Equine back disorders 1. Clinical presentation, investigation and diagnosis

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Potential back pain is frequently investigated as a cause of poor performance or behavioural problems in horses. The term 'back pain' encompasses a range of osseous, muscular and ligamentous pathologies and it is often challenging for the equine veterinarian to determine whether a horse has primary back pain, back pain secondary to lameness and an alteration in gait pattern, or has a training or behavioural issue. Careful examination and analysis is essential to reach an accurate diagnosis in these cases. This article, the first in a two-part series, will discuss the approach to investigating suspected back pain, including the appropriate choice of diagnostic tests and imaging modalities to aid decision making in these potentially difficult cases. The second article, to be published in a subsequent issue of *In Practice*, will describe the conservative and surgical treatment options for the management of thoracolumbar and sacroiliac region pain.

Presentation

Horses with back pain may present with a variety of clinical signs. A subtle reduction in ridden performance or increase in sensitivity during handling or grooming may be the only noticeable signs. In other cases, an inability to saddle or mount the horse, or dangerous behaviour during riding, may be apparent – owners frequently report a marked change in the demeanour of the horse. History taking provides an opportunity for a veterinary surgeon to gauge the experience of the rider and gain an impression of the horse-rider relationship. Some important questions to ask when taking a history are given in Box 1.

A breed predisposition has been identified for some conditions, with thoroughbred horses more likely to be diagnosed with impingement of the dorsal spinous processes (IDSP) than warmbloods or thoroughbred crosses (Zimmerman and others 2012). In the same study, racing was the discipline in which IDSP was most commonly diagnosed, although other research has identified a high proportion of IDSP in jumping and dressage horses. Warmblood sports horses used for dressage and showjumping may be at an increased likelihood of developing sacroiliac (SI) joint pain with a history of chronic decrease in performance. SI joint disease in standardbred pacing horses has also been reported and is thought to occur as a result of lateral bending forces placed on the SI region during motion (Haussler 2010).

Assessment

Clinical examination

Assessment of overall conformation of the horse may give an indication as to potential disease processes, and some useful anatomical information about the thoracolumbar vertebral column and SI joint is provided in Box 2. Short-backed horses may be at an increased risk of developing vertebral injury due to reduced flexibility of the vertebral column, while long-backed horses may develop ligamentous injuries (Goff and Cook 2007). The same number of dorsal spinous processes (DSPs) is fitted into a shorter distance in short-backed horses and it is speculated this may increase the likelihood of IDSP (Henson and Kidd 2009).

A thorough static clinical examination should be carried out during evaluation of horses for back pain, including full limb palpation to rule out orthopaedic abnormalities. Symmetry of the tuber sacrale, tuber coxae and tuber ischii should be assessed with the horse standing square on a level surface. The thoracolumbar epaxial musculature and gluteal, quadriceps and semitendinosus/semimembranosus musculature should also be assessed

Box 1: Important questions to ask during history taking

- What is the current/intended use of the horse and at what level is it currently working?
- What is the exact nature of the problem and the activities during which the problem occurs?
- Has the horse suffered any known traumatic incident?
- Has the owner observed any alteration in musculature or symmetry of the back and pelvis?
- Has, or is, the horse currently undergoing any veterinary or complementary treatments (physiotherapy, chiropractic or acupuncture)?
- Has the problem behaviour or below expected level of performance remained consistent or worsened over time or with management changes?
- Has the horse been examined for lameness or had any previous lameness problems?
- Has the tack been changed and has saddle fit been assessed?
- Has the farrier reported any difficulty in lifting the limbs or altered wear of the shoes?
- What is the experience level of the rider(s)?
- Does the problem occur with just one rider or with multiple riders?

from both sides of the horse and from behind for symmetry and areas of focal or generalised atrophy (Fig 3).

The thoracic spine should be checked for white hairs or alopecic areas, which may be evidence of previous saddle sores. Collagen granulomas (small firm nodules) may develop over the saddle area as a result of pressure from poorly fitting tack or secondarily to insect bites. These nodules calcify with age and are usually painless. In most cases, treatment is not required, although surgical excision or an intralesional steroid injection may be required if the granulomas are causing pain or irritation.

