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Ultrasonographic examination of the musculoskeletal system in sheep

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ABSTRACT

Objective of this review is to present relevant information about ultrasonographic examination of sheep and to discuss its applications within the frame of sheep health management. The technique can be employed primarily in the diagnostic procedure of arthritis. It can be of help in rams as part of the clinical reproductive evaluation, as well in sheep with diseases affecting the joints, in which it may support diagnostic procedure and decision-taking for their management.

1. Introduction

Ultrasonographic examination is the most practical and rapid method of obtaining images of the musculoskeletal system and can provide valuable information regarding various disorders. The technique is used extensively in companion animals (e.g., dogs, horses), where, primarily, it is employed to support decisions of surgeons regarding management of orthopaedic cases (Genovese et al., 1986; Kramer et al., 1997), as well as post-operative evaluation of the animals to assess progress of recovery. It can also be employed in other circumstances, for example in cases of microbial diseases (e.g., arthritis) as an adjunct method for accurate diagnosis of the disorder, or to facilitate synovitis detection in cases of osteoarthritis, among other potential uses. The method is also widely employed in sport-performing animals, in which disorders of the musculoskeletal system occur particularly often (Craychee, 1995).

Ultrasonographic examination is not employed in sheep as frequently and as significantly as in companion animals. However, it is a method that may be potentially employed in that species, also given that by means of portable equipment, sheep with orthopaedic problems may be examined in the field, away from veterinary hospitals. There are some references regarding ultrasonographic examination of the musculosceletal system of sheep. Objective of this review is to present the relevant information and to discuss its applications within the frame of sheep health management.

2. Methodology of ultrasonographic examination

In sheep, ultrasonographic examination of joints ('arthrosonography') and/or muscles is undertaken with the animal in standing position or restrained in lateral recumbency. Examination is usually performed using real-time B-mode scanner with a 7.5 MHz linear transducer, whilst it is advisable to use a 1 cm-thick flexible offset device ('stand-off') when information is required regarding thickness of joint capsules and amount and nature of joint effusions (Kofler, 1995, 2009; Nuss, 2007; Scott and Sargison, 2010). Linear transducers are also preferred for tendon evaluations, in order to ensure that the beam is perpendicular to the tissue under examination (Samii and Long, 2002; Kofler et al., 2014; Kofler, 2009). Preparation includes clipping of hair and cleaning skin in the region of interest and application of ultrasound coupling gel onto the skin.

Ultrasonographic orientation is based on identification of familiar and easily identifiable anatomical structures (e.g., bone surfaces, ligaments, tendons and their insertions, joint spaces, vessels). Bone surfaces appear typical in shape and as hyperechoic linear echos (Kofler 1996a,b, 2009; Kofler et al., 2014). Sound waves are acoustically impeded by the intact cortical surface of bones (Samii and Long, 2002). The areas under evaluation should be examined in transverse and longitudinal planes. During ultrasonographic examination of tendons or ligaments, the transducer should be placed parallel or perpendicular to their fibres (Kofler, 2009; Kofler et al., 2014). Joints should be examined in flexion and in extension.

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Fig. 1. Ultrasonographic appearance of normal right elbow joint in a sheep aged 2 years (longitudinal view): the joint is distended after intra-articular infusion of 10 mL normal saline and the transducer is positioned in the cranio-lateral aspect; hyperechoic bone surfaces of lateral humeral condyle (a) and radius (b) are interrupted by the distended joint space (d); joint capsule (c) is clearly visualised as 1.2 mm thick echogenic line covering the bone surfaces; more superficially, the hypoechoic fibre bundles of the extensor muscles can be noted.

Fig. 2. Ultrasonographic appearance of normal right antebrachiocarpal joint in a sheep aged 2 years (longitudinal view): the joint is extended and the transducer is positioned in dorsal aspect; skin (a) and subcutis (b) are visualised superficially; the tendon of the extensor carpi radialis muscle (c) is highly hyperechoic, imaged with multiple parallel lines; the hyperechoic bone surfaces of the distal radius (d) and carpal bone (e) are covered by the joint capsule (f).

The pressure applied by the transducer during examination of soft tissue areas should be minimized; otherwise, fibrous and adipose tissues are compressed and the image received becomes more echogenic (Kramer et al., 1997). It is recommended that, when imaging limbs, bilateral examination is always performed. This will be of significant help for comparison with a healthy side or for identification of differing features between the two sides.

