Lameness Associated with the Stifle and Pelvic Regions

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1. Introduction

The reciprocal apparatus of the hindlimb means that similar lameness characteristics are shared by many causes of hindlimb lameness in both the proximal and distal parts of the limb. It is rarely possible by evaluation of gait alone to identify accurately the source of pain causing lameness, although a combination of clinical signs may lead the clinician to suspect a site of pain. It is only through the diligent use of local analgesic techniques that the source of pain can be reliably determined, and interpretation of these is not always straightforward. To my knowledge, there have been no epidemiological studies investigating the relative incidence of different sites of pain causing hindlimb lameness, and any such study would be heavily dependent on the accuracy of diagnosis. It is my impression, after 22 yr of lameness investigation, that lameness ascribed to the pelvic region is often over-diagnosed. In my opinion, comprehensive clinical examinations combined with local analgesic techniques are possible with minimal risk, provided that horses are quietly and appropriately restrained. Over a 3-yr period (January 1999 to December 2001, inclusive) I investigated 318 horses of 2 yr of age or older with hindlimb lameness in which a definitive diagnosis of the source of pain was established; 49 horses (15%) had lameness associated with the stifle region and only 29 horses (9%) had lameness associated with the pelvic region. Horses presenting with restricted hindlimb impulsion and back stiffness, which were ultimately diagnosed with sacroiliac joint pain, were excluded from this assessment. A further 22 horses (6% of 340) with unilateral hindlimb lameness were evaluated in this period and a definitive diagnosis of the source of pain causing lameness could not be established, despite thorough clinical examination, comprehensive local analgesic techniques and nuclear scintigraphic examination. These figures, based on a referral population of horses and restricted to horses 2 yr of age or older, may overestimate the incidence of upper hindlimb lameness in the general horse population. In my opinion it is critical to be able to reliably perform perineural analgesia of the tibial and fibular nerves in order to exclude definitively the hock region and distal parts of the limb as po-

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tential sources of pain causing lameness, bearing in mind that it is frequently only possible to achieve improvement in lameness, rather than its complete alleviation. The purposes of this paper are to describe an approach to the diagnosis of stifte and pelvic injuries and some of the more common causes of lameness, and to highlight some of our current limitations in diagnosis. It focuses on horses of 2 yr of age and older and, therefore, does not consider conditions more prevalent in immature horses, such as juvenile osteochondrosis.

2. Anatomy
Accurate knowledge of functional anatomy is crucial for understanding the role of the stifte in the reciprocal apparatus of the hindlimb. Detailed knowledge of anatomy is also essential for interpretation of radiographic, ultrasonographic, and nuclear scintigraphic images and for understanding the limitations of diagnostic techniques. However, it is beyond the scope of this paper to discuss anatomy in depth.

3. History
Lameness associated with the stifte may be acute or insidious in onset and may or may not be associated with localizing clinical signs. History of a kick or hitting a fixed fence mean that a fracture must be ruled out. Although osteochondrosis (OC) is usually manifest in immature horses, it may not become symptomatic until later in life. History of lameness that is variable in severity may be suggestive of a subchondral bone cyst (SBC). Difficulties in getting up from lying down may be associated with either stifte or pelvic region pain. Pelvic injury in a mature athlete is a comparatively unusual cause of lameness, except as the result of trauma due to a fall, rearing, and falling over backwards, and becoming cast in the stable or sustaining an injury during transport. When there is no history of trauma, diagnosis can be difficult and it is frequently necessary to exclude all possible sources of pain in the distal limb before focusing on the pelvic region.

4. Clinical Examination
Visual Assessment and Palpation
Some horses with stifte pain tend to stand with the stifte rotated outwards. Visual inspection may reveal distension of the femoropatellar (FP) or medial femorotibial (MFT) joint capsules. Detectable distension of the lateral femorotibial (LFT) joint is unusual. A horse with severe stifte pain may stand bearing weight only on the toe of the foot. It is easiest to palpate the stifte joint if the horse is fully load bearing, with the limb in a normal position, neither protracted or retracted. I grasp the horse's tail with one hand and palpate with the other, first locating the tibial crest and then moving proximally to assess the patellar ligaments, the collateral ligaments of the FT joint and the joint capsules. Enlargement of the medial patellar ligament may reflect previous medial patellar desmotomy. Firm pressure should be applied to all soft-tissue structures and bony prominences to see if pain can be elicited. It can be helpful to rock the horse's weight from one hindlimb to the other and to observe whether the patella remains relatively stable in position, or moves jerkily. Repeated upward pressure on the patella may be resented by horses with delayed release of the patella. The limb is picked up and flexion is assessed. Some horses with stifte pain pick up the limb exaggeratedly, avoiding maximum flexion of the stifte (Fig. 1). The ligamentous and bony structures are palpated again. In my experience, the use of other manipulative tests of the stifte to assess integrity of the cruciate ligaments is of no value. Abduction of the limb may cause pain associated with injury of the medial collateral ligament of the FT joint, but this is a nonspecific test, which is also resented by some clinically normal horses.