The cervical vertebrae should be palpated. The normal range of motion of the neck can be assessed by encouraging the horse to flex the head laterally to touch the ribs and ventrally between the forelimbs (Fig 4). Back palpation should be left until the rest of the clinical examination has been completed. Horses normally dip their back (ventroflexion) in response to palpation of the thoracolumbar region and arch it (dorsiflexion) in response to palpation of the SI region. Pelvic dorsiflexion may be elicited by continuing palpation over the pelvis and the semitendinosus/semimembranosus musculature. Palpation of the epaxial musculature should result in lateral flexion of the vertebral column. Excessive tension or spasm within the musculature, boarding of the epaxial musculature, moving away from the examiner and kicking out may all be indicators of pain. There is a marked variation in response depending upon the type and temperament of horse: thin-skinned horses may be more reactive to palpation than cobs or draft breeds.

Box 2: Key anatomical facts relating to the thoracolumbar vertebral column and sacroiliac joints

- There are normally 18 thoracic and six lumbar vertebrae and five fused sacral vertebrae in the horse, although some anatomical variation is recognised (Fig 1).
- Each vertebra has one dorsal spinous process (DSP), two (left and right) transverse processes, and cranial and caudal articular processes (facets), which form synovial articulations with the adjacent vertebral bodies (articular process joints). The vertebral bodies are separated by fibrous intervertebral discs (Fig 2).
- The thoracic vertebral DSPs of T1-14 are angled caudally. T15 is upright and is known as the 'anticlinal vertebra'. The caudal thoracic and lumbar DSPs are angled cranially. The lumbosacral junction forms the widest interspinous space.
- The sacrum is formed from five fused vertebrae. The sacroiliac joints are synovial joints formed by the ilial wings (left and right) and the sacrum, and are supported by ligaments. The dorsal, ventral and interosseous sacroiliac ligaments together form a sling to attach the pelvis to the hindlimbs.
- The musculature associated with the thoracolumbar spine can be divided into several groups (Stubbs and others 2010) that must function efficiently as one. The main muscle groups include:
  - Hypaxial muscles, which are located below the spine and include the ventral abdominal muscles (eg, rectus abdominis and the sublumbar iliopsoas muscle). The iliopsoas muscle controls hip flexion and allows the hindquarters to step under the horse;
  - Epaxial muscles, which are located dorsal and lateral to the spine, and can be subdivided into long and short muscles. The longissimus dorsi is the most significant 'long' muscle and extends from the neck to the sacrum. Bilateral contraction results in hollowing of the back and unilateral contraction in lateral bending. The multifidus muscle consists of multiple segments and is the most significant 'short' muscle, extending from the caudal cervical spine to the sacrum. Short muscles attain a higher degree of localised control over the spine and are responsible for stabilisation and protection of the lumbar spine. The multifidus complex continues caudally as the sacrocaudalis dorsalis complex.

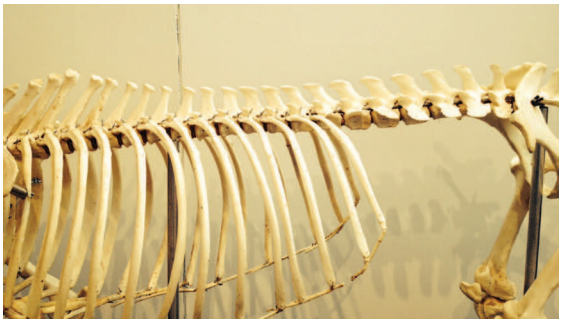

Fig 1: Thoracolumbar spine showing the difference in shape between the thoracic and lumbar dorsal spinous processes

