Imaging of the Thoracolumbar Region and Pelvis

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Back problems can be a cause of poor performance and lameness in horses. Diagnosis of back pain is a challenge and requires a thorough clinical examination combined with imaging techniques. Imaging allows localization of lesions, which is one of the difficulties in diagnosis of back pain. Palpation can be helpful; however, certain areas are not accessible with palpation. Radiographs can identify osseous lesions. The requirement of general anesthesia for pelvic radiographs is undesirable in many cases. Nuclear scintigraphy provides useful information on the location and physiology of lesions. Ultrasound can be used to document osseous and soft tissue lesions. The significant improvements in technology allow radiographic and ultrasonographic evaluation of the thoracolumbar region and pelvis with better detail leading to identification of lesions that were not accessible or imagined previously.

Thoracolumbar Region

Radiographic technique for the thoracolumbar region in the standing horse has been described.1-2 This process requires a high output x-ray machine and the use of a grid. Additional steps, such as wedge filters and lead backed cassettes, will further improve image quality and decrease scatter. Due to the anatomy and varying degrees of the tissue thickness, multiple views are necessary to adequately image the thoracolumbar region. Five views usually provide a complete examination between T10 and L4 and allow visualization of the dorsal spinous processes and vertebral bodies.2

Nuclear scintigraphy is useful for the detection of abnormalities in the thoracolumbar spine. Lateral and dorsal views provide the most information and aid in localization of lesions. Motion correction software is beneficial and will improve image quality. Shielding during acquisition or masking as a post processing step of areas of normally increased radiopharmaceutical uptake, such as scapulae and kidneys, may improve visualization of lesions.

Dorsal Spinous Processes

The echogenic margins with complete shadowing of the dorsal spinous processes can be easily visualized with ultrasound. In the cranial thoracic spine, calcification of the secondary centers of ossification occurs on the summits of the dorsal spinous processes at approximately 12 months of age.3 These can persist into old age and should not be mistaken for avulsion fractures. The variation in these ossification centers will result in asymmetry between adjacent dorsal spinous processes when imaged with radiographs and
ultrasound. Size, shape, margins and alignment of the dorsal spinous processes should be evaluated on imaging studies.

Impingement of the dorsal spinous processes can be diagnosed using ultrasound and radiographs. This lesion can be identified in the lumbar spine. However, it is most common in the caudal thoracic spine. Ultrasonographic examination can demonstrate contact between the dorsal spinous processes, bony remodeling or transverse thickening of the processes, abnormal alignment and avulsion fracture. The diagnosis of impingement of the dorsal spinous processes should be clinically correlated. This condition can be present in horses without back pain.

Nuclear scintigraphy can be helpful to identify both evidence of active bone remodeling of the dorsal spinous processes as well as other potential lesions. It is important to note that increased radiopharmaceutical uptake is not always indicative of pain. Increased radiopharmaceutical uptake can result from impingement or insertional injuries of the dorsal spinous processes.

**Supraspinous Ligament**

Injuries of the supraspinous ligament are best demonstrated with ultrasound. These injuries can result in focal deformation of the profile of the back with palpable swelling and pain. The normal supraspinous ligament progressively increases in echogenicity in the caudal thoracic and lumbar regions compared to the cranial thoracic region due to increasing fibrous content. The fibers of the supraspinous ligament are oriented caudoventrally as they attach over the dorsal margin or summit of the spinous processes. It may be necessary to change to probe angle to produce the normal echogenic pattern of this ligament throughout its length. The position of the back will also affect to echogenicity of the supraspinous ligament. Extension of the thoracolumbar region may cause relaxation artifact in the supraspinous ligament.

Injury to the supraspinous ligament will appear as abnormalities in size, margins and echogenicity. Fiber disruption can also be identified. Comparison to the adjacent ligaments should be performed. Hypoechoic regions can be the result of fiber disruption and/or fluid accumulation in the ligament. Hyperechoic regions with or without shadowing can result from severe fibrosis, dystrophic mineralization or avulsion fracture. Abnormalities should be documented in 2 planes. In addition to ligament injury, insertional injuries can be documented with ultrasound. Bone proliferation or resorption and avulsion fragments can be identified at the ligament insertion, and often occur with concurrent ligamentous abnormalities.

**Interspinous Ligament and Space**

The fibers of the interspinous ligament are oriented caudoventrally between the dorsal spinous processes. The interspinous space appears hypoechoic because the ultrasound beam cannot be oriented perpendicular to the fibers of the interspinous ligament. Ultrasound can be used to demonstrate narrowing or loss of the interspinous space.
Technique for the Dorsal Spinous Processes, Supraspinous Ligament and Interspinous Ligament

Ultrasonographic imaging of the dorsal spinous processes and supraspinous ligament should be performed with high frequency probe, such as a 7.5 MHz linear probe. An stand-off pad is not usually required to visualize the proximal margin of the dorsal spinous processes but is required for the superficial margin of the supraspinous ligament. The interspinous ligament and space should be imaged with the highest frequency probe that will allow appropriate depth penetration.

