How to Perform a Transrectal Ultrasound Examination of the Lumbosacral and Sacroiliac Joints

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1. Introduction

There is increasing interest in pathology of the lumbosacral and sacroiliac joints giving rise to stiffness and/or lameness and decreased performance in equine sports medicine.1–3 Pain arising from these regions can be problematic alone or in conjunction with lameness arising from other sites (thoracolumbar spine, hind limbs, or forelimbs).4 Localization of pain to this region is critically important through clinical assessment, diagnostic anesthesia, and imaging.

In general, diagnostic imaging of the axial skeleton and pelvis is difficult to perform and to interpret. Radiography is infrequently performed. To obtain good-quality diagnostic radiographs, general anesthesia, a high-output radiographic generator, and special techniques must be performed.5,6 Variation in the size and shape of the sacroiliac joints and sacral wings and caudal sacral osteophytes are common7,8; special techniques for taking radiographs have allowed for identification of these structures and the inter-transverse joints.5 These authors urge caution in the interpretation of lesions identified on radiography in the absence of other diagnostic imaging and clinical examination. Nuclear scintigraphy is an important component of work-up for sacroiliac region pain, but limitations exist. Several reports9,10 exist detailing the anatomy and technique findings in normal horses11,12 and findings in lame horses.13 Patient motion, camera positioning, and muscle asymmetry can cause errors in interpretation. In normal horses, the appearance of the sacroiliac region varies with age but is generally symmetric. In horses with sacroiliac problems, it is more difficult to distinguish the tubera sacrale from the sacroiliac joint than in normal horses, and, in horses with lameness, there is more asymmetry detected.12,13

Techniques for percutaneous and transrectal ultrasound examination have been described, and
their use is increasingly common.\textsuperscript{2,14–19} Ultrasound is very useful for the evaluation of the joint margins and lumbosacral intervertebral disc.\textsuperscript{14} Similar to the radiographic anatomy of the region, variability exists in the appearance of the tubera sacrale, dorsal sacroiliac ligaments, thoracolumbar fasciae, and the lumbosacral joint.\textsuperscript{3,19} Artifacts of acquisition and interpretation can occur with improper technique in the ultrasound examination, and knowledge of reference images and the regional anatomy is paramount in accurate interpretation of diagnostic imaging studies of this region. All diagnostic imaging techniques should also be interpreted in light of the anamnesis and the static and dynamic clinical examination.

The purpose of this “How-to” presentation is to provide a review of the technique for transrectal ultrasound with reference images and ultrasound images of examples of pathology of the lumbosacral junction, lumbosacral intertransverse joints, and sacroiliac joints. This presentation will review imaging findings in 231 horses presenting to Lingehoeye Diergeneeskunde, Equine Referral Hospital, The Netherlands, for evaluation of stiffness or poor performance in 2012.

2. Materials and Methods

The diagnostic imaging picture archiving and communications system (PACS) of Lingehoeye Diergeneeskunde was searched for all horses undergoing transrectal ultrasound during 2012. Age and breed data were collected. All horses had a complete clinical evaluation for poor performance. After anamnesis and static and dynamic examination, a percutaneous examination of the lumbar spine and a transrectal examination of the sacroiliac and lumbosacral junction were performed.

Transrectal ultrasound examination was performed with the use of the technique described by Denoix.\textsuperscript{20} and illustrated in Fig. 1. A 5- to 10-MHz micro-convex intra-operative ultrasound probe was used per rectum. All horses were sedated with an \textalpha-2 agonist and restrained in stocks. The rectum was cleaned, and copious lubricant was introduced into the rectum. A stand-off pad was not used. Anti-spasmodic agents were used infrequently (nine horses). The ultrasound images are oriented so that ventral is to the bottom of the image display screen, and, when appropriate, cranial is to the left.

Technique

Step 1: Lumbosacral Disc

Transrectally, the aorta and its bifurcation (normally at the level of the fifth lumbar vertebra) can be palpated. Place the ultrasound probe in a median plane, caudal to the aorta and vena cava (bifurcation normally at the level of L5). The L6 and S1 vertebrae can be recognized by the well-defined hyperechoic shadowing ventral margins, meeting at approximately a 140° to 150° angle. At this site, the lumbosacral (LS) disc, the ventral longitudinal ligament, and, occasionally, the dorsal longitudinal ligament, can be identified (Fig. 2). At this location, scan the entire disc by moving the probe left and right, maintaining a paramedian orientation of the probe.