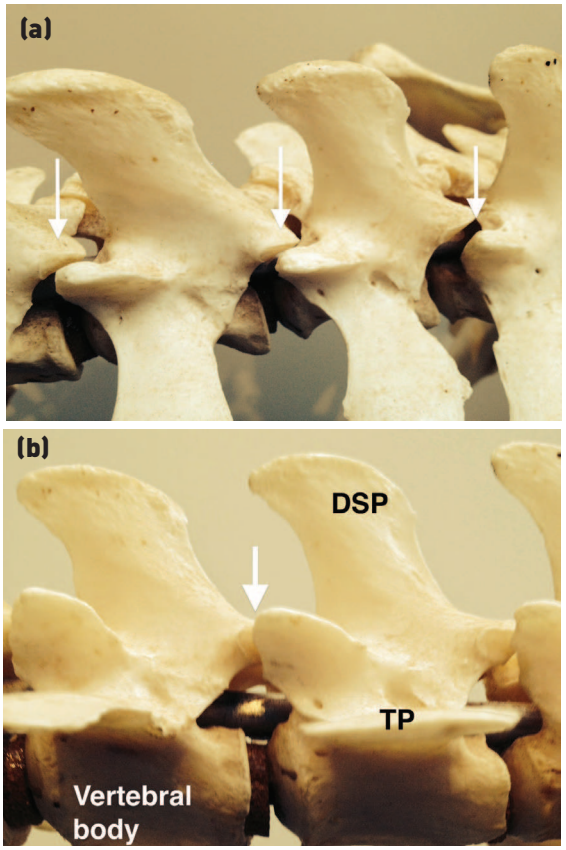

Fig 2: (a) Articular process joints are formed at the junction between the caudal articular process of one vertebrae and the cranial process of the next vertebrae (arrows); they form synovial articulations. The left and right sides of the vertebral bodies have separate joints. (b) Relative positions of the dorsal spinous process (DSP), vertebral body, transverse process (TP) and articular process joint (arrow)

Fig 3: (a) Short-backed horses may be at an increased risk of back pain due to overcrowding of the dorsal spinous processes. (b) Marked atrophy of the left gluteal musculature gives the pelvis an asymmetrical appearance

Dynamic examination

A standard orthopaedic examination, including walking and trotting in hand on a level firm surface, flexion tests and lunging on both reins on both hard and soft surfaces, should be performed to assess lameness and gait abnormalities or inconsistencies. If there is any doubt regarding neurological status, a thorough neurological evaluation should be performed; however, details of this are beyond the scope of this article.

During a lunging exercise, horses with back pain may show one or more of the following abnormalities at exercise:

- A stiff gait with boarding or guarding of the back;
- A reluctance to lower the head and neck;
- Lack of impulsion;
- A 'bunny hopping' gait of the hindlimbs when cantering. As the maximal range of motion at the lumbosacral junction occurs at the canter, clinical signs are often most easily observed at this gait.

Fig 4: To test the flexion and extension of the neck, the horse is encouraged to stretch laterally to both the left and the right. Horses with normal flexion will be able to reach the ribs and girth region, as demonstrated here

The horse should be observed carefully during saddling for any indication of pain or evasive behaviour such as biting or kicking. Incorrectly fitted or inappropriate tack can have a significant effect on equine back pain, and observing the horse with alternative tack may give the clinician additional information.

At times, the aversion to any pressure on the back can be assessed on the lunge with the horse saddled. Ridden exercise is extremely useful and should be performed provided there is minimal risk to the rider. The ridden evaluation should follow the normal ridden exercise programme, including normal head position and movements. Evaluation of lameness, gait abnormality, resistance to going on the bit, evasive behaviours and difficulty in performing transitions or particular movements should be noted. If possible, the horse should be ridden by more than one rider, which may help to determine whether the observed behaviour is a reflection of pain, asymmetry or poor technique of the rider, or is related to training of the horse. In some cases, ridden evaluation will highlight a poorly matched horse and rider.

In one retrospective study, 19 per cent of horses investigated for suspected 'back pain' were diagnosed with concurrent hindlimb lameness and thoracolumbar pain, a further 3 per cent of horses had concurrent hindlimb lameness and SI region pain, and 3 per cent had both thoracolumbar and SI pain with hindlimb lameness (Zimmerman and others 2012). SI disease may present as low-grade chronic lameness or poor performance rather than overt pain on palpation.

It is important that a comprehensive orthopaedic examination is performed before a decision is made on further diagnostics or treatment of a suspected back problem. To treat one without attention to the other can result in a frustrating treatment failure for the client and the veterinary surgeon.

Common back diagnoses for riding horses are given in Table 1. Uncommon pathologies within the thoracolumbar vertebral column include vertebral body fractures, intervertebral disc prolapses and rib fractures. Vertebral body fractures may occur following a single traumatic event or due to cumulative microdamage that results in laminar stress fractures of the lumbar vertebrae. Vertebral spondylosis (ankylosis of adjacent vertebral

