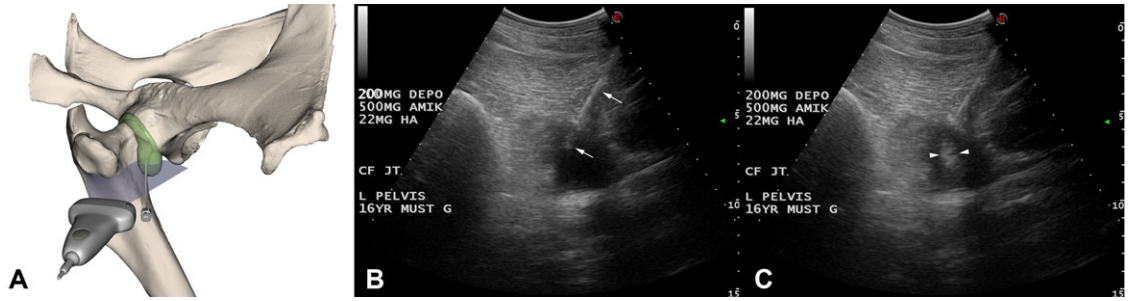


FIG. 5. /Video 2. (A) Transducer and needle position to perform ultrasound-guided injection into a distended cranioventral recess of the coxofemoral joint. (B) Corresponding ultrasound image showing the spinal needle (arrows) within the distended cranioventral recess in a horse with coxofemoral luxation (not visible in this image). (C) Upon injection, echogenic material (arrowheads) swirls within the cranioventral recess to confirm intrasynovial deposition.

## Discussion

To the authors' knowledge, our ultrasound-guided approach to the cranioventral recess is the first description of an alternative, nondorsal approach to the CFJ. Horses with cranioventral distention of the CFJ represented nearly 10% of horses (13/139) that underwent pelvic ultrasonography during the 6-year study period. Despite the presence of severe coxofemoral pathology in injected horses, distended cranioventral recesses presented large, easily accessible targets for ultrasound-guided needle placement. Injections were successfully performed in standing horses, and two postmortem injections were accomplished in lateral recumbency suggesting this approach would be equally useful in recumbent or anesthetized horses. Distention was visible regardless of weight bearing status (full, partial, or recumbent) which aided our ability to accurately place needles with only one attempt. In contrast, ultrasound-guided injections using a dorsal approach to the CFJ required greater than one needle repositioning ($1.5 \pm 1.3$) in normal horses in a previous study.[5]

Dorsal approaches, whether performed blind or ultrasound-guided, are well documented and are typically the only approach considered for intrasynovial access to the CFJ.[1–5] In fact, two horses with cranioventral distention were excluded from analysis in this study because a dorsal approach had been used for injection. Furthermore, one previously reported horse with cranioventral distention due to coxofemoral subluxation from our institution underwent two ultrasound-guided injections using a dorsal approach.[12] Dorsal injections were performed in these instances despite known cranioventral distention and a lack of visible effusion along the dorsal joint margins. This choice was primarily based on the historical use of dorsal approaches but was also affected by clinician resistance to the cranioventral approach in the first few injected cases. The low incidence of coxofemoral lameness, relative lack of opportunities to inject the CFJ and difficulty level of coxofemoral injections[1,2,5,17,24,25] coupled with a desire to become competent with traditional approaches were cited as reasons for clinician pushback. In later cases, increased awareness and the presence of such a large target in horses with cranioventral distention helped prioritize our use of the cranioventral approach.

The close anatomic location of the sciatic nerve to the CFJ should be considered when selecting approaches in horses with cranioventral effusion. The sciatic nerve is located medial to the acetabulum and extends caudodistally along the caudal margin of the femur. Anesthesia of

the sciatic nerve is a known risk of CFJ anesthesia and can occur due to inadvertent extra-synovial placement or extravasation of anesthetic agents.[2,5] Subsequent paresis or loss of motor function to the ipsilateral limb may result in the horse stumbling, falling or sustaining further injury. By contrast, injection into a visibly distended cranioventral recess should decrease the risk for extra-synovial injections. Even with extravasation of anesthetic agents, unintended anesthesia of the sciatic nerve seems less likely given its relatively distant anatomic location from the cranioventral recess when compared with the dorsal joint capsule.

Ultrasound-guided techniques to access synovial structures have been shown to be superior to blind techniques,[26] yet even with ultrasound guidance, aspiration of synovial fluid from the normal CFJ has been inconsistent.[5] While our cranioventral approach yielded synovial fluid in 100% of injections, all horses had significant effusion due to coxofemoral pathology. We also had no instance of needle bending with the cranioventral approach using either a 16-ga or 18-ga spinal needle. Needle bending has been reported with dorsal approaches due to muscle contractions as the needle is advanced to the joint.[1,4,5] This is consistent with our own clinical experience and therefore a 16-ga spinal needle is typically recommended for dorsal injections. Needle selection should also consider the skin-to-target distance measured along the intended needle path prior to injection. Although we used an 8″ needle for several injections, a 6″ spinal needle would have sufficed given the skin-to-target distance of 8–10 cm in adult horses.

This study is limited by the low number of reported cases. As a retrospective study, decisions for injection were based on owner request to improve comfort level in affected horses. Case numbers were also affected by lack of clinician awareness or acceptance of the cranioventral approach early in the study period. Additionally, no live horse underwent confirmation of intrasynovial placement via contrast radiography as has been reported in normal horses[5]; however, synovial fluid was retrieved in all instances, all injections were ultrasonographically monitored in real-time and both euthanized horses underwent necropsy and/or radiographic validation of intrasynovial placement. Finally, the cranioventral injection technique was not validated in normal or control horses; however, distention of the cranioventral recess is an infrequent finding in horses without coxofemoral pathology based on our experience with this and a previous study on coxofemoral subluxation where 6/7 horses showed cranioventral distention.[12] Furthermore, descriptions of this recess are not found in the anatomic literature. We theorize that the cranioventral recess develops as a pathological response to severe effusion and/or joint capsule stretching due to excessive femoral head excursion in horses with subluxation or luxation. For these reasons, it seems unlikely that the cranioventral approach would be useful or advantageous in horses without effusion.

With the increasing use of pelvic ultrasound in horses, more horses with coxofemoral lameness will likely be identified in both ambulatory and referral hospital settings. Cranioventral distention appears to be associated with severe CFJ pathology, and lone distention of the cranioventral recess should not be expected. This report provides veterinarians with an alternative ultrasound-guided approach to the CFJ in horses with severe effusion and concurrent joint disease that could benefit from palliative injections or confirmation of the CFJ as the source of lameness. While this study did not compare injection techniques, the cranioventral approach was considered straightforward by performing clinicians (M.B.W./B.V.), both of whom have extensive experience with ultrasound-guided procedures and dorsal CFJ injections. While injected horses remained lame, owners generally reported an improved comfort level which was viewed as a positive response given the severity of pathology in injected horses.

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## Supporting Information

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