Clinical assessment of individual structures of the pelvic region by visual examination and palpation is not easy, especially in warmblood and draft breeds, because of the large muscle mass of the hindquarters. It is frequently only possible to palpate the tubera coxae (TC) and tubera sacrale (TS). Large muscle mass may prohibit palpation of the greater trochanter of the femur. Atrophy of the hindquarter musculature is nonspecific and can reflect disuse due to pain arising anywhere in the limb, although...
atrophy of the muscles around the tail head often reflects injury to the tuber ischium, or local nerve damage. Asymmetry of the height of the TS is a common finding in horses in full work, free from lameness, although may be seen in association with poor performance or alterations in hindlimb gait. Alteration in muscle mass in the proximity of the TS can superficially give a false impression of asymmetry of the TS themselves (Fig. 2). Asymmetry of the TC may reflect a previous injury unassociated with ongoing pain. Poor muscle development in the lumbar region and over the hindquarters may make the TS and the summits of the spinous processes of the lumbar vertebrae appear abnormally prominent. This may reflect the way in which the horse has been worked, or may reflect disuse muscle atrophy associated with pain.

The pelvic region should be appraised visually and palpated systematically and, although preliminary assessment is usually best performed in the stable, for accurate evaluation of symmetry of the musculature and bony elements of the pelvic region the horse should be standing completely squarely behind, on a firm, level surface with the horse looking straight ahead. In a horse with severe lameness this may not be possible, because the horse may be unwilling to load fully the lame limb. Careful differentiation should be made between muscular and bony asymmetry. Marked muscular atrophy can make accurate assessment of symmetry of the pelvic bones difficult. In order to evaluate accurately the levelness of the TC, it is necessary for two assistants to place an index finger on the craniodorsal aspect of each tuber coxae, and extend the finger horizontally, or to mark the TC with tape. Elevation of the tail may be necessary to identify muscle atrophy around the tail head, which may be seen in association with either nerve damage, or injuries of the ipsilateral tuber ischii (TI).

Assessment of symmetry when the horse is unwilling to bear weight evenly on both hindlimbs is not easy, but particular attention should be paid to the way in which the limb is positioned. An abnormally straight limb may reflect luxation of the coxofemoral (CF) joint and secondary upward fixation of the patella. The greater trochanter of the femur of the lame limb may appear higher than that of the contralateral limb.

The muscles of the lumbar and pelvic regions should be assessed carefully to identify any area of abnormal muscle tension, pain on palpation or unusual firmness. Firm stroking of the muscles

Fig. 2. (A) Symmetry of the bony prominences of the pelvis and the overlying musculature. (B) Atrophy of the right gluteal musculature, but symmetry of the bony prominences. (C) Atrophy of the left gluteal muscles and apparent asymmetry of the tubera sacrale. The left tuber sacrale appears higher than the left. The horse had a left ilial wing stress fracture.
firstly with a finger and then with a blunt-ended object, e.g., artery forceps, is useful to determine whether either muscle spasm or muscle fasciculation are induced. Palpation of the caudal muscles of the crus is also important because abnormal pain or tension can reflect either primary muscle injury, or an injury of the ipsilateral TI.

Firm pressure should be applied to the bony prominences to see if pain can be induced, or an abnormal reaction such as marked sinking on the hindlimbs when pressure is applied to the TS. Both TC should be grasped simultaneously and the horse rocked from side to side to determine whether crepitus can be detected by palpation or auscultation, bearing in mind that the absence of crepitus does not preclude the presence of a fracture.

Careful, systematic examination of the pelvic canal region per rectum is also indicated in order to assess the aorta and iliac arteries, the psoas musculature and the caudal aspect of the ilial shaft, and the pubis and ischium.

Manipulation of the limb may be resented if there is pain associated with the CF joint, but generally the responses to flexion of the limb, protraction, retraction, or abduction are rather nonspecific. A horse with pain associated with the sacroiliac (SI) joints or a CF joint may be reluctant to stand on one limb, with the other limb raised and may behave very awkwardly in anticipation of discomfort. However, this is a nonspecific reaction and it must be borne in mind that some horses present difficulties in picking up the hindlimbs in the absence of any sign of lameness or poor performance.

Difficulties in picking up hindlimbs may be due to reluctance to accentuate weight bearing on the lamest limb, reluctance to flex the lame limb or psychological. If the horse is a shiverer, unilaterally or bilaterally, the response to hindlimb flexion can be difficult to assess.

Gait Assessment

Lameness associated with the stifle region is often not significantly different in character from lameness associated with pain arising in the more distal parts of the limb. Some horses rotate the stifle of the lame limb outwards. Horses with an unstable meniscus or severe desmitis of a collateral ligament of the FT joint may show increased discomfort when turned in small circles. Severe lameness associated with a fracture may result in the horse bearing weight only on the toe. There is often a reduced height of arc of foot flight, resulting in a variable degree of toe drag. Lameness may be worse with the affected limb on either the inside or outside of a circle on the lunge. Bilateral stifle pain may result in poor hindlimb impulsion rather than overt lameness.

Mild lameness is usually accentuated by ridden exercise, especially when the rider sits on the diagonal of the lame limb, but this is nonspecific and typical of many horses with hindlimb lameness. Proximal limb flexion (hock flexion test) often increases lameness, but a negative response does not preclude stifle pain. A very marked response to flexion is usually more likely to reflect stifle than hock pain. Holding the limb behind the horse in the shoeing position, by supporting the crus, without undue flexion of the hock, nor pressure on the fetlock, may accentuate stifle pain in some horses (Fig. 3).