3. Findings during ultrasonographic examination of the musculoskeletal system

3.1. Findings in healthy sheep

3.1.1. Joints

In longitudinal planes, joint spaces are identified as interruptions of the hyperechoic bands that represent the bone surfaces. Bone tissue, articular cartilage, ligaments and tendons can be easily identified in healthy sheep joints. In contrast, possible presence of synovial fluid and the joint capsule are visible only after distension of the joint by intra-articular infusion of 5–10 mL of isotonic saline (Macrae and Scott, 1999). The ‘joint pouch’ is considered to be the maximum width of the synovial cavity; the ‘joint space’ is defined as the maximum width between the bone surfaces of the joint. Joint cavity distension is assessed by measuring the maximal width of the joint pouches (from the articular surface to the synovial membrane) (Kofler, 1996a,b, 2009; Kofler et al., 2014).

The lateral and medial aspects of the elbow joint (*articulatio cubiti*) are visualised longitudinally. After distension with 10 mL saline, the joint capsule can be visualised being 1 mm-thick, whilst the joint pouch is imaged 10–12 mm-wide (Fig. 1).

The dorsal aspect of the carpus (*articulatio carpi*) is also viewed longitudinally; views should be taken with the carpal joint extended and flexed. Dorsal views are preferred, due to presence of collateral ligaments and the accessory carpal bone (*os carpi accessorium – os pisiforme*) at other aspects in this joint. The tendon of the *musculus extensor carpi radialis* and the subchondral bone surface are easily identifiable in a non-distended carpal joint (Fig. 2). Transverse plane is more suitable for initial examination, whilst longitudinal plane is preferred thereafter, as it allows a better overview (Kofler, 2000, 2009; Kofler et al., 2014). A moderately echogenic area overlying the extensor tendons represents subcutaneous soft tissues. Optimum visualisation of the antebrachiocarpal joint can be achieved during flexion. The mid-carpal and carpometacarpal joints can be visualised only after distension with 5 mL saline. The joint pouch varies in size from 5 mm (carpometacarpal joint, *articulationes carpometacarpeae*) to 15 mm (antebrachiocarpal joint, *articulatio antebrachiocarpea*); the joint space is 2 mm-wide, with the joints in flexion and the capsule is 1 mm-thick.

Longitudinal views of the dorsal fetlock joint (*articulationes metacarpophalangeae*) are used. Dorsal views are preferred, due to presence of collateral ligaments and sesamoid bones at other aspects of this joint. After distension with 5 mL saline, the joint capsule can be visualised being 1 mm-thick, whilst the joint pouch is imaged 5 mm-wide.

The stifle (*articulation genus*) is viewed in the longitudinal and transverse axes, with the transducer placed on the cranial, craniolateral and craniomedial aspects of the joint, with the stifle in flexion (Kofler, 1999; Macrae and Scott, 1999). These scanning planes are considered to allow optimal visualisation of the synovial membranes and joint capsules, which are the soft tissue structures most commonly affected in long-standing joint disease in sheep (Angus, 1991). The lateral and medial ridges of the femoral trochlea (*trochlea femoris*), the patella (*patella*) and the lateral and medial condyles of the tibia (*condylus lateralis tibialis*, *condylus medialis tibialis*) are used as anatomic landmarks to orientate the transducer position. These bony surfaces appear as echogenic lines with acoustic shadowing below. The patellar ligament (*ligamentum patellae*) is identified in transverse and longitudinal views as a homogeneously echogenic structure. The fat pad below the patellar ligament and the menisci are visualised, but the joint capsule cannot be identified separately (Fig. 3). Cartilage is visualised as a smooth, distinct hypoechoic image between two hyperechoic lines (the interfaces between soft tissue-cartilage and cartilage-subchondral bone). Full flexion enables better visualisation of the joint. The joint capsule is

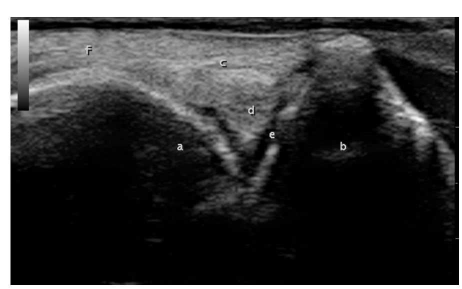

Fig. 3. Ultrasonographic appearance of normal right stifle joint in a sheep aged 2 years (longitudinal view): the joint is flexed and the transducer is positioned in craniolateral aspect; the lateral ridge of the femoral trochlea (a) and the lateral condyle of the tibia (b) appear as hyperechogenic lines with acoustic shadowing below them; the joint capsule (c) cannot be identified separately; the fat pad (d) below the patellar ligament and the menisci (e) are also visualised; the patellar ligament (f) is visualised as a homogeneously highly echogenic structure.

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