Diagnostic Stifle Joint Arthroscopy Using a Needle Arthroscope in Standing Horses

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Objective: To assess use of an 18 g arthroscope for diagnostic stifle joint examination in the standing horse.
Study Design: Phase 1 used cadaver limbs and simultaneous ultrasonographic assessment. Phase 2 used 6 normal horses where stifles were assessed in both a standing and flexed position. Phase 3 used horses with suspected stifle injury or disease.
Animals: Normal horses (n = 6) to assess ability to perform diagnostic procedure (phase 2) and 3 clinical cases (phase 3).
Methods: Five cadaver limbs were used in phase 1 to assess all stifle joints. Phase 2 used standing sedated and locally anesthetized horses. Routine arthroscopic approaches were used in both weight bearing and flexed nonweight bearing positions. In both phase 1 and 2 simultaneous ultrasonographic and arthroscopic examinations were used to confirm extent of diagnostic examination. The methods developed in phase 2 were used to examine the stifle in 3 horses with suspected stifle disease.
Results: In cadaveric limbs and horses, all intra articular structures that constitute a complete arthroscopic examination were identified; no intra -or postoperative morbidity occurred. In phase 3, the needle arthroscope was used in accurate identification of pathologic change and in 1 horse, an osteochondral fragment not detected by ultrasonography and radiography was identified.
Conclusions: This preliminary work indicates that an 18 g arthroscope can be used for diagnostic examination of the equine stifle in standing horses.

The prevalence of stifle injuries in most equine athletic disciplines is not accurately known. Scant attention was given to athletic injuries of the equine stifle in part because of diagnostic limitations and lack of successful treatment options. It has been suggested athletic injuries to the stifle may account for >40% of injuries in sport horses[1] and is thought to be similar in western equine disciplines in the author's opinion.

In our experience, many practitioners do not feel comfortable performing diagnostic anesthesia of the stifle, limiting the diagnosis of stifle disease. Further limiting definitive diagnosis is an inability to accurately image soft tissue and bone of the stifle region with high sensitivity and specificity. Whereas radiography can be helpful, many lesions, particularly soft tissue lesions go undetected. Ultrasonography joint has helped broaden diagnosis of stifle lesions, especially of soft tissue structures (collateral ligaments, patellar ligaments, menisci). Ultrasonographic examination of the cruciate ligaments remains difficult because of the orientation and deep anatomic location of these structures. Moderate to severe pathology appears to be readily detected using ultrasonography,[2,3] but detection of slight to moderate lesions is difficult. Cohen et al. defined the sensitivity (79%) and specificity (56%) of ultrasonography in the equine stifle joint using surgery as the gold standard[4] with a positive predictive value of 73% and negative predictive value of 62%. These results highlight the current limitation of equine stifle ultrasonography. Although many consider routine arthroscopy the gold standard for stifle joint diagnostics, complete observation of intra-articular structures such as the meniscus are limited.[5] Computed tomography (CT) using contrast arthrography has been used to image the stifle; however, availability of this modality and magnetic resonance imaging is limited. Thus other methods to safely and quickly evaluate the stifle would be advantageous to facilitate more accurate clinical diagnosis of stifle disease. Our purpose was to assess the use of an 18 ga disposable arthroscope to safely and efficiently provide complete observation of the stifle joint in the standing horse.

MATERIALS AND METHODS

This study had 3 phases. In phase 1, 18 ga and standard 4 mm arthroscopic examination of cadaveric stifles was compared and in phase 2, exploratory stifle examination was performed

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with the 18 g arthroscope in standing horses. In both phase 1 and 2 simultaneous ultrasonographic and arthroscopic examination were used to confirm limitations and location of intra-articular structures. In phase 3, the 18 ga needle arthroscope was used to assess suspected stifle disease in 3 horses.

Equipment

The 18 ga needle arthroscope (1.3 mm diameter (BioVision Technologies, Golden, CO) is a compact and portable unit that consists of a light source and imaging processor in 1 console and a camera attached to a cable, which connects with the base console (Fig 1). The standard 100 mm long arthroscope and cannula/obturator (2.0 mm outer diameter, OD) systems are disposable. A separate, stiffer cannula/obturator (2.5 mm OD) system was used in phases 2 and 3, and part of phase 1 (Fig 1). Fluid distention of the joints was achieved through use of a 60 mL syringe or automated pressure sensitive arthroscopic fluid pump system.