The degree and character of lameness associated with the pelvic region depends on the underlying cause. Fractures or luxation of the CF joint result in acute onset, severe lameness. Lameness associated with other lesions in the pelvic region may be variable in degree, both between horses with similar lesions, and within and between examination periods. Pain associated with the CF joint frequently results in the horse moving on three tracks with the nonlame limb being placed between the two forelimbs, i.e., the horse is drifting away from the lame limb. On the lunge the horse may be inclined to break to canter, rather than move with adequate hindlimb impulsion, but this is not specific for pelvic pain, and is typical of many hindlimb lamenesses. Pain associated with the CF joint, or the greater trochanter of the femur sometimes results in the horse carrying the lame limb in canter. Lesions associated with the SI joints may result in the horse crossing over each hindlimb at the trot, i.e., plaiting, but this is not seen in all horses. The horse may move with reduced hindlimb impulsion, rather than overt lameness. This restriction in gait may be much more obvious when the horse is ridden.
though acute fractures of the TI invariably cause lameness, chronic injuries may result in loss of performance (e.g., jumping to the right), rather than overt lameness.

The response to flexion tests is rather nonspecific. Bear in mind that increased weight bearing on one limb, caused by flexing the contralateral limb, may accentuate lameness in the weight-bearing limb. Turning the horse in small circles, inducing rotational forces on the CF joint, may accentuate lameness associated with the CF joint.

Ridden exercise is invaluable in horses presenting with a history of poor performance, reduced hind-limb impulsion, or low-grade lameness, because frequently the lameness is accentuated. Some horses with SI pain, or pain associated with new bone on the caudal aspects of the wings of the sacrum will show extreme reluctance to go forward freely. However, care must be taken to differentiate these horses from those with bilateral hindlimb lameness, thoracolumbar pain, recurrent low-grade exertional rhabdomyolysis and those performing poorly due to the rider, due to previous poor schooling or to a combination of boredom and an unwilling temperament.

5. Local Analgesia

If there are obvious clinical signs of stifle pain, e.g., distension of the medial PT joint capsule, exaggerated lifting of the limb during flexion and outward rotation of the stifle, or there has been known trauma to the stifle region, it may be reasonable to proceed directly to radiography and ultrasonography. However, in many horses with stifle pain localizing clinical signs are absent or equivocal, and local analgesia is essential to determine the source of pain, bearing in mind the limitations of intra-articular (IA) analgesia.

The stifle

Intra-articular injection of the FP joint may either be performed alone, or in conjunction with the medial and lateral PT joints. Although in a significant number of horses there is communication between the FP and each of the medial and lateral PT joints, this is not a consistent feature. Diffusion of mepivacaine to all compartments of the stifle after injection of one compartment has been demonstrated, but the concentration of mepivacaine achieved may be inadequate to provide pain relief. In my experience, unless there is definitive clinical suspicion of a stifle problem involving a specific compartment, blocking each joint independently may result in an overall false-negative result, whereas if all three compartments are blocked simultaneously, lameness may be significantly improved. If there is obvious distension of a joint capsule then it may be indicated to block a single compartment. The response to IA analgesia is often delayed and a positive response is sometimes not evident until up to 90 min after injection.

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I prefer to inject the stifle joints with the horse restrained in stocks. Most horses resent needle penetration of the skin, rather than advancement of the needle and injection, and therefore in the majority there is little advantage to be gained by placing subcutaneous blebs of local anaesthetic solution. It is important that the horse remains fully weight bearing on the limb to be injected, so it may be helpful in some horses to pick up the ipsilateral forelimb. In many horses the horse’s attention can be adequately distracted by application of a nose twitch and stroking the ipsilateral forelimb. If the horse is very difficult, sedation for injection can be considered, provided that the lameness is of moderate to severe in degree. Sedation with xylazine and butorphanol is recommended. The effect of the block cannot be assessed for approximately 30 min, but because the effect of mepivacaine usually lasts for 2 to 3 h, delay in assessment is not a problem. Sedation is not appropriate if lameness is only mild, because it may induce a mild, persistent bilateral toe drag, which can confound interpretation. A 3–4 cm 20-gauge needle is used for each joint and 20 ml of mepivacaine.

In my experience, the response to perineural analgesia of the tibial and fibular nerves may be delayed for up to 2 h in some horses, especially if performed by an inexperienced clinician, with inaccurate placement of the local anaesthetic solution. It is therefore advisable that at least 2 h should elapse between performing these blocks and IA analgesia of the stifle to avoid misinterpretation.

FP joint

Technique. The FP joint may be approached from the cranial or lateral aspects. For the cranial approach, palpate the tibial crest and the middle and medial patellar ligaments. The needle is inserted between these ligaments and directed obliquely proximally or horizontally at an angle of approximately 45°–90° to the skin. The depth of insertion depends on the thickness of the overlying patellar fat pad. Unless the joint capsule is distended it is unusual to retrieve synovial fluid using this approach. At least 20 ml of mepivacaine should be injected.

The lateral approach is more likely to yield synovial fluid. The needle is inserted caudal to the lateral patellar ligament, approximately 5–6 cm proximal to the lateral edge of the proximal tibia, perpendicular to the long axis of the femur. The needle is inserted until it meets bone and is then withdrawn slightly.