Table 1: Common back pathologies in general riding horses

Pathology/disease process	Aetiology/predisposing factors	Location
Impinging dorsal spinous processes (most commonly diagnosed cause of equine back pain)	Certain breeds are predisposed (eg, thoroughbreds) Eventers/jumpers are most commonly affected	T12-T16 most commonly affected
Fractured dorsal spinous processes	Fall or blunt trauma	Predominantly affects withers region (T2-T8) May occur in conjunction with sepsis of the supraspinous bursa
Sacroiliac joint disease (osteoarthritis and desmitis)	May occur secondarily to hindlimb lameness Standardbred pacers and warmblood sports horses are predisposed Dorsal sacroiliac ligament disease may occur secondarily to jumping, high-speed exercise, and falls	Dorsal sacroiliac ligament desmitis Osteoarthritis is chronic and degenerative
Muscle pain/damage	May be the primary cause of disease or secondary to lameness	Multifidus muscle atrophy indicates pathology of the ipsilateral vertebral column
Vertebral body articular process joint disease	May occur secondarily to lack of core muscle strength	Frequently affects two to five joints T15-L2 associated with clinically significant disease

bodies) is reported to occur in approximately 3 per cent of cases of back pain, most frequently at T10-T14 (Meehan and others 2009).

Diagnostic tests

The most frequently used tests for diagnosing back pain in horses include diagnostic analgesia, radiography, gamma scintigraphy and ultrasonography. Selection of the appropriate diagnostic tests will depend upon a number of factors, including the availability and cost of the imaging modalities, the temperament of the horse and any suspicion of multiple pathologies.

Abnormalities noted on diagnostic images may not always be associated with clinical signs and a proportion of horses without clinical evidence of back pain will have atypical radiographic, ultrasonographic or scintigraphic images. It is important to confirm that the abnormalities noted on any images are the cause of back pain or poor performance, so the use of multiple imaging modalities in conjunction with diagnostic analgesia will help to determine their significance.

Fig 5: Horse standing square and positioned between the x-ray tube and the Bucky grid for radiography of the thoracolumbar vertebral column. Metallic markers have been placed at known intervals to aid image orientation

Radiography

Diagnostic-quality radiographs of the thoracolumbar vertebral bodies and DSPs can be obtained in most horses, although in large, well-muscled animals it may be more challenging to obtain images of the lumbar region. Use of a gantry-mounted, high-output radiography machine with a Bucky grid and careful collimation is necessary to optimise radiographic quality and to reduce the dose of radiation to personnel. It is possible to obtain diagnostic-quality radiographs of the DSPs of the thoracic vertebral column using a portable machine; however, images of the vertebral bodies, articular process joints and lumbar vertebral column may be more difficult. Metallic markers should be placed at known intervals along the thoracolumbar spine to aid in interpretation (Fig 5).

It is not possible to obtain diagnostic-quality radiographs of the SI joint.

Evaluation of the DSPs

To evaluate the DSPs, laterolateral views are the most useful. In horses that appear normal radiographically, a clear space can be seen between the spinous processes (the interspinous ligament). The margins of each DSP are smooth and well demarcated with homogenous radiodensity.

IDSP is seen radiographically as a reduction in, or in some cases total loss of, space between the DSPs. Areas of periosteal new bone formation and sclerotic or lucent areas within the subchondral bone are more clinically significant than the close proximity of adjacent DSPs. The cranial margin of the DSP may undergo remodelling and develop a 'beak', and bony ankylosis may occur in severe cases. The pathology is most often located within the proximal third of the DSPs, with a normal space between the spinous processes below this (Fig 6).

A number of studies have provided evidence of IDSP in clinically 'normal' horses (ie, those without evidence of back pain). Jeffcott (1979) identified radiographic