Phase 1

Five cadaver limbs with intact stifles were used. Limbs were positioned in a flexed or extended position using a custom limb stand. Each stifle had routine arthroscopic examination including the caudal portion of the medial and lateral femorotibial (LFT) joints.[3] In 2 limb specimens, the 18 ga arthroscope was used first followed by the 4 mm arthroscope to complete exploration of each joint compartment. The other 3 limbs were only assessed using the 18 ga arthroscope. No initial distention of any of the joint compartments was used; however, communication of joint compartments could allow for fluid distention after the first exploratory (based on anatomic location). The order of exploration was: cranial medial femorotibial (MFT), caudal MFT, cranial LFT, caudal LFT and femoropatellar joint. A lateral followed by a cranial approach to the cranial MFT joint was used[4] in both a flexed and extended limb position. The caudal approach to the MFT using the technique of Trumble et al.[5] was used in both a flexed and extended limb position. The medial approach to the cranial LFT joint was made using the technique of Moustafa et al.[6] using the previous lateral portal to the cranial MFT joint. The caudal LFT joint was entered using an approach described by Walmsley[7] 2.5 cm proximal to the tibial plateau and 3 cm caudal to the lateral collateral ligament and was only performed in the flexed position. The femoropatellar joint was entered through a standard cranial approach in the extended position.[3] In 2 limbs, simultaneous ultrasonographic examination of the location of the 18 ga arthroscope was performed to either confirm the extent of meniscus identified or structures such as the medial collateral ligament as previously described.[8]

Phase 2

Six clinically normal horses (both stifles were assessed) were studied after approval by the Institutional Animal Care and Use Committee. Horses were ~500 kg and aged from 2 to 8 years. Phenylbutazone (2 g) was administered before surgery and for 3 additional days. Ceftiofur (2.5 mg/kg intravenous [IV]) and gentamicin (6.6 mg/kg IV) were administered just before the procedure. Horses were restrained in stocks and were lightly-moderately sedated with a combination of butorphanol and detomidine, as needed. Specifically, horses were sedated with detomidine (10 mg intramuscularly [IM]) at the time of clipping and initial surgical site preparation. The stifle area was clipped with a #40 clipper blade and prepared for aseptic arthroscopic surgery.[8] Just before local skin and tissue anesthesia, detomidine (3 mg IV) and butorphanol (5 mg IV) were administered. Next ~10 mL 2% mepivacaine hydrochloride was used to desensitize the skin and deeper tissues at each of the entry portals described in phase 1. Additional aseptic preparation of the clipped area was completed after use of local anesthetic.

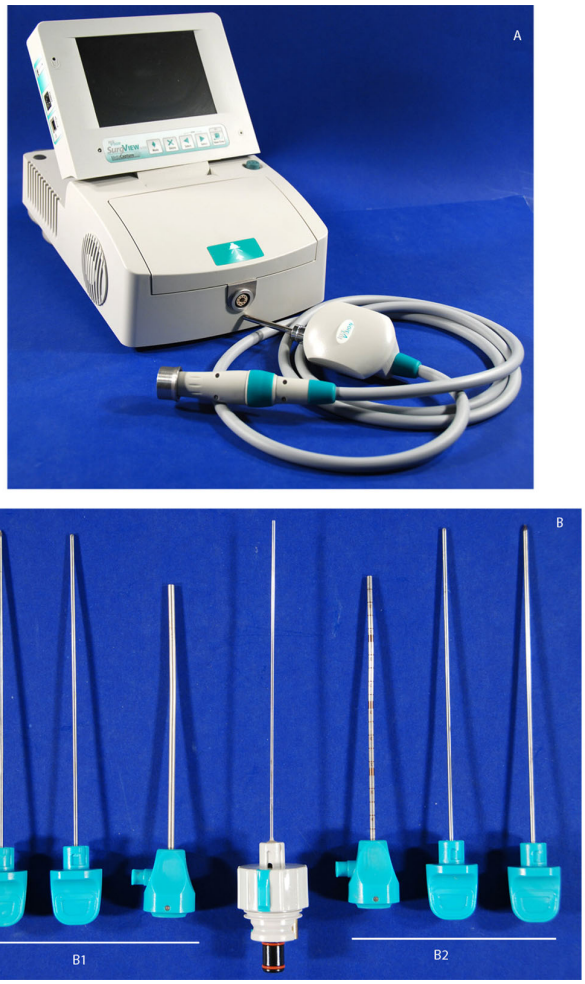

Figure 1 (A) Integrated fiber optic xenon light source, 6.4″ high resolution LCD monitor and light cable/480 line high resolution camera. (B) 18 ga flexible arthroscope, (B1) sharp and blunt obturator and stiff cannula and (B2) sharp and blunt obturator and standard cannula.