Interpretation. IA analgesia of the FP joint is not specific because it usually communicates with the MFT joint. Intra-articular analgesia is generally not required in juvenile cases of OC, because clinical signs are usually obvious. However, chronic OC can result in poor hindlimb action, or more obvious lameness in mature horses and in
these cases localizing clinical signs may be less obvious. In such horses, IA analgesia usually produces some improvement in lameness, but the degree of improvement may only be slight. Flattening and subchondral bone sclerosis of the lateral trochlea of the femur can be identified radiographically in both clinically normal horses and those with hindlimb lameness. Thus, the significance of such lesions can be difficult to determine. The patellar ligaments are periarticular or extra-articular structures. Injuries of the middle patellar ligament occurs most frequently, but IA analgesia of the FP joint usually results in little or no improvement in lameness.

MFT joint

**Technique.** The MFT joint is approached between the medial patellar ligament and the medial collateral ligament of the FT joint, approximately 2 cm proximal to the tibia. The needle is directed horizontally, perpendicular to the skin. Synovial fluid may appear spontaneously in the needle hub if the joint capsule is distended, but otherwise it may not be possible to retrieve synovial fluid. There is usually no resistance to injection. If injection is impossible, partially withdraw the needle and redirect the needle caudally and proximally to avoid the medial meniscus.

**Interpretation.** See below.

LFT joint

**Technique.** The LFT joint is approached either between the lateral patellar ligament and the long digital extensor tendon, or between the long digital extensor tendon and the lateral collateral ligament of the FT joint. The needle is inserted horizontally approximately 2 cm proximal to the proximal tibia. It is unusual to retrieve synovial fluid.

**Interpretation.** It is unusual for pain associated with the stifle to be eliminated completely by IA analgesia. It is therefore important to be fully aware of the degree of lameness before injection, so that mild to moderate improvement is not missed. SBCs in the medial femoral condyle are often associated with a variable degree of lameness, within and between examination periods. Improvement in lameness associated with a SBC in the medial femoral condyle following IA analgesia is very variable. Other osseous cyst-like lesions (OCLs), e.g., in the proximal tibia, respond inconsistently to IA analgesia. Lameness associated with meniscal tears, meniscal ligament tears or damage to a cranial or caudal cruciate ligament is usually significantly improved. However lameness due to a cruciate ligament injury often has a delayed response due to the position of the cruciate ligaments behind the synovial membranes separating the medial and lateral compartments of the femorotibial joint. The improvement in lameness due to osteoarthritis (OA) of the FT joint is also variable. Slight improvement should be regarded as significant. Lameness due to injury to either one of the patellar ligaments or the collateral ligaments of the FT joint, or the fibula, is usually not affected.

CF joint

**Technique.** IA analgesia of the CF is technically difficult, because in many well-muscled, mature horses it is impossible to palpate the bony landmarks and, therefore, their position must be determined ultrasonographically. The horse should be standing reasonably squarely, bearing weight evenly on each hindlimb. The needle is inserted between the greater and lesser protuberances of the greater trochanter of the femur. A 14-cm 18-gauge spinal needle is required. It is preferable to insert this through a subcutaneous local anaesthetic bleb. The needle is directed from caudally at an angle of approximately 30° to the long axis of the horse and advanced slightly distally. The aim is to direct the needle along the axis of the femoral neck. Bear in mind that the CF joint is situated vertically above the stifle joint. Synovial fluid may be aspirated in some, but not all cases. Thirty ml of mepivacaine should be injected. Lack of resistance to injection is not a good indicator that the needle is correctly positioned. Extra-articular deposition of local anaesthetic solution may result in temporary obturator nerve paralysis, which completely confounds interpretation of the block.

**Interpretation.** Lameness associated with the CF joint in mature horses is comparatively rare. In the presence of advanced OA there may be a false-negative response.

SI joint

By using a 9–18 cm needle inserted abaxial to the midline at the lumbosacral space, between the TS, and directed approximately 20° caudally, local anaesthetic solution (20 ml per side) can be infiltrated around the caudal aspect of the SI joints. This improves clinical signs in many horses, sometimes dramatically, but in my experience a negative response does not preclude the presence of significant SI joint disease. Improvement is usually apparent within 15–20 min after injection. Sciatic nerve paralysis is a potential complication, although in my experience is rare. Localized patchy sweating over semitendinosus and transient ipsilateral partial perineal paralysis has been seen in one horse.

**Serum Muscle Enzyme Concentration**

Measurement of serum concentration of creatine kinase (CK) and aspartoaminotransferase (AST) is invaluable for the diagnosis of both acute and chronic cases of rhabdomyolysis (tying up). In chronic cases it may be necessary to compare resting levels with concentrations reached after maximum exercise. Peak levels of CK are likely to occur 3 h after exercise.
exercise. If a horse has had a tying-up episode within the last 4–5 d AST levels will almost invariably be raised. Some horses with chronic recurrent problems will have constantly elevated levels of both CK and AST. The degree of elevation of muscle enzyme concentrations may show a poor correlation with the severity of clinical signs.

Diagnostic Imaging

Radiography

Radiographic examination of the stifle requires a minimum of lateromedial, caudolateral-cranio-medial oblique and craniocaudal views. Flexed lateromedial views may give additional information about the proximal aspect of the tibia and the trochlear ridges and femoral condyles and permit more accurate evaluation of the apex of the patella. Cranioproximal-craniodistal oblique views of the flexed stifle are essential for the diagnosis of some patellar fractures.

Flattening of the lateral trochlear ridge, with normal subchondral bone opacity or some sclerosis, is a reflection of OC, but may be clinically silent in a mature horse (Fig. 4). A slight depression in outline of the cortical bone of the medial femoral condyle with normal subchondral bone opacity can be seen as an incidental radiological abnormality. The fibula ossifies from one or several centers and transverse or oblique lucent lines may persist between ossification centers, and should not be confused with a fracture.