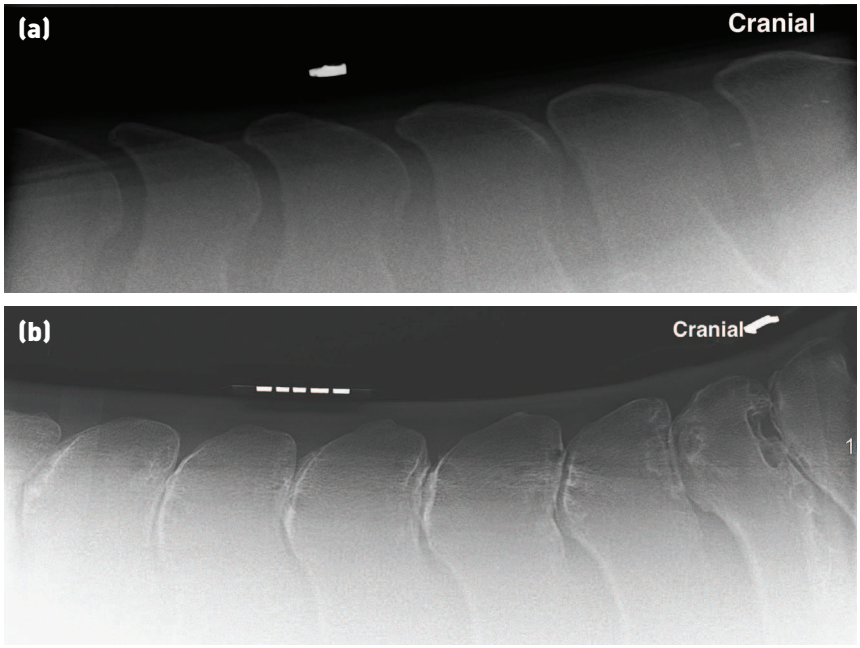

Fig 6: (a) Normal radiographic appearance of the caudal thoracic spine. There is a clear interspinous space between the dorsal spinous processes and the bone is smoothly marginated with no evidence of sclerosis or lysis. (b) Radiograph showing impingement of the caudal thoracic dorsal spinous processes resulting in a loss of the normal interspinous space. Areas of both increased (sclerotic) and decreased (lytic) bone can be seen where there is impingement

abnormalities in 34 per cent of thoroughbred horses that did not have clinical signs of back pain. Similarly, 62 per cent of control horses in a study by Cousty and others (2010) had radiographic abnormalities of the thoracolumbar spine. Therefore, careful interpretation of such findings is essential.

Evaluation of the vertebral bodies and articular process joints

Both laterolateral and lateral 20° proximal oblique radiographic views should be acquired to evaluate the vertebral bodies and articular process joints (Fig 7). Oblique projections are required to counteract superimposition of the left and right articular facet joints. Obtaining these views using a portable radiography system is difficult since higher exposures are required than for these views of the DSPs. Radiographs must be taken from both the left and right sides of the horse to obtain maximum information.

The articular process joints are located proximal to the vertebral bodies at the base of the DSPs. There can be variation in the normal radiographic appearance of the articular process joints within the thoracolumbar spine, with the lumbar articular process joints appearing larger and more irregular than those of the thoracic vertebrae. It can be difficult to visualise the articular process joints in the thoracic spine due to superimposition of the ribs.

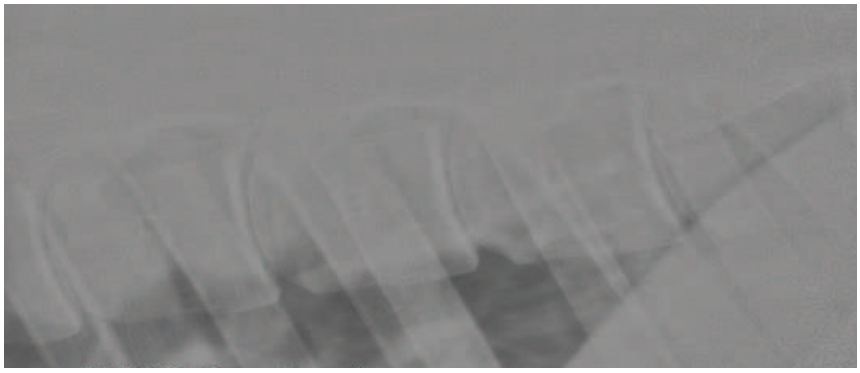

Fig 7: Radiographic appearance of the vertebral bodies in a normal horse

Abnormalities of the joints include loss of clear joint space (accurate radiographic projections are required to determine this), sclerosis, osteolysis and periarticular new bone formation. Abnormalities of the vertebral bodies include ventral proliferative new bone, resulting in ankylosis of the intervertebral joint spaces (spondylosis) and vertebral fractures.

Increased severity of radiographic abnormalities of the DSPs and the presence of IDSP with other osseous pathology, including the articular process joints, has been associated with clinically significant thoracolumbar back pain (Zimmerman and others 2012).

Nuclear scintigraphy

Nuclear scintigraphy is frequently chosen as an imaging modality to assist with the diagnosis of back pain. It may be appropriate when lesions are suspected in a location where radiographic images cannot easily be obtained (such as the pelvis) or to confirm the significance of radiographic abnormalities. It may also be used where violent behaviour under saddle precludes the safe use of diagnostic analgesia.

Nuclear scintigraphy can provide information about the osseous structures of the back, pelvis and SI region; however, it will not provide information about soft tissue structures such as muscles or ligaments, although enthesitic new bone may be apparent. Scintigraphic images of the back, pelvis and hindlimbs are often obtained within the same study, since certain back conditions tend to occur concurrently with hindlimb lameness.