A team of 1 surgeon and 2 assistants performed the arthroscopic examinations. One assistant was used to flex the limb and provide additional sedation as necessary the other assistant handed instruments to the surgeon. The femoropatellar, MFT and LFT joints were blocked separately using ~20 mL local anesthetic before introduction of the needle arthroscope. The fluid used to distend the joint during surgery had 100 mL 2% lidocaine/L of fluid, with the exception of the 1st horse that had no lidocaine added to the fluid. If horses needed additional sedation during the procedure detomidine (3 mg) and butorphanol (3 mg) were administered IV.

A stab incision just big enough to introduce the sharp tip of obturator was made using a #15 blade. The sharp obturator was used to introduce the stiff arthroscopic cannula through the skin and soft tissues but advancement of the arthroscope cannula into the joint was done using the blunt obturator.

When the horses were assessed in flexion another assistant was used to stabilize the limb by holding the hoof in the restraining device with 1 hand and the other hand stabilizing the point of the hock. In 4 horses, a customized stand was made to hold the limb in flexion (Fig 2) and in 2 horses another method of holding the limb in flexion that was more versatile, was used. More specifically, the distal aspect of the limb was bandaged with a quilt and track wrap, then placed in a Kimzey leg save splint (Kimzey, Inc., Woodland, CA). A custom base (BioVision Technologies) was made to accept the Kimzey splint and allowed for variable flexion of the limb based on how high the base was from the ground (Fig 2).

Given the small size of the skin incision no suture or other methods of closure was used. Ceftiofur (600 mg) was administered in the joints(s) immediately after the procedure.

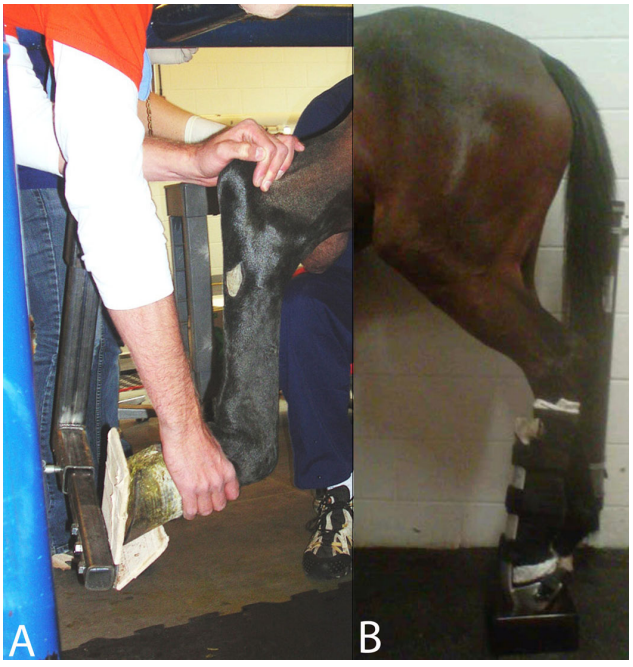

Figure 2 (A) Stationary limb positioning stand. (B) Mobile limb positioning device.

Horses were stall confined and observed twice daily for 7 days. The observation included pain, swelling, discharge, and lameness.

Phase 3

Three horses with suspected stifle disease had diagnostic arthroscopy using the 18 ga arthroscope.

RESULTS

Phase 1

Each limb (N = 5) had the cranial and caudal aspects of the femorotibial joints (medial and lateral) as well as the femoropatellar joint assessed using the 18 ga arthroscope; 2 limbs also had standard 4 mm arthroscope used. Simultaneous ultrasonographic examination was performed to confirm location and extent of observation of intra-articular structures, specifically cranial and caudal aspect of the medial and lateral menisci, medial collateral ligament, popliteal tendon and long digital extensor tendon. Complete examination of the intra-articular structures (as defined by McIlwraith and coworkers[3]) was identified using both the 18 ga and 4 mm arthroscope. Further, ultrasonographic confirmation of the intra-articular structures was obtained[8] in 2 limbs (Fig 3). Complete examination of the remaining 3 limbs was also completed without incident.

Manipulating the standard obturator protecting the 18 ga arthroscope within the joint space resulted in occasional bending of the cannula. The cannula could be straightened and because of the flexibility of the arthroscope no apparent damage was incurred. This precipitated use of the stiff obturator, which prevented bending and was easier to manipulate in the joint space. Introduction of the sharp cannula and standard obturator was relatively easy without any skin incision, however introduction of the sharp cannula with the stiff obturator was more difficult (because of the difference in cannula and obturator size, i.e., a "step") and introduction through the skin was facilitated by a 1mm skin incision.