Radiographic examination of the pelvic region of a horse can be performed either with the horse anesthetized and positioned in dorsal recumbency, or in the standing position. Because the advent of nuclear scintigraphy and diagnostic ultrasonography the indications for radiographic examination have reduced. If pain inducing lameness has been localized to the CF joint, radiographic examination is indicated to determine the nature of the pathology and, hence, prognosis. High-quality radiographs can only be obtained with the horse positioned in dorsal recumbency under general anesthesia. Evaluation of the SI joints can be difficult because of the superimposition of abdominal viscera. Identification of new bone formation on the caudal aspect of the joint, or irregular joint-space width are poor prognostic indicators. Nuclear scintigraphic examination gives accurate information about bone turnover, but anatomical detail is less well defined; therefore, radiography of a suspected acetabular fracture may be indicated at least 6 wk after the onset of lameness to determine whether or not a suspected fracture involves the CF joint, which merits an extremely guarded prognosis for return to full athletic function in a mature horse.

Radiographs of the CF joint obtained in the standing position may be satisfactory for confirmation of luxation of the joint.

Diagnostic Ultrasonography

Diagnostic ultrasonography of the stifle is readily performed by using a 7.5- or 10-MHz linear transducer and permits evaluation of the collateral ligaments of the FT joint, the patellar ligaments, the joint capsules of the PT and FP joints, the bone surfaces, the cranial meniscal ligaments and parts of the meniscal cartilages. It is possible to view limited parts of the cruciate ligaments with a sector transducer, but little diagnostic information can be acquired. Ultrasonography is most useful for identification of soft-tissue injuries of the stifle, but may be more sensitive than radiography in determining the extent of periarticular osteophyte formation in association with OA.

Diagnostic ultrasonography of the pelvic region can be performed either transcutaneously, or per rectum. The choice of transducer frequency depends on the structures to be imaged. Transcutaneous evaluation of the bony elements of the pelvis and the deep musculature requires a 5- or 3.5-MHz transducer, depending on the size of the horse, whereas evaluation of the dorsal sacroiliac ligaments, the sublum-
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Table 1. Clinical Features, Response to Local Analgesia, and Results of Radiographic, Ultrasoundographic, Scintigraphic, and Arthroscopic Examination of 24 Horses with Stifle Pain January 1998 to August 1999*

<table>
<thead>
<tr>
<th>Clinical Features</th>
<th>Response to IA Analgesia</th>
<th>Radiology</th>
<th>Ultrasoundography</th>
<th>Scintigraphy</th>
<th>Arthroscopy</th>
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<tbody>
<tr>
<td>Lameness</td>
<td></td>
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<tr>
<td>Joint effusion, 2</td>
<td>Positive, 14</td>
<td>OCLL, 4</td>
<td>Middle patellar desmitis, 3</td>
<td>Generalized IRU, 5</td>
<td>Mild cartilage damage, 4</td>
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<tr>
<td>Abnormal flexion, 12</td>
<td>Equivocal, 5</td>
<td>OC, 2</td>
<td>Joint effusion, 3</td>
<td>IRU femoral condyle, 3</td>
<td>Cranial meniscal ligament tear, 2</td>
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<tr>
<td>Enlarged medial patellar ligament, 1</td>
<td>Negative, 2</td>
<td>OA, 2</td>
<td>No abnormality detected, 12</td>
<td>IRU proximal tibia, 2</td>
<td>Meniscal tear, 1</td>
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<td>Favored limb at rest, 1</td>
<td>Not performed, 3</td>
<td>Modeling in region of intercondylar eminence of tibia, 4</td>
<td>Not performed, 6</td>
<td>IRU cranioproximal tibia, 4</td>
<td>Abnormal cartilage, 1</td>
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<tr>
<td>Stiffe rotated outwards, 2</td>
<td>Modeling of patella, 1</td>
<td></td>
<td></td>
<td>IRU patella, 2</td>
<td>Not performed, 14</td>
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<td>Lameness</td>
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<td>Mild</td>
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<td>Severe</td>
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*Femotibial joint pain, 6; OCLL, 4; middle patellar ligament desmitis, 3; osteochondrosis, 2; osteoarthritis, 2; cranial meniscal ligament desmitis, 2; cranial cruciate ligament desmitis, 2; meniscal tear, 1; abnormal cartilage, 1; focal lesion caudal femoral condyle, 1.

Nuclear Scintigraphy

Nuclear scintigraphic examination of the stifle should ideally include both lateral and caudal views. Careful positioning of the gamma camera and long acquisition times, preferably by using a motion correction program, are essential for diagnostic quality caudal views. Acquisition of too few counts may result in lesions being missed. Scintigraphic examination may be negative in association with primary soft-tissue injuries, such as meniscal tears, cranial meniscal ligament desmitis, and cruciate injury. With good-quality scintigraphic images, medial femoral condyle SBCs can generally be seen scintigraphically. OC in mature horses is often scintigraphically negative. A retrospective study of horses with lameness improved by IA analgesia of the stifle and scintigraphic findings showed a rather poor correlation in a significant proportion of horses (Table 1). False focal regions of increased radiopharmaceutical uptake (IRU) sometimes occur (Fig. 5).