In the scintigraphic process, technetium-99m bound to a bone marker, usually methylene disphosphonate, is taken up by bone in the axial and appendicular skeleton. Increased radiopharmaceutical uptake (IRU) indicates areas of increased or abnormal bone remodelling activity (Fig 8), although all bone will show some uptake as a result of normal levels of constant bone turnover.

Interpretation of nuclear scintigraphic images may be subjective or quantitative (Box 3). Mild IRU within the thoracic DSPs and articular process joints is a normal finding in ridden horses. A specific region of interest can be analysed after images have been obtained and allows quantitative comparison between areas of bone within an image and between matching images on the left and right sides of the horse. The symmetry of the SI joints and ilial wings can be assessed by profile analysis.

Diagnostic anaesthesia

Diagnostic anaesthesia of the thoracolumbar and SI regions can be used to validate imaging findings. The aim is to compare performance under saddle before and following focal injection of a local anaesthetic.

Analgesia of the DSPs

Diagnostic analgesia of the DSPs may be achieved by infiltration of local anaesthetic into the epaxial musculature either side of the spinous processes. A volume of 60 to 100 ml should be distributed between the affected sites, as close as possible to the bone of the process. Alternatively, local anaesthetic can be injected into the interspinous ligament between the affected spinous processes using radiographic guidance;

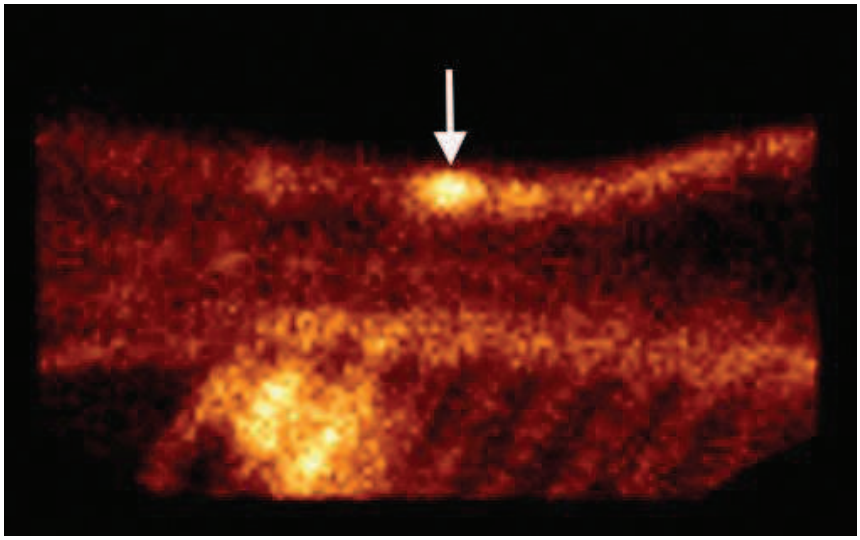

Fig 8: Lateral scintigraphic image showing focal increased radiopharmaceutical uptake (arrow) within the caudal thoracic dorsal spinous processes. An area of increased radiopharmaceutical uptake can also be seen within the right kidney

however, accessing this space may be very difficult in horses with IDSP. All affected DSPs should be blocked at the same time.

Analgesia of joints

Diagnostic analgesia of the articular process joints may be carried out in the thoracolumbar spine, with 5 ml of 2 per cent mepivacaine injected each side of each joint. Accurate placement of local anaesthetic requires ultrasound guidance. One cadaver study reported that only 27 per cent of ultrasound-guided injections of the thoracolumbar articular process joints were correctly positioned intra-articularly, with the rest positioned periarticularly, although it was proposed that if injections were within 2 mm of the joint capsule this may be sufficient for an effect to be seen (Fuglbjerg and others 2010).

Periarticular infiltration of local anaesthetic around the SI joints can be performed using cranial and caudal approaches with or without ultrasound guidance. A cranial approach with a 3.5 inch spinal needle placed on the contralateral side of the SI and advanced across the midline is associated with the least morbidity (Haussler 2010). Care should be taken not to use an excessive volume of local anaesthetic since anaesthesia of the sciatic nerve can occur, resulting in loss of function of the extensor muscles, which can lead to standing difficulties. Inadvertent anaesthesia of the sciatic nerve is reported more frequently when a caudal approach is used. We use 8 to 10 ml of 2 per cent mepivacaine at the left and right sides of the joint.