Although the field of view was smaller than the 4 mm arthroscope, complete examination of the joints was easily completed with the 18 ga arthroscope. It took slightly longer to distend the joint with the 18 ga compared with the 4 mm arthroscope, because of the diameter of the obturator.

Phase 2

Similar diagnostic examination was possible in standing normal horses, except for 1 horse in which the caudal aspect of the MFT joint was not observed after 3 attempts. The other joints in all horses were entered with similar ease to conventional arthroscopy. In the first 2 horses, simultaneous arthroscopy and ultrasonography were performed as in phase 1 to confirm the extent of the exploratory examination and intra-articular structures (Fig 4). Originally we planned to place the

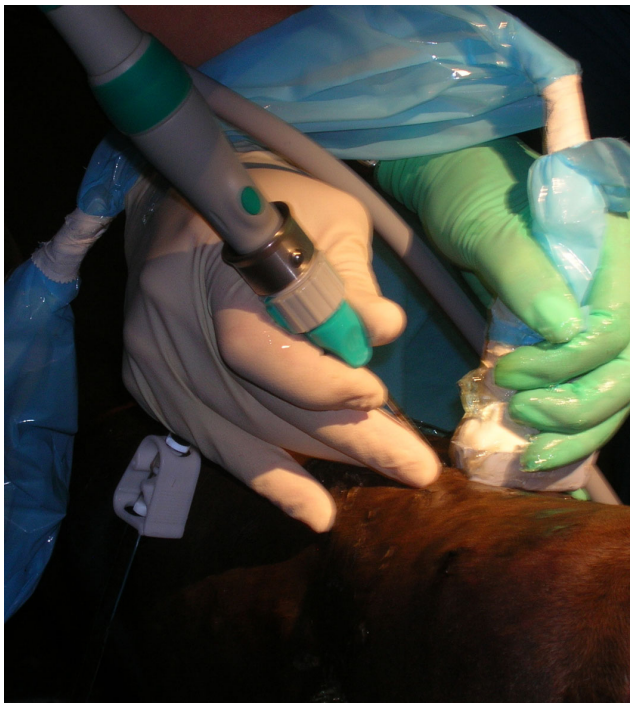

Figure 3 Simultaneous arthroscopic and ultrasonographic examination using a cadaver limb.

arthroscope with ultrasonographic guidance, but this did not prove necessary. None of the horses appeared to react when the cannula was in contact with the articular cartilage and; occasionally, a mild reaction would be elicited by the cannula coming in contact with soft tissue structures within the joint. While not objectively measured, it was our opinion that this occurred more often earlier in the procedure. All horses tolerated the procedure in both a standing and flexed position (Fig 4). In 1 horse with the limb flexed and the cannula/scope in the cranial MFT through the lateral portal the horse straightened the limb and bent the cannula. On re-examination, no joint was detected and the cannula and 18 ga arthroscope were free of damage. Mild discomfort was noted as more fluid was used to distend the joint in the 1st horse; in the subsequent horses lidocaine was added to the fluid and this response was ablated.

Greater observation of the condyles was possible in both cranial femorotibial joints when the limb was flexed (18 ga or 4 mm arthroscope) compared to the standing position. The only notable difference between using the 18 ga arthroscope standing and routine arthroscopic examination was the degree of change in the appearance of the meniscus when weight bearing versus nonweight bearing (Fig 5).

Postoperatively no heat, pain or swelling was noted involving any of the surgical sites, during lameness examinations performed while the horses were hospitalized.

Phase 3

Three horses with a history of stifle disease or suspected stifle disease had standing arthroscopy with the 18 g arthroscope