Nuclear scintigraphic evaluation of the pelvic region is useful for the identification of fractures, stress reactions in bone, increased bone modeling associated with OA and other bony lesions, evidence of recurrent exertional rhabdomyolysis (RER) (in some, but not all cases), evaluation of blood flow in the aorta, iliac and femoral arteries, and assessment of the SI joints. Sensitivity of the technique is in part dependent on the angle of the gamma camera to the area of interest and the degree of overlying muscle mass. It is important to recognize that some lesions may be bilateral; therefore, recognition of the normal scintigraphic appearance of the region in horses of different ages and involved in different disciplines is important. Bear in mind those superficial bony structures such as the TC and TS will always appear “hotter” than deeper structures. Unilateral muscle atrophy may also confound interpretation.

Diagnostic Arthroscopy

Diagnostic arthroscopy is an invaluable tool for investigation of stifle pain in the absence of obvious radiological changes, and is the only method of definitive diagnosis of some stifle injuries; however, access is restricted and only limited amounts of the
The stifle

Osteochondrosis

Although OC is a developmental abnormality of cartilage and bone, in some horses clinical signs may

Fig. 5. Lateral scintigraphic view of the stifle. There is focal increased radiopharmaceutical uptake in the cranioproximal aspect of the tibia, but lameness was unrelated to the stifle.

Differential Diagnosis

A breakdown of diagnoses for 71 horses, 2 yr of age or older, with stifle pain examined between January 1998 and December 2001 is summarized in Table 2. Lameness associated with pain arising from the femorotibial joints was most common.

Fig. 6. (A) Dorsal scintigraphic view of the pelvic region of a normal 3 year old Thoroughbred. Note the clearly demarcated tubera sacrale. (B) Dorsal scintigraphic view of the pelvic region of a 10-year-old Thoroughbred cross. Note that in this older horse the definition between uptake in the tubera sacrale and the surrounding sacroiliac joint region is less distinct than in the younger horse (A). However in both (A) and (B) there is left right symmetry.

Close window to return to IVIS
not be manifest until maturity. Generally clinical signs in an adult are less obvious than in a horse less than 2 yr of age. Effusion of the FP joint is a variable feature. Horses with bilateral OC may present with poor hindlimb action rather than overt hindlimb lameness. Lameness associated with a mobile fragment may be episodic in nature and may only be apparent performing particular movements. Occasionally, a fragment that was previously immobile and clinically silent may become dislodged by trauma causing lameness. There is a positive response to IA analgesia of the FP joint, although horses with flattening of the lateral trochlear ridge associated with tightly adherent but highly abnormal articular cartilage may show only slight improvement. Radiological abnormalities include altered contour of the lateral and/or medial trochlear ridge of the femur, and alterations in subchondral bone opacity, with or without one or more mineralized fragments. Concurrent evidence of OA warrants a guarded prognosis. Treatment is by arthroscopic removal of fragments and debridement of loose cartilage. Prognosis in these horses is favorable, but those with a cobblestone appearance to the articular cartilage, which is well adhered to the parent bone, have a more guarded prognosis.

Subchondral Bone Cyst of the Medial Femoral Condyle

Subchondral bone cysts of the medial femoral condyle are consistent in their pathological appearance, having a fibrous cyst lining. Well-defined radiolucent lesions elsewhere do not always have a consistent structure and are therefore referred to as osseous cyst-like lesions (OCLLs). SBCs may occur unilaterally or bilaterally and usually cause acute-onset lameness of variable degree, both between horses and within individual horses, from day to day or during an exercise period. There appears to be little correlation with the size or duration of the SBC and the degree of lameness, although very large SBCs, especially those close to the medial epicondyle of the femur, are generally associated with severe lameness and the horse may have difficulties in getting up from lying down. There is generally no palpable effusion of the FT joint. The response to IA analgesia is very variable: in some horses lameness is dramatically improved, whereas in others little difference is seen. Diagnosis is based on radiographic identification of a SBC and either localization of pain causing lameness to the MFT joint or exclusion of other potential sources of pain. In horses that do not respond to IA analgesia, nuclear scintigraphy is sometimes helpful. No treatment is uniformly successful. Treatment options include intra-lesional injection of corticosteroids, arthroscopic debridement, with or without installation of a cancellous bone graft, rest, or work combined with nonsteroidal anti-inflammatory drugs. Choice of treatment is dependent on the age of the horse, its intended use, the size and shape of the cyst, and response to previous treatments. Pre-existing radiological evidence of OA warrants a more guarded prognosis. I favor arthroscopic debridement and installation of a bone graft in horses that do not respond to conservative management, assuming that the shape of the cyst neck will hold the graft in place. A recent experimental study showed no advantage of grafting, but in my clinical experience results have been more favorable than curettage alone.