Step 2: Intervertebral Disc and Vertebral Bodies of L5–6 and L4–5

From the LS disc, move the ultrasound probe in a cranial direction while maintaining the median plane orientation. As the probe is moved forward, maintain visualization of the ventral vertebral margin. The L5–6 disc is just dorsal and is usually caudal to the aortic bifurcation. The probe is moved cranially to identify the L4–5 disc space dorsal to the aorta.

Step 3: Lumbosacral Intervertebral Foramen

Identify the LS disc space. Move the probe in a lateral direction, maintaining a paramedian imaging plane. As the probe is moved laterally, look for a smoothly demarcated defect in the bone surface that represents the intervertebral foramen. Once
the defect is identified, look for the L6 nerve root that can be identified as a bundle of long, parallel, hyperechoic fibers. When the foramen is first identified, the imaging plane will be oblique to the nerve, and probe manipulation is needed to orient the ultrasound probe parallel to the nerve root to char-

Fig. 2. These images depict the desired ultrasound image and probe position for evaluation of the lumbosacral joint, including the LS disc, in a median plane (A1 and A2) and a transverse plane (B1 and B2). This represents Step 1 of the examination. Stars mark the spinal cord; X marks the ventral longitudinal ligament.

Fig. 3. This image depicts a paramedian plane of the lumbosacral intertransverse joint and the associated probe position along the ventral aspect of the sacrum. This represents Step 4 of the examination. Arrow demarcates the joint space.
characterize this structure as it passes through the foramen.

*Step 4: Lumbosacral Intervertebral Intertransverse Joints*

From the LS intervertebral foramen, continue to move in a lateral direction to cross the LS intertransverse joint. The joint is identified as a small defect in the bone surface (Fig. 3). Center the surface defect (joint space) in the ultrasound image and move the probe in a medial to lateral direction while maintaining a paramedian probe orientation. This allows for evaluation of the joint margins.

*Step 5: S1–2 Intervertebral Foramen*

Return to the L6 nerve root at the LS intervertebral foramen (see Step 3). Move the entire probe in a caudal direction, maintaining the same probe orientation to identify the S1–2 intervertebral foramen and the S1 nerve root. The imaging characteristics are similar to the LS intervertebral foramen and the L6 nerve root. The operator must maintain awareness of their orientation and location relative to the described landmarks in order to insure accurate identification of these structures.

*Step 6: Sacroiliac Joint*

From the S1 nerve root, move the entire probe in a lateral direction, maintaining a paramedian probe orientation. The ventral surface of the sacral wing has a convex contour, allowing it to be identified. As the probe is moved along the convexity of the sacrum, a large artery, the caudal gluteal artery, will be identified. Immediately dorsal to the caudal gluteal artery, the convex surface of the sacral wing will form a junction with another hyperechoic shadowing but flat bone surface. This junction represents the sacroiliac joint. The caudal gluteal artery is used as an acoustic window for evaluation of the sacroiliac joint margins. Additionally, the ventral sacroiliac ligament can be identified, providing an additional landmark for the sacroiliac joint. The

Fig. 4. These images depict longitudinal sections through three different sacroiliac joints (A) and the associated probe position (A1 and A2). Star marks the ventral sacroiliac ligament. This represents Step 6 of the examination. Arrow marks the joint space.
ventral sacroiliac ligament long axis is oblique to the paramedian imaging plane and perpendicular to the joint margin; therefore, probe manipulation is required to optimize images of this ligament.

Make longitudinal images of the caudomedial margin of the sacroiliac joint including the ventral sacroiliac ligament (Fig. 4).

Optional: Step 7: Psoas Minor Tendon
Move the entire probe in a lateral and ventral direction along the ventral concavity of the ilium. The psoas minor tendon is encountered and can be identified by the typical imaging characteristics of a tendon (long, parallel hyperechoic fibers). This structure can be tracked by means of ultrasound to its attachment on the ilium.

Step 8
Repeat for the contralateral side. Using the same imaging landmarks identify the contralateral intervertebral foraminae, lumbosacral intertransverse joint, sacroiliac joint, and ventral sacroiliac ligament. The psoas minor tendon and its insertion on the ilium can also be visualized at this site.