Sedation

If the horse is going to be examined under saddle after diagnostic analgesia has been performed, sedation should be avoided or minimised to ensure rider safety. However, if sedation is required, a short-acting α2-agonist, such as xylazine, is preferable to longer-acting α2-agonists. Opioids should be avoided since they may have a more significant analgesic effect than α2-agonists.

Interpretation of results

Interpretation of diagnostic anaesthesia results is based on an improvement in the quality of gait and stride length, and a reduction in previously noted evasive or difficult behaviours. Visual assessment of the improvement can be difficult so an assessment of ridden performance before and after the block is frequently the best way to determine any improvement.

Box 3: Interpreting nuclear scintigraphic images of the thoracolumbar vertebral column

- Images should be interpreted with regard to their anatomical location. Structures with little muscle coverage will appear to have a greater degree of radiopharmaceutical uptake than structures located deep to large muscles.
- Asymmetric radiopharmaceutical uptake can occur as a consequence of unilateral hindlimb lameness, focal muscle atrophy or poor positioning of the horse during image acquisition.
- Technetium-99m (Tc-99m)-methylene diphosphonate is excreted via the urinary tract; therefore, build-up of Tc-99m within the kidneys and bladder should be considered during image acquisition and interpretation. Both obtaining oblique images, or allowing the horse to urinate or administering a diuretic to help it empty the bladder will separate it from underlying structures, enabling the clinician to differentiate between pathology and superimposition.
- As with other imaging techniques, suspected lesions should be evaluated using orthogonal views.

Ultrasonography

The most frequent indications for ultrasound examination of the back are to aid the diagnosis of soft tissue injuries and for ultrasound-guided injection techniques. Ultrasonography of the spine and pelvic region should be performed with the horse adequately restrained, ideally in stocks. The area of interest should be clipped and scrubbed before scanning, with the exception of some thin-skinned thoroughbred horses, where soaking of the hair coat and skin with isopropyl alcohol may be sufficient. Both high-frequency (7 to 12 MHz linear) and low-frequency (3 to 7.5 MHz curvilinear) transducers may be required for complete examination. Practice and an understanding of normal anatomy and anatomical variation are required to perform and interpret musculoskeletal ultrasonography effectively.

Ligament injuries

Ligamentous injuries of the supraspinous ligament or dorsal ligaments of the SI joints can be detected ultrasonographically as a change in echogenicity or size, or due to the presence of enthesophytes. The supraspinous ligament is more hyperechoic than the interspinous ligament and may vary in angle as it crosses the summits of the DSPs; this should not be confused with pathology. Pathological changes are uncommon, but include focal areas of hypoechogenicity.

Multifidus muscle abnormalities

In normal horses, the multifidus muscle is a segmental muscle located between the dorsal and transverse processes of the vertebrae and deep to the longissimus dorsi muscle, which extends from the neck to the sacrum. It is shaped like a teardrop and is smallest at the level of T13 (Fig 9), becoming much larger more caudally where greater dorsoventral movement occurs within the spine (Stubbs and others 2011). Comparison of the left and right

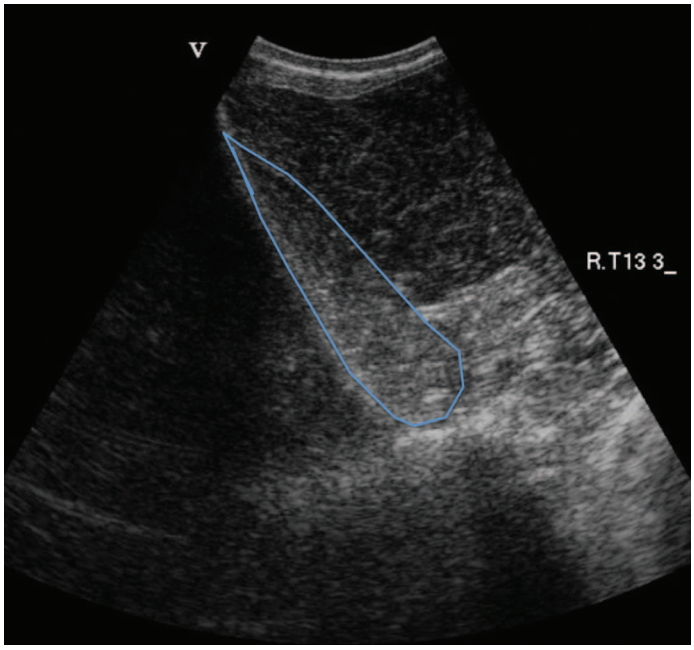

Fig 9: Normal ultrasonographic appearance of the longissimus dorsi muscle and underlying multifidus muscle (blue outline) at the T13 level