Dimples

Flattening or a depression in the outline of the medial, or less commonly the lateral, femoral condyle can be seen in the contralateral limb of a horse with a SBC, and in a mature horse these are generally not progressive. However, these lesions can be seen alone and, if there is alteration in the underlying subchondral bone opacity, there may be associated lameness (Fig. 7). There are usually no localizing clinical signs. Lameness is usually improved by IA analgesia. Diagnosis is based on radiography. Arthroscopic exploration may or may not reveal abnormalities of the overlying articular cartilage. Often there is a wrinkling or in-folding of the cartilage at the typical site of a SBC. Such lesions may be associated with either sclerotic subchondral bone or less commonly sugary type bone. Debridement or forage has resulted in clinical improvement, but a limited number of horses have subsequently developed SBCs.
Other OCLLs

OCLLs occur in the lateral femoral condyle or the proximal tibia. In my experience, the most common location is the proximomedial aspect of the tibia (Fig. 8). These are usually well-defined unilocular lesions, often surrounded by a sclerotic rim. Five of 6 adult horses with OCLLs of the proximal tibia had medial lesions, that were considered to be secondary to OA. In my experience, these lesions vary in appearance, size, and location, and may be traumatic in origin. Some horses have responded to debridement or IA mediation, whereas in others lameness has been persistent. Eleven horses had dimples, wrinkling, or in-folding of the articular cartilage at the typical site of a SBC opening in the medial femoral condyle. This cartilage was not firmly attached to the subchondral bone. Four horses had more generalized cartilage fissuring and irregularities. Treatment by surgical debridement had a good outcome in six of seven horses with focal lesions, but the prognosis for more widespread lesions was poor.

Intra-articular Pain, but No Identifiable Cause

There is currently a group of horses that eludes definitive diagnosis of the cause of lameness, despite localization of pain to the FT joints. These horses have no identifiable radiological or ultrasonographic abnormality. In some, there is a diffuse increased uptake of radiopharmaceutical in the stifle region. No lesions compatible with the degree of lameness are identifiable arthroscopically; however, the limi-
tations of arthroscopic examination must be borne in mind.

Desmitis of the Collateral Ligaments of the FT Joint

Desmitis of the medial or lateral collateral ligament of the FT joint is usually the result of trauma. There may be associated effusion of the FT joint. Stressed radiographs are helpful in severe injuries to assess the degree of joint laxity. The extent of the lesion can be determined ultrasonographically. There is usually enlargement of the ligament, with disruption of its normal architecture. The origin and insertion should be inspected carefully for the presence of any avulsion fragments. In more chronic injuries there may be enthesesous new bone at the origin or insertion of the ligament. Sometimes desmitis occurs in conjunction with other injuries, so the entire joint should be carefully appraised radiographically and ultrasonographically. Treatment is by conservative management and prognosis depends on the severity of the original injury. Some horses make a complete functional recovery, but with severe injuries the prognosis is guarded.

Cruciate Ligament Injury

Tears of the cranial (CrCrL) and less commonly the caudal (CaCrL) cruciate ligament usually occur in the mid body, or close to the insertion. Complete rupture is very unusual. Diagnosis is dependent on arthroscopic identification of a lesion, although in chronic cranial cruciate injuries new bone cranial to the intercondylar eminence of the tibia may be seen. This enthesesous new bone is best identified in flexed lateromedial views. There may be effusion in the medial FT joint. Lameness is variable in degree and is usually improved by IA analgesia, although the response may be slow. Lesions of the CaCrL are often best seen from the MFT joint, and lesions of the CrCrL may be best evaluated from the LFT joint, although it may be necessary to debride the synovial covering of the cruciate ligament to evaluate it properly. In some horses with cruciate ligament injury the synovial septum between the medial and lateral FT joints is partially disrupted. The ligaments should be both inspected and probed. Some horses have obvious discoloration and fibrillation of the ligament, whereas in others the extent of fiber disruption is only determined by probing. The prognosis is dependent on the severity of the original injury. Twenty-one of 28 horses (78%) with Grade 1 lesions made a full functional recovery, but only 6 of 17 horses (35%) with grade 2 lesions were able to resume full work and no horses (of 4) with a grade 3 lesion became sound.

Meniscal Tears

Meniscal tears vary in their configuration, some being sagittal plane splits through the axial aspect of the meniscus, whereas others are transverse splits that can involve up to two thirds of the meniscus. Tears extending longitudinally from the cranial meniscal ligament into the meniscus with minimal separation are categorized as grade 1. Tears involving the cranial axial pole, the full extent of which can be evaluated are categorized as grade 2.
and severe lesions, the full extent of which cannot be determined are grade 3. Medial meniscal lesions predominate. Lameness is usually moderate to severe. There is generally effusion of the affected FT joint. Lameness is improved by IA analgesia Some, but by no means all, mensical tears can be identified ultrasonographically (Fig. 10). Radiographic evidence of narrowing of the FT joint space, dystrophic mineralization of the meniscus or OA are all poor prognostic indicators. Definitive diagnosis requires arthroscopic examination; it may or may not be possible to evaluate the full extent of the tear, depending on its location and configuration. This also influences the ability to debride lesions (Fig. 10). Prognosis depends on the severity of injury. Fifteen of 28 horses (54%) with grade 1 lesions resumed full work. Seven of 14 horses (50%) with grade 2 lesions returned to athletic function after debridement. However, severe grade 3 lesions have a guarded prognosis, with only 2 of 8 horses (25%) making a functional recovery.33

**Meniscal Ligament Damage**

Tearing of one of the cranial meniscal ligaments, or less commonly recognized, a caudal mensical ligament results in instability of the meniscus and lameness. Lesions may occur in isolation or in conjunction with meniscal tears. Minor fibrilliation
is often seen arthroscopically, but is often not a primary cause of lameness. There is invariably effusion and moderate to severe lameness. Lameness is improved by IA analgesia. In some horses large rather poorly defined radiolucent zones are seen distal to the intercondylar eminence of the tibia associated with chronic cranial meniscal ligament trauma. Such changes have also been seen in association with chronic cranial cruciate ligament injury. Minor tears have a favorable prognosis, but tears resulting in meniscal instability have a poor prognosis.

