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Systematic arthroscopic investigation of the bovine stifle joint

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ABSTRACT

The objective of the present study was to establish a protocol for arthroscopic exploration of the bovine stifle joint using craniomedial, caudolateral and caudomedial approaches. An anatomic and arthroscopic study using 26 cadaveric limbs from 13 non-lame adult dairy cows was performed. The craniomedial approach was created between the middle and medial patellar ligaments to investigate the cranial pouches of the stifle joint. The inter-condylar eminence, the proximal aspect of the medial femoral trochlear ridge and the lateral aspect of the lateral femoral condyle were used as starting points for systematic examination of the medial femorotibial, the femoropatellar and the lateral femorotibial joints, respectively.

The observed structures were: the suprapatellar pouch, articular surfaces of the patella, femoral trochlear ridges, cruciate ligaments, menisci, and the meniscotibial ligaments. The arthroscopic portal for the caudomedial femorotibial pouch was about 6–8 cm caudal to the medial collateral ligament. The proximal and distal caudolateral femorotibial pouches were explored 3 cm and 1.5 cm caudal to the ipsilateral collateral ligament, respectively. The observed structures were the caudal aspect of femoral condyles, menisci, caudal cruciate ligament, popliteal tendon and the meniscofemoral ligament. Restricted joint size and risk of common peroneal nerve damage were the major limitations for exploration of the caudal femorotibial compartments. The study described the arthroscopic portals and normal intra-articular anatomy of the bovine stifle joint but further investigations are warranted to validate these techniques in clinical cases.

Introduction

Lameness originating from the stifle joint is relatively common in cattle (Ducharme et al., 1985; Pentecost and Niehaus, 2014). The complex arrangement of osseous, articular, fibro-cartilaginous and ligamentous structures and the biomechanics of the stifle joint during motion as well as hereditary factors in certain breeds were suggested to be predisposing factors in stifle lameness (Ducharme et al., 1985). Disorders of the bovine stifle include fractures, septic arthritis, traumatic arthritis with injuries of the menisci, collateral, meniscal and/or cruciate ligaments and osteoarthritis (Hurtig, 1985; Munroe and Cauvin, 1994; Gaughan, 1996; Trostle et al., 1997; Tryon and Farrow, 1999).

Radiography, ultrasonography, magnetic resonance tomography (MRT) and computed tomography (CT) have been used in bovine orthopaedics (Kofler et al., 2014). The bovine stifle joint has been thoroughly examined with radiography and ultrasonography (Kofler, 1999; Siegrist and Geissbuehler, 2011) but radiography provides little information on soft tissue structures and ultrasonography is limited to bone surfaces. CT and MRT are valuable diagnostic imaging modalities, but their use in cattle is limited to advanced veterinary clinics due to the high cost and the need for general anaesthesia (Lee et al., 2009; Ehlert et al., 2011; Nuss et al., 2011).

Arthroscopy and arthrotomy offer valuable information for diagnosis and treatment of stifle joint injuries (Hurtig, 1985; Plesman et al., 2013). Arthroscopy is superior to arthrotomy because of the minimal damage to the peri-articular soft tissues, multiple joint approaches, smaller incisions, short operative times, improved intra-articular visibility, enhanced cosmetic appearance, and rapid recovery (Honnas et al., 1993; Necas et al., 2002). In addition, arthroscopy allows examination of structures within the joint that are inaccessible with routine arthrotomy (Honnas et al., 1993; Lardé and Nichols, 2014); however, arthroscopy is not widely used in cattle due to cost and availability, so its use is limited to valuable cows and breeding bulls (Lardé and Nichols, 2014).

The bovine stifle consists of the femoropatellar (FP), medial femorotibial (MFT), and lateral femorotibial (LFT) joints (Dyce and Wensing, 1971; Ashdown and Done, 1984; Nickel et al., 1985; Desrochers et al., 1996; Lopez et al., 1996; Budras et al., 2003; Dyce et al., 2010). The FP and MFT joints always communicate, while the MFT and LFT joints communicate in 57% of bovine stifles (Desrochers et al., 1996).

The cranial arthroscopic approach to the stifle joint has been reported in cattle (Hurtig, 1985; Munroe and Cauvin, 1994; Lardé and Nichols, 2014; Nichols and Anderson, 2014), horse (Martin and

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McIlwraith, 1985; Moustafa et al., 1987; Vinardell et al., 2008), dog (Marino and Loughin, 2010), South American camelids (Pentecost et al., 2012) and sheep (Modesto et al., 2014). Although the caudal approaches to the femorotibial (FT) joints have been described in horses (Watts and Nixon, 2006) and sheep (Modesto et al., 2014), reports on the arthroscopic evaluation of the caudal FT pouches in bovine are lacking. Consequently, the objective of the current study was to develop a satisfactory technique for arthroscopic examination of the FT and FP joints in cattle and to establish a protocol for exploration and characterization of the cranial and caudal aspects of the FT joints to provide a detailed systematic description of the intra-articular structures of the bovine stifle joint.

Materials and methods

Study design

Pelvic limbs (26) from (13) adult Holstein–Friesian cow cadavers euthanased for reasons unrelated to orthopaedic disease were evaluated. Arthroscopic exploration of 22 stifles was performed (12 cranial and 10 caudal compartments) and four stifles were dissected in detail to demonstrate the regional anatomy. The animals' ages ranged from 3 to 12 years (mean 3 years) with weights ranging from 400 to 600 kg (mean 475 kg). The limbs were disarticulated at the hip joint, stored at −20 °C, and thawed at room temperature for all procedures. Anatomical evaluations were performed via gross dissection, computed tomography and arthroscopy.