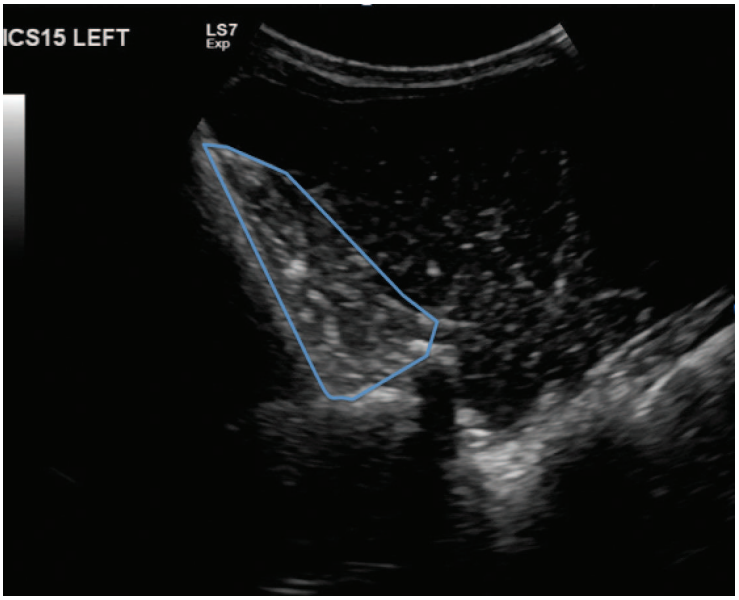

Fig 10: Ultrasonographic image at the T15 level of a horse with acute, severe atrophy and fibrosis of the multifidus muscle (blue outline) following a fall two months previously. The muscle shows areas of mixed hyperechogenicity (fibrosis) and hypoechogenicity (loss of normal fibre pattern)

sides of the vertebral column may also help to identify abnormalities.

Evidence from both human and veterinary literature indicates that atrophy and fibrosis of the multifidus muscle is a marker of pain on the ipsilateral side of the vertebral column. Muscle atrophy may occur within a few days of injury and loss of stability may predispose to secondary injuries, such as articular process osteoarthritis (Fig 10).

Osseous abnormalities

Diagnosis of osseous abnormalities associated with articular process joint disease and the DSPs can be made using ultrasonography. Proliferative new bone may be seen at the articular process joints in cases of osteoarthritis. Comparison of adjacent and contralateral joints will help with the interpretation of ultrasonographic findings. Ultrasonographic examination per rectum of the lumbar intervertebral joint spaces and SI joints may be possible, but interpretation requires an experienced examiner. Evidence of periarticular new bone or bony callus may indicate osseous pathology of these regions.

Biochemistry

Rhabdomyolysis

If rhabdomyolysis is suspected as a result of breed, or a history of recurrent stiffness or muscle pain, biochemistry should be analysed. Rhabdomyolysis can cause primary muscle pain and clinical signs that mimic back pain, such as a reluctance to move under saddle, stiffness and poor performance. Blood samples should be taken from the resting horse to assess creatine kinase (CK) and alkaline phosphatase (AT), after which the patient is subjected to moderate exercise and further samples are taken four to six hours and 24 hours later. Following exercise, CK rises rapidly and peaks after four to six hours; AT will be at its maximum level approximately 24 hours after exercise and may remain elevated for several days. Comparison of the resting and exercising samples is used to diagnose an exertional myopathy.

The semimembranosus muscle can also be biopsied when laboratory results are equivocal or in animals with repeated or unexplained episodes of exertional rhabdomyolysis.

Other myopathies

Other forms of myopathy, including genetic diseases such as polysaccharide storage myopathy, can be diagnosed using either a muscle biopsy or via genetic testing.

Summary

Potential equine back pain is commonly investigated by veterinarians, with IDSP being the most frequently diagnosed condition. Before investigating the thoracolumbar vertebral column, it is important that a full orthopaedic examination is performed to identify any concurrent lameness. To confirm a diagnosis of back pain, clinicians should use multiple diagnostic techniques, including imaging (radiography, scintigraphy and ultrasonography) and diagnostic analgesia, as well as clinical examination.

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Further reading

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