**Intermittent Upward Fixation or Delayed Release of the Patella**

A horse that has locked the patella is easy to recognize, but intermittent upward fixation or delayed release can be much more difficult to identify, because of its episodic nature. Abnormal jerky movement of the patella may be seen as the horse moves over in the stable, or when it decelerates from canter to trot, or from trot to walk, or when walking down a steep incline. Repeated delayed release of the patella can cause stifl soreness, and unwillingness to work, although overt lameness is unusual. Warmblood horses with straight hindlimb conformation appear to be predisposed. Treatment aims to increase fitness of particularly the quadriceps muscles, and to improve bodily condition when necessary. A change in foot angle may be beneficial. The use of internal blisters is sometimes helpful.34 Desmotomy of the medial patellar ligament should be considered a last resort.

**Fragmentation of the Apex of the Patella**

Fragmentation of the apex of the patella is recognized as a potential sequel of medial patellar ligament desmotomy,35-37 causing mild to moderate lameness, which is often associated with effusion of the FP joint. Lameness is improved by IA analgesia of the FP joint. Diagnosis is based on radiographic evidence of modeling or fragmentation of the apex of the patella, best seen on a flexed lateromedial view. Radiographs may underestimate the degree of bony and cartilaginous abnormality. Treatment is by arthroscopic debridement and the prognosis is favorable.

**Desmitis of the Patellar Ligaments**

Desmitis of the patellar ligaments has probably been underdiagnosed. Middle patellar desmitis occurs most often, either alone or together with desmitis of the lateral patellar ligament.38 Seven of nine horses were show jumpers. With acute injury there may be mild periligamentous soft-tissue swelling and pain on palpation of the ligament in the flexed position, but in more chronic injuries there may be no localizing clinical signs. Lameness, which varies from mild to severe, is partially improved by IA analgesia of the FP joint in a small proportion of horses. Lesions of the middle patellar ligament may be associated with abnormal movement of the patella, or previous medial patellar ligament desmotomy. There are usually no radiological abnormalities. Lesions occur at the origin, mid-body, or insertion and are identified ultrasonographically (Fig. 11). There is usual focal loss of echogenicity and poor fiber pattern. Insertional lesions of the middle patellar ligament may be associated with increased radiopharmaceutical uptake (IRU) in the craniodorsal aspect of the tibia. To date, horses have been treated conservatively and the prognosis for return to full athletic function without recurrent injury has been guarded.

**Fractures**

**Patella.** Fractures of the patella are usually the result of direct trauma, either a kick, or hitting a fixed fence, resulting in sudden onset severe lameness.39,40 Lameness often improves quite quickly, but mild to moderate lameness persists. In the acute stage, before development of periarticular soft tissue swelling, it may be possible to palpate a displaced fracture fragment. Pain may be elicited by firm palpation of the medial aspect of the patella. The most common fracture configurations are small, displaced pieces from the base of the patella, readily seen in a lateromedial radiographic view, or fragments of the medial pole of the patella. Displaced fragments from the medial pole of the patella may be seen in lateromedial projections, but their origin cannot be determined. Skyline projections of the flexed stifle are required to determine the origin of the fragment and to identify nondisplaced fractures. Fractures of the base of the patella heal satisfactorily when treated conservatively and have an excellent prognosis. Fractures of the medial pole of the patella must be treated by surgical removal, because even if nondisplaced initially, these fractures become displaced and secondary OA is an inevitable sequel.39 Most fractures can be treated by arthroscopic removal,41 although large fragments may need to be removed via an arthrotomy incision centered over the fragment. The prognosis for return to full athletic function is excellent.

**Femoral Trochleas.** The femoral trochleas are also vulnerable to external trauma, especially a horse hitting a fixed fence.40,42 Fracture of a trochlear ridge of the femur may occur concurrent with a fracture of the medial pole of the patella, so even if an obvious lesion is seen in a lateromedial radiograph, a skyline projection should also be obtained. There is usually acute-onset severe lameness associated with distension of the FP joint capsule. Diagnosis is made radiographically. Treatment is by arthroscopic removal of the fracture fragments and the prognosis is good.

**Femoral Condyles.** Small chip fractures arising from the femoral condyles can also result from a horse hitting a fixed fence, in turn resulting in acute-onset severe lameness. Radiographic examination often reveals the fracture fragment(s), but it
may not be possible to determine its origin. Most horses respond favorably to arthroscopic removal of the fragments.

**Tibial Crest.** Fracture of the tibial crest is usually the result of trauma, such as hitting a fixed fence. Most fractures are oriented obliquely, from craniodistal to caudoproximal, but are nonarticular. Fractures may be nondisplaced, or displaced craniodistally. There is usually acute onset of severe lameness, with mild, localized soft-tissue swelling and focal pain. Diagnosis is made radiographically. Both conservative and surgical management have yielded good results, with return to full athletic function. Surgical management by internal fixation of large fragments, or removal of smaller fragments, results in more rapid recovery, and may be preferable for large displaced fragments.

**Intercondylar Eminence of the Tibia.** Fracture of the intercondylar eminence of the tibia is an unusual injury. Lameness is moderate to severe and is usually associated with effusion of the MFT joint. Lameness is improved by IA analgesia and diagnosis is confirmed