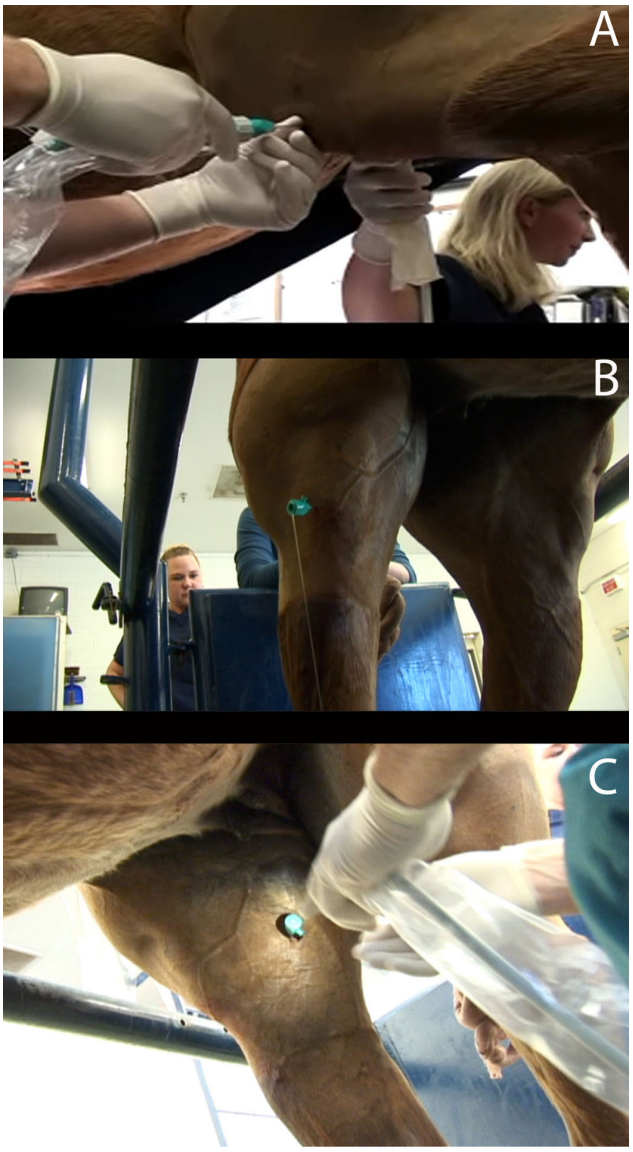

Figure 4 (A) Simultaneous diagnostic arthroscopy and ultrasonographic examination in a standing horse with the operated limb flexed. (B) Synovial fluid draining from a stiff (2.5 mm) cannula inserted in the cranial MFT joint from a lateral portal in a standing horse. (C) Cannula placement in the caudal MFT joint in a standing horse.

using the protocol described for phase 2. All horses had at least 3 months follow-up.

Horse 1. An 8-year-old, ~550 kg, Quarter horse stallion used for national level reining and roping had 2 previous surgeries to address a medial meniscal tear and a cartilage lesion of the MFC. The 1st surgery was 2 years before admission. After this initial surgery the horse competed as a national level reining horse until lameness required the horse to become a national level rope horse, which he performed for 8 months until becoming 4/5 lame.[9] After this incident the horse had

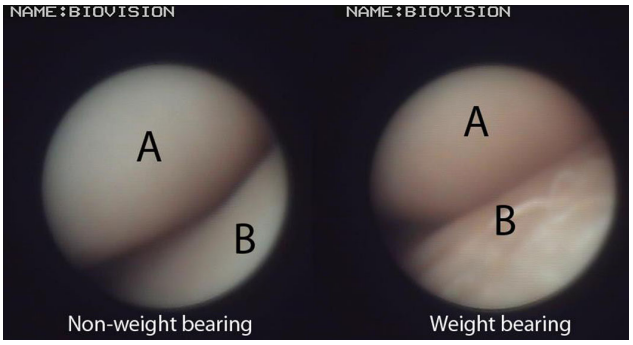

Figure 5 Comparison of the cranial aspect of the medial femorotibial joint in a nonweight bearing and weight bearing position in the same horse. The configuration of the medial meniscus changes considerably when the joint is being loaded. The medial femoral condyle (A) and medial meniscus (B) are visible.

diagnostic arthroscopy and further surgical treatment of the meniscal and condylar lesions. Postoperatively the horse remained between 2/5 and 4/5 lame for 4 months and was referred. Compared with earlier radiographic and ultrasonographic examinations, no significant changes were observed.

A lateral approach was used for diagnostic arthroscopy of the cranial MFT joint. Moderate hyperemic and hypertrophied synovial membrane was observed as well as a cranially prolapsed medial meniscus. The previous cartilage lesion was identified with detached cartilage margins of the lesion. A 2 mm × 4 mm osteochondral fragment was also observed (Fig 6). Because of the degree of pathologic change the decision was made to do surgical arthroscopy and the standing procedure was discontinued. The stab incision was closed with skin glue and postoperatively a similar regime as described for phase 2 was followed. No adverse events or increase in swelling or lameness occurred. Three weeks later the horse returned for therapeutic arthroscopy under general anesthesia. No other additional findings were made in the cranial portion of the MFT.