Ultrasound images were reviewed on a dedicated workstation with DICOM viewing software (eFilm, Merge Healthcare), including digital calipers. One author reviewed the images of the lumbosacral disc,
intertransverse joint, and sacroiliac joint, retrospectively (H.J.B.). To grade the following structures, a subset of reference images were identified and graded as normal, mild, moderate, or severe by two authors (H.J.B. and S.M.P.). On the basis of the subset of reference images, the grading of the remaining images was performed. The LS disc echogenicity and homogeneity were considered together, and the disc was graded (normal, mild, moderate, severe). The LS disc grading was mild if the disc has localized regions of increased echogenicity or changes from homogenous to mildly heterogeneous, moderate if there was increased echogenicity and the disc appeared heterogeneous, and severe if the disc was hyperechoic and heterogeneous (Fig. 5). The vertebral margins at the LS intervertebral space were characterized for changes in shape and margination (normal, mild, moderate, severe). They were considered mildly abnormal if there was focal irregularity or shape change, moderate if the irregular margination involved most but not all of the vertebral border, and severe if the margin was irregular and there was shape change indicating bone modeling (Fig. 6). The intervertebral space was measured from the caudoventral margin of L6 to the cranioventral margin of S1. The degree of ventral bulging of the LS disc was measured in the fashion described by Nagy et al3 (Fig. 7). The left and right sacroiliac joints were considered separately. Bone proliferation as identified by increased size and irregular margination at the joint margin was characterized for the ilium and the sacrum (normal, mild, moderate, and severe) (Fig. 8 and Fig. 9). The ventral sacroiliac ligament was noted as normal or abnormal if it was thickened and heterogeneous. The lumbosacral intertransverse joints were also characterized as normal or abnormal if proliferation was identified. Descriptive statistics were calculated.

3. Results
Two hundred thirty-one horses were identified. The breed distribution included 199 Warmblood horses and 32 other breeds. The mean age was 8.8 years (standard deviation = 3.7). The median age

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Fig. 6. These composite images depict three different grades demonstrating alterations in the lumbosacral joint vertebral margins. Images are made in a median plane. Alteration in margination is demarcated by the arrowheads. A, Focal, mild change; B, regional, moderate change; C, severe change along the majority of the visible margin of L6.

Fig. 7. This median plane image of the lumbosacral joint demonstrates the measurements. Measurement A (1.8 cm) was made from the caudoventral margin of L6 to the cranioventral margin of S1. Measurement B (0.3 cm) was made by drawing a line perpendicular to measurement A to the ventral margin of the intervertebral disc. Stars mark the ventral longitudinal ligament.
was 8, with a range of 3 to 22 years. In 227 horses, poor performance was attributed at least in part to abnormalities of the lumbosacral or sacroiliac joints. Four horses were asymptomatic, and transrectal ultrasound was performed as a part of pre-purchase examination.

Images of 228 lumbosacral disc spaces were reviewed. There was sacralization of the LS space in three horses (1%). Three horses were excluded because diagnostic images were not saved to the PACS. Because of data presented previously by Nagy and Dyson, normal and mild were considered...
together for the lumbosacral disc space descriptive characteristics. The results for ultrasound findings of the lumbosacral disc and vertebral margins are presented in Table 1 and Table 2, respectively. Measurements of the lumbosacral disc space and LS disc bulging are presented in Table 3. Abnormalities of the lumbosacral intertransverse joints were infrequent, with 38 of 462 (8%) identified.

Sacroiliac joint abnormalities were separated into joint margin abnormalities on the ilium and on the sacrum; the results are presented in Table 4. Left and right were considered separately, and, of the total abnormal sacroiliac joints (n = 173), abnormalities of the left were identified in 71 and abnormalities of the right were identified in 102. The ventral sacroiliac ligament was characterized as abnormal (thickened and heterogeneous) in 113 of 461 (24%) joints. Similar to the intertransverse joints, when considering moderate and severe abnormalities of the sacroiliac joints, abnormalities of higher severity were more frequently identified on the right 71 of 113 than the 42 of 113.

4. Discussion

The objective of this report was to provide a review of the procedure for transrectal ultrasound evaluation technique of the lumbosacral and sacroiliac joints and to provide reference images from a population of horses with clinical signs of lumbosacral and/or sacroiliac dysfunction. For each of the anatomic sites evaluated, this population of horses had variability in the severity of the abnormal findings. It remains difficult to determine the clinical significance of alterations in echogenicity and margination at the lumbosacral joint. In this group of horses, there was variability in the echogenicity of the LS disc and the margination of the endplates of L6 and S1, but the majority of horses were categorized as normal or mildly abnormal. A moderate proportion of horses were described as moderate to severely abnormal. Previous reports detailing the ultrasound evaluation of this region in horses without clinical signs of lumbosacral disease demonstrated that there can be variability in the echogenicity and margination at this site, but marked change was not present. Although it is impossible to make a direct comparison of the two studies, it is likely that horses in this population with moderate or severe ultrasound changes have clinically significant imaging findings. Moderate to severe changes at the lumbosacral junction are identified in clinically abnormal horses. It must be underlined that subclinical manifestations with incidence on the horse behavior, locomotion, or performance do exist.