Anatomical study

A gross dissection was performed in four limbs to determine the anatomical landmarks for the arthroscopic portals, the intra-articular structures and the communication between the FT and FP compartments. In order to ensure correct identification of the anatomical structures seen arthroscopically, long spinal needles (Spinocan 22G × 180 mm, B. Braun) were placed into each tissue under arthroscopic guidance, and tissue identity was confirmed with subsequent dissection.

Gross dissection was performed at the end of each procedure to determine entry site and structures penetrated during portal creation. Fluid extravasation and iatrogenic damage to the articular surfaces were observed and recorded.

Computed tomography (CT)

Survey CT scans were performed on three cadavers using a 16-detector row helical scanner (Philips Mx8000 IDT 16-slice helical CT scanner). The acquisition settings were: 120 kV, 400 mA, slice thickness of 1 mm, slice increment of 0.6 mm, rotation time of 1 s, pitch of 0.635, scan field of view of 45 cm, window width of 2000 and window level of 500 Hounsfield Units and matrix size of 512 × 512 pixels. Reconstruction of the transverse images was performed and a three-dimensional image was created to illustrate the relationships between the osseous and soft tissue structures of the stifle joint (Figs. 1–3).

Arthroscopy

Instruments

A 4 mm diameter and 30° angle view arthroscope (Storz) was used to evaluate the three compartments of stifle joint. Continuous joint irrigation and distension were maintained using an Arthroflow (Ormed) system. A fibre optic light cable connected to a 175 W, xenon light source (Karl Storz Endovision) was attached to the arthroscope to provide joint illumination. Representative images and videos were recorded for later review (Aida Vet DVD, Karl Storz Endovision).

Cadaver positioning and preparation

Limbs were tied just below the fetlock joint, elevated and positioned as if the animal was in dorsal recumbency using an overhead hoist. The arthroscopic sleeve and conical obturator were manipulated into the MFT with the stifle joint in 120° of flexion. The cranial and caudal compartments of the FT joints were examined with the stifle joint in 90° of flexion. Limbs were secured in position via a metal frame attached medially and laterally to the thigh region. The stifle region was clipped of hair and cleaned.

Joint distension

Due to the communication between the three compartments of the stifle joint in most instances (nine cadavers), joint distension was achieved through needle insertion into the craniomedial FT joint. An 18 G needle was inserted approximately 1–2 cm cranial to the medial collateral ligament, halfway between the medial tibial plateau and medial femoral condyle. The joint was distended with 30–60 mL saline solution until the joint pouch was visibly distended and there was mild resistance to injection. In three cadavers, the cranial LFT and MFT pouches appeared to be separated by a synovial septum and distension of the LFT joint was achieved via 30–60 mL saline using an 18 G needle inserted between the lateral and middle patellar ligaments.

Surgical procedure

Cranial FT and FP joints

Using a number 15 scalpel blade a 1 cm incision was created through the skin and fascia between the middle and medial patellar ligaments halfway between the tibial crest and the distal aspect of the patella. The arthroscopic sleeve and conical

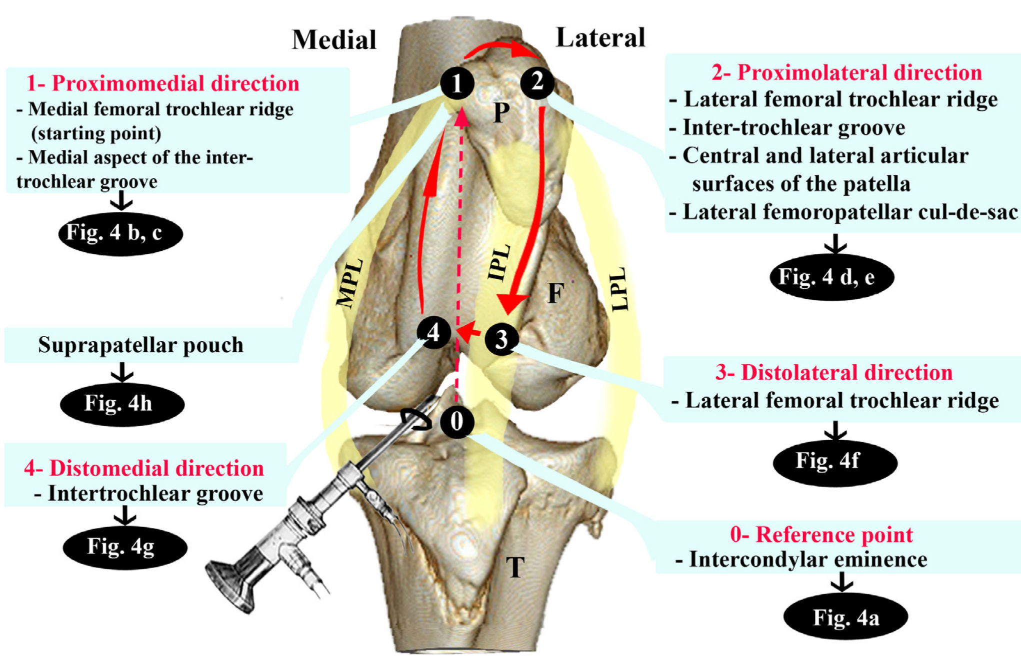

Fig. 1. Computer tomographic image of a left stifle illustrating the arthroscopic approach to the femoropatellar joint using a craniomedial arthroscopic portal (between the middle and medial patellar ligaments). Red arrows indicate the direction of the arthroscope (0–4) within the joint cavity. The intra-articular structures viewed during the arthroscopic investigation and their figure numbers are listed. P, patella; F, femur; T, tibia; MPL, medial patellar ligament; IPL, intermediate patellar ligament; LPL, lateral patellar ligament.