Horse 2. A 4-year-old, ~450 kg, Quarter Horse gelding used for cutting with a unilateral subchondral bone cyst in the medial femoral condyle based on diagnostic anesthesia and radiographs. For financial reasons, the owners requested injection of the cyst lining with triamcinolone acetonide. Using a lateral approach, standing arthroscopy of the cranial MFT joint was performed and the cloaca of the cyst was readily identified; however, despite 3 attempts to reposition the needle in the cyst, the axial orientation of the cloaca, precluded needle placement without risk of contamination. The horse was anesthetized and the procedure finished (Fig 7) using the 18 ga arthroscope. No postoperative morbidity was observed.

Horse 3. A 13-year-old, ~650 kg, Warmblood gelding used for eventing had a 6 weeks history of acute 4/5 lameness that was localized to the MFT joint using intrasynovial anesthesia. No radiographic abnormalities of the stifle region were identified. The referring veterinarian suspected a horizontal meniscal lesion based on ultrasonographic examination.

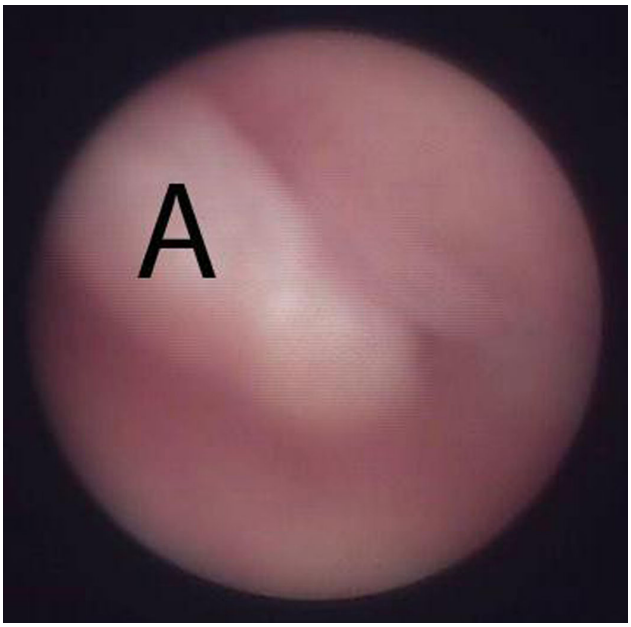

Figure 6 Arthroscopic view of loose osteochondral fragment (A) in the intercondylar area of horse 1.

Standing diagnostic arthroscopy was performed to determine if therapeutic surgery was indicated.

Standing arthroscopy of the cranial MFT joint through both a lateral and cranial approach was performed. After joint distention and partial flexion of the joint (75% of the cranial medial condyle visible), a 15 mm × 6 mm triangular partial thickness cartilage lesion was observed just abaxial to midline on the condyle. The edges of the lesion were not fibrillated suggesting the lesion was acute in nature. Slight fibrillation of the cranial ligament of the medial meniscus was seen. A linear horizontal (1 mm × 6 mm) area of hemorrhage in the cranial medial meniscus as noted directly adjacent to the cartilage lesion, this area was also demarcated by moderate synovitis. It was felt that based on the cartilage lesion, and ultrasonographic and arthroscopic assessment, this area could represent a horizontal meniscal tear (Fig 8). No other abnormalities were noted in the medial aspect of the joint. The 2 stab incisions were closed using a single skin staple each and 500 mg of amikacin injected into the MFT joint. No postoperative morbidity occurred.

DISCUSSION

The cadaveric study enabled development of the best method to insert the obturator/cannula, comparison of techniques for joint distention, optimal portal placement as well as confirmation of ability to perform a complete diagnostic arthroscopy. The sharp cannula in the standard obturator (softer) was similar to using a 16 ga needle to penetrate the skin and soft tissues. The blunt obturator (used to enter the joint) provided similar tactile feedback to use of the standard obturator/cannula system. The