Articular Processes: Synovial Intervertebral Articulations

Arthrosis of the articular facets or synovial joints between the vertebrae in the spine has been associated with back pain. This joint which is referred to as the synovial intervertebral articulation is composed of the caudal articular process of one vertebra and the cranial articular process of the following vertebrae. This synovial structure is subjected to stress with exercise and reacts similar to other joints and can develop arthrosis from excessive physiologic stress. The location of the joint relative to the dorsal spinous process varies in the spine. In the mid thoracic region the joint is located in the middle of dorsal spinous process. At the anticlinal vertebra, which is commonly T15 but can range between T14-T16, it is adjacent to the interspinous space. In the caudal thoracic and lumbar region it is in the middle of the dorsal spinous process of the caudal vertebral body.

Radiography can be used to visualize the synovial intervertebral articulations. Superimposition of overlying structures and scatter in this region usually limits detection of mild abnormalities. Ultrasound is more sensitive to abnormalities on the joint margins. However, it is limited to detection of superficial abnormalities. On ultrasound images the joint margins should be smooth and hyperechoic. Comparison of the joint margins on the left to right sides as well as the joints cranial and caudal is essential. The joint space is a hypoechoic line or region between hyperechoic articular margins. The orientation of the joint margins, which varies in the spine, will determine the ease and degree of visualization of the joint space. The mammillary process can be identified on the cranial articular process. The mammillary processes show some variation in location relative to the articular process in the spine. However, they are generally bilaterally symmetrical. Therefore comparison between right and left sides should be performed to differentiate the mammillary process from bone proliferation.

Abnormal Findings in the Synovial Intervertebral Articulations

Nuclear scintigraphy is beneficial for localizing lesions in the spine. Radiographs can demonstrate peri-articular proliferation, bone lysis or resorption, sclerosis and fracture. Ultrasound is often more readily available and demonstrates a variety of lesions, but is limited to superficial margin changes. A combination of imaging method will best to document abnormalities. Dorsal periarticular bony proliferation indicative of joint
arthrosis is the most frequent abnormal ultrasonographic finding. Lack of visualization of the joint space can indicate severe proliferation or anklyosis.

**Technique for the Synovial Intervertebral Articulations**

Imaging of the synovial intervertebral articulations should be performed with the highest frequency probe that will allow adequate depth penetration. Most often this will require a probe between 3.5 to 5 MHz, depending on the size of the horse. The dorsal spinous processes and the transverse processes can be used as landmarks to locate the synovial intervertebral articulation. Using the split screen function on the ultrasound machine is beneficial to compare the symmetry of joints on the right and left sides of the spine. Images should be made in 2 planes and long axis images can be used to compare joints cranial and caudal to the site in question. The synovial intervertebral articulations can be well imaged in the caudal thoracic and lumbar spine. The cranial thoracic spine is more difficult due to the increased depth of the facets and joint space. In addition to the diagnosis of lesions, ultrasound can be used for guided injections.

**Pelvis and Coxofemoral Joint**

Complete ultrasound examination of the pelvis requires transrectal and transcutaneous examination. Transrectal examination allows visualization of the intervertebral discs (L4-S1), the intertransverse lumbar joints, the sacral foramina and associated nerve roots and the sacroiliac joint. In addition, the ilial wing and body, medial acetabular margin, pubis, and ischium can also be evaluated. Transcutaneous examination allows visualization of the dorsal sacroiliac ligaments, the ilium and the coxofemoral joint.

The ventral aspect of lumbosacral joint on midline and can be used as a reference for the starting point of the transrectal exam. The L6-S1 intervertebral disc is normally the most caudally visible intervertebral disc after imaging in cranial direction along the ventral midline margin of the fused sacral vertebrae. Ankylosis or sacralization of the L6 can obscure this landmark. Continuing cranially along the ventral margin of the vertebral bodies will allow visualization of the intervertebral discs of L5-L6 and L4-L5. Moving the probe in an abaxial or lateral direction from midline will allow visualization of the S1 nerve root and foramen. Continuing cranially will allow visualization of the L6 nerve root and foramen as well as the intertransverse lumbar joint. The lumbosacral intertransverse joints are imaged laterally to the L6 ventral intervertebral foramen which contains the echogenic L6 nerve root. Only the medial aspect of this joint can be examined. The lateral part is obscured by the iliopsoas muscles.