Anomalous anatomy was rare in this population. Historic literature has discussed variability in the anatomic configuration of the pelvis and lumbosacral region, and sacralization of the lumbar vertebra has been reported previously. Ultrasound evaluation is limited to the ventral aspect of the osseous structures, and the identification of anomalies is dependent on the anomaly causing overall shape change of the vertebra or loss of the intervertebral disc space, visible from the ventral surface.

Lumbosacral intertransverse joint pathology was also very uncommon in this population. Ultrasonic evaluation of these joints is limited to the ventral joint margin. Postmortem evaluation of Thoroughbred racehorses showed that the entire population had degenerative changes of the intertransverse joints. The low incidence of intertransverse joint pathology relative to this previous report may be caused by the differences in patient population or possibly the limitations of transrectal ultrasound as compared with ex vivo postmortem evaluation. Lumbosacral intertransverse joint pathology has been observed with a higher prevalence in racing Standardbred trotters.

The sacroiliac joint abnormalities of the majority of horses in this study showed normal or mild changes. Nevertheless, slightly greater than one

<table>
<thead>
<tr>
<th>Table 1. Lumbosacral Disc Echogenicity</th>
<th>Number (n = 225)</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Normal</td>
<td>120</td>
<td>82</td>
</tr>
<tr>
<td>Mild</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>35</td>
<td>16</td>
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<tr>
<td>Severe</td>
<td>4</td>
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<tr>
<th>Table 2. Lumbosacral Disc Space Vertebral Margins</th>
<th>Number (n = 225)</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Normal</td>
<td>146</td>
<td>92</td>
</tr>
<tr>
<td>Mild</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Severe</td>
<td>6</td>
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<tr>
<th>Table 3. Lumbosacral Disc Space Measurements</th>
<th>LS Disc</th>
<th>Measurement A</th>
<th>Measurement B</th>
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<tbody>
<tr>
<td>Mean (SD)</td>
<td>15.4 mm (2.5)</td>
<td>1.7 mm (0.95)</td>
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</tr>
<tr>
<td>Median (range)</td>
<td>15 (8–22)</td>
<td>2 (0–3)</td>
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<th>Table 4. Sacroiliac Joint Margin Bone Proliferation</th>
<th>Number</th>
<th>Percentage</th>
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<tr>
<td>Sacrum (n = 462)</td>
<td>Normal</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>53</td>
</tr>
<tr>
<td>Ilium (n = 462)</td>
<td>Normal</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>32</td>
</tr>
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third of horses in this group with clinical signs had moderate to severe sacroiliac changes. Ultrasound evaluation of the joint margins allows for the identification of periarticular proliferative new bone (osteophytes), as expected in this or any other joint with joint disease. Variability in the appearance of the sacroiliac joint is expected in normal populations; however, many publications agree that abnormalities of increasing severity are increasingly likely to be clinically significant.4,10,12,18 Scintigraphic abnormalities are often identified in horses with hind limb lameness; however, care should be taken in the interpretation of these findings because overlap exists between horses with sacroiliac disease confirmed by diagnostic anesthesia and horses with other causes of hind limb lameness.4,12,13 It is likely that a similar corollary exists for ultrasound evaluation of the same region, whereby overlap exists between clinically significant and clinically silent pathologic change. However, sacroiliac pathologic change has been a common finding in postmortem studies, which may indicate that this truly represents a common pathology.7,8,21 By contrast, it is also important to recall that ultrasound of the caudomedial margin of the sacroiliac joint may represent a small window relative to overall size of the joint and associated soft tissue structures.

In summary, transrectal ultrasound of the sacroiliac and lumbosacral joints is a key component the evaluation of horses with lumbosacral and sacroiliac stiffness or poor performance. The technique requires a knowledge of the anatomy, the ability to perform ultrasound, good equipment, and knowledge surrounding the identification and interpretation of abnormalities. Transrectal ultrasound should be used in conjunction with anamnisis, complete clinical examination, and percutaneous ultrasound evaluation of the lumbar facet joints. This technique can be used to guide diagnostic and treatment decisions. Although it is a potentially useful technique for prepurchase examination evaluation, caution should be exercised in image interpretation until a broader body of knowledge exists.

References