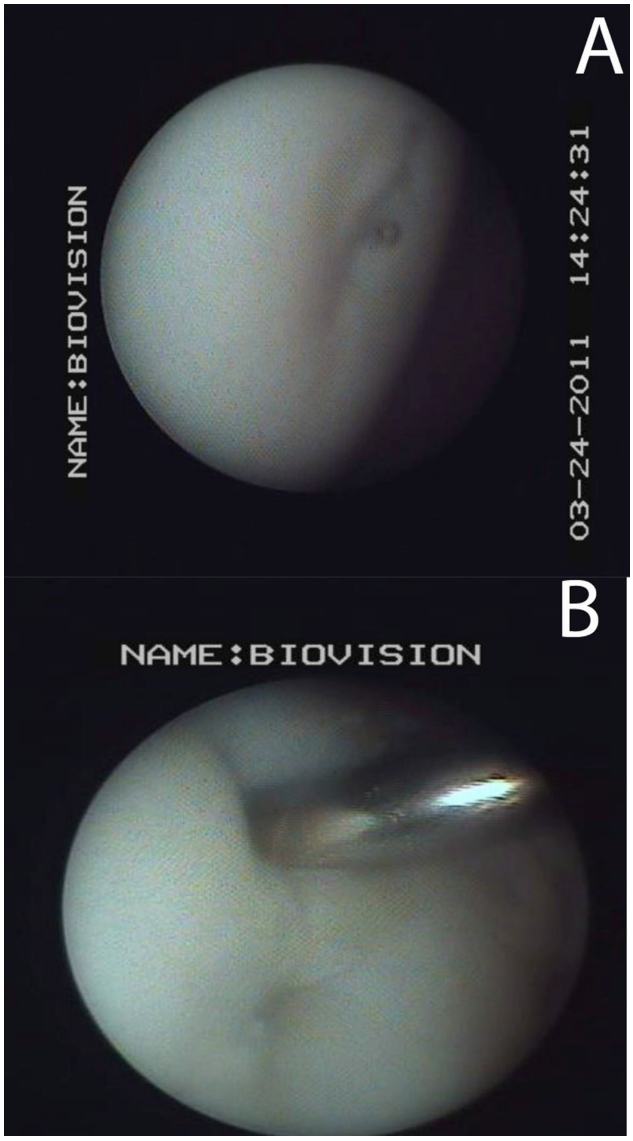

Figure 7 (A) Image of cyst cloaca identified in horse 2, standing with the limb flexed and (B) image of 18 ga needle in the cyst cloaca with the limb flexed under general anesthesia.

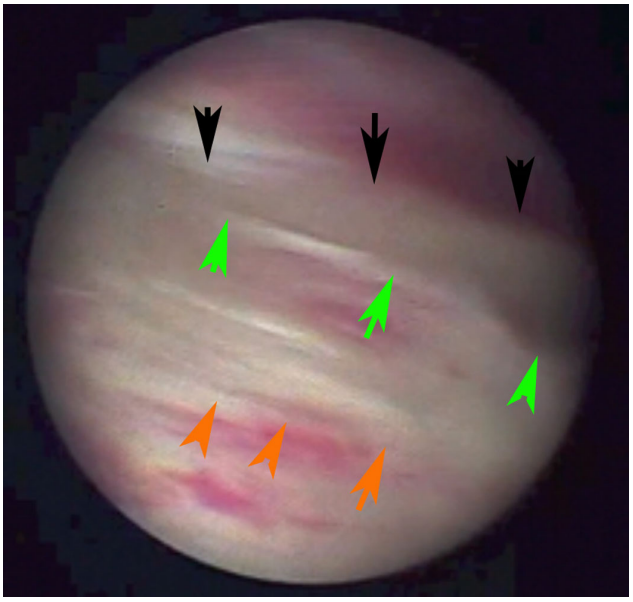

Figure 8 Image of the cranial compartment of the MFT of horse 3 in a weight-bearing position. The black arrows delineate the margin of the proximal articular margin of the medial condyle and reflection of synovial membrane. The green arrows delineate the proximal boarder of the medial meniscus. The orange arrows delineate the horizontal tear in the medial meniscus, which was noted to become larger as the horse became more nonweight bearing.

stiffer cannula did not have as good a fit between the cannula and obturator and resulted in a step in diameters. Creation of a 1 mm skin incision facilitated placement of the obturator through the skin. No difference was noted between the cannulas except that the stiffer cannula was easier to manipulate in the joint and did not result in bending. When bending occurred with the softer standard cannula it did not appear to adversely affect the arthroscope as because the manipulations occur by actively moving the cannula with the arthroscope passively following. The weakest point is the connection of the arthroscope to the camera; however, this is not of clinical concern because it is located outside the joint. Despite the disposable nature of the arthroscope, each arthroscope was useful for 5–10 joints in cadaver limbs. In standing horses, the arthroscopes worked well for 3–6 joints. When they failed it was with light escaping at the connection of the plastic base and the arthroscope. These failures were not a medical concern or risk to the horse.

Joint distention was obtained by using either a manual (assistant providing fluid ingress) or a pressure sensitive system, with the pressure sensitive system being superior for control of joint distention. As expected, some degree of constant interaction with the fluid pressure is needed if an automated system is not used. In our opinion either method could be used.