Dynamic examination of the lumbosacral joint can be used to assess the intervertebral disc during flexion and extension. During flexion the intervertebral disc bulges ventrally and the ventral intervertebral disc space narrows as the lumbosacral joint angulation decreases. During extension, the ventral aspect of the intervertebral disc straightens due to increased tension and the intervertebral disc space thickness widens as the lumbosacral joint angulation increases.
In normal horses, the L4 and L5 intervertebral disc spaces are thinner than the lumbosacral disc space. Only the ventral aspect of these intervertebral discs is consistently imaged. This is a consequence of the shape of the joint space which results from the curvature of the endplates of the vertebral bodies in this region. The caudal endplate is convex and the corresponding cranial endplate is concave, the curvature in this region obscures the joint space.

The normal intertransverse joint is imaged as a small anechoic line created by the hyperechoic ventral bone surfaces of the transverse processes of the L6 and S1 vertebrae. The joint margins are normally smooth and regular.

Transrectal examination allows evaluation of the sacroiliac joint. The normal sacroiliac joint has smooth margins and the ventral sacroiliac ligament can be identified filling the joint space. This ligament is triangular in shape and uniformly echogenic. Transcutaneous examination can be used to evaluate the dorsal sacroiliac ligaments and the margins of the tuber sacrale. Due its position in the pelvis, the interosseous ligament of the sacroiliac joint can’t be imaged with ultrasound.

Abnormalities in the Pelvis

Narrowing of part or the entire intervertebral disc is indicative of intervertebral disc disease. Ankylosis of the joint space or sacralization of L6 will prevent identification of the lumbosacral joint space. Ankylosis of the lumbosacral joint can put additional stress on the L5-L6 joint space and intervertebral disc predisposing it to injury. Widening of this joint space has been detected in horses with lumbosacral ankylosis. Abnormalities in echogenecity in the intervertebral disc can provide additional evidence of disc disease. Decreased echogenecity in the disc can indicate disc degeneration, fiber rupture or focal cavitation. Focal hyperechoic regions with and without shadowing can represent mineralization or fibrosis in the disc. Ventral spondylosis in the spine can also be detected. Abnormalities identified in an intervertebral disc space require careful examination of surrounding intervertebral discs and joint for associated abnormalities. Peri-articular proliferation, ankylosis, and focal bone resorption and/or osteolysis can be identified in the intertransverse lumbar joint. Peri-articular proliferation on the joint margins and thickening of ventral sacroiliac ligament can be identified with transrectal examination of the sacroiliac joint. Injury to the dorsal sacroiliac ligaments characterized by abnormalities in echogenecity and fiber can be identified with transcutaneous examination. Enthesopathy at the attachment of the dorsal sacroiliac ligaments on the tuber sacrale can also be identified.

Technique for Imaging the Pelvis

Transrectal examination should be performed with a high frequency linear probe, such as a 7.5 MHz probe. Transcutaneous examination of dorsal sacroiliac ligaments and tuber sacrale requires high frequency probe, while examination of the ilial wing and body requires a 2-5 MHZ probe for depth penetration.
Coxofemoral Joint

Radiographic examination of the hip in the adult horse usually requires a high output machine and general anesthesia. A standing technique for radiography of the pelvis has been described. However, this technique provides a limited view of the pelvis compared with images obtained under general anesthesia. In many cases, ultrasound and nuclear scintigraphy used in combination can provide a diagnosis without the risks associated with recovery from general anesthesia. Ultrasound is readily available and can provide valuable information about the coxofemoral joint with transrectal and transcutaneous exam.

Transcutaneous examination of the coxofemoral joint can be performed starting with the greater trochanter as a landmark. Moving the probe cranial and angling it ventrally will allow visualization of the acetabulum, caudal aspect of the femoral head, femoral neck and the cranial margin of the greater trochanter. The bone margins should be smooth and regular. Due to the depth of this joint subtle lesions may be difficult to detect. Ultrasound guidance can be used for arthrocentesis of the coxofemoral joint. The medial margin of the acetabulum can be imaged transrectally. After identifying the cranial margin of the pubis and the obturator foramen and then moving the probe laterally towards the coxofemoral joint the medial margin of the acetabulum can be identified by an increased dimension in the bone width in the cranial to caudal direction. The bone will narrow again at the transition to the ilial body. The bone margin on the medial margin of the acetabulum has a vascular groove, but otherwise should be smooth and echogenic.

Abnormalities in the Coxofemoral Joint

Per-articular osteophyte formation, synovial effusion and joint capsule thickening can be identified with transcutaneous examination of the coxofemoral joint. Diagnosis of fracture of the acetabulum, caudal femoral head and neck can be achieved with transrectal and transcutaneous examination of the coxofemoral joint, depending on the location of the fracture. Discontinuity of the bone, hematoma, and bone fragments can be identified with fractures in this region.

Technique for Imaging the Coxofemoral Joint

Transrectal examination of the acetabulum is best performed with a high frequency, 7.5 MHz linear probe. Transcutaneous examination of the coxofemoral joint of a horse requires between 2-5 Mhz probe, depending on the size of the horse and the overlying muscle mass.

References