As expected, the field of view is smaller than that of a 4 mm arthroscope but this was not considered a limitation. In fact, the 18 ga arthroscope provided a better exploratory of the stifle joint than would be obtained with a 2.7 mm arthroscope. Further the resolution of the system was good at 640 × 480 for still and video capture. Because an egress portal was not used in clinical cases or normal horses the joint fluid was not flushed as thoroughly as it would be in routine therapeutic arthroscopy. It was also helpful to have the audio recording with the video to aid in identifying specific structures because the smaller field precluded concurrent observation of surrounding landmarks in some locations.

The 100 mm length of the arthroscope affects the ability to move around the joint from a single portal and increases the need for good anatomic placement of the portals. This was not seen as a limitation and in some cases when using the cranial approach to the MFT, the small diameter of the obturator/

arthroscope allowed easier access to the caudal portion of the axial surface of the joint where observation of the medial collateral ligament can occur. Likewise the decreased diameter of the cannula-arthroscope made exploration of the caudal joint compartment easier compared to the 4 mm arthroscope.

Six normal horses were used to ensure that the procedure was tolerated in standing horses and diagnostic examination of the stifle joints was possible. The horses were of normal to below average in their degree of domestication and thus represented a cross section of equine demeanor. All horses tolerated the procedures, although a range of ease in working with the horses was experienced. It appeared that waiting >15 minutes after intra-articular anesthesia as well as adding local anesthetic to the joint distention fluid improved the ease of completing the examination. The parenteral sedation used was adequate for this group of horses and subsequent clinical cases although epidural anesthesia may assist an inexperienced surgeon or facilitate examination in a particularly refractory horse.

Ultrasonography was helpful especially in placement of portals to enter the caudal compartment of the femorotibial joint in both the standing and flexed position. Likewise cartilage defects were noted on the medial femoral condyle of 1 horse before arthroscopic examination, such observations might help adjustment of portal selection in clinical cases.

The only structure that appeared markedly different in the standing horse was the cranial aspect of the medial meniscus. As can be appreciated from Fig 5 the amount of meniscal body that is observed in the standing position is less than that seen in a nonweight bearing position and during the first few standing procedures time was needed to clarify orientation of the meniscal location.

Two different methods of holding the limb in flexion were used. The combination Kimzey splint and base were found to be far more versatile for small movements of the horse and position within the stocks. Further this method is more easily adapted to various types of restraint situations.

In recruiting clinical cases, the following attributes were desired: (1) pain regionalized to the stifle using intra synovial anesthesia, (2) lack of a definitive radiographic diagnosis, (3) definitive ultrasonographic diagnosis missing or unclear and (4) owners unwillingness to perform general anesthesia without a clear diagnosis. Two horses met these criteria and for third (horse 2) the owner was unwilling to perform general anesthesia without knowing if other intra-articular lesions may be contributing to the lameness as well as having fiscal constraints. The 18 ga standing arthroscopic examination in horse 1 provided diagnostic information that was not identified by radiography or ultrasonography; specifically, the presence of an osteochondral fragment within the joint. It is reasonable that this fragment was in part the cause of the intermittent increase in the lameness this horse was experiencing after the initial arthroscopic surgery. The examination was also helpful in defining cartilage and meniscal lesions that needed to be addressed therapeutically.

Horse 2 provided evidence that the subchondral bone cyst was probably the only cause of the pain emanating from the joint. We elected to proceed with injecting the cyst lining under general anesthesia after 3 attempts to place the spinal needle in the cyst cloaca. Under general anesthesia the procedure was easily completed. Retrospectively, starting more axially with the needle position would have aided correct placement without the risk of contamination from the prepuce and penis, and ultrasonographic guidance may have improved accuracy of the portal placement. We feel this is a procedure that could be completed in a standing horse. The 3rd horse provided an example where ultrasonographic suspicions could be confirmed and the decision that further surgical therapeutic intervention was not warranted.

We were able to confirm that an 18 ga arthroscope could be used to perform complete diagnostic examination of the 3 compartments of the stifle joint. Further, we found that in some areas of the joint where space was limited the small diameter of the 18 ga arthroscope was an advantage, despite the smaller field of view. Diagnostic arthroscopy of the stifle joint was tolerated, even with range of equine temperaments. Finally, the use of the 18 ga arthroscope played a unique and beneficial role in the 3 clinical cases where it was used.

DISCLOSURE

BioVision provided partial funding for this study through donated equipment and funding for supplies. The authors declare no financial or other conflicts related to Biovision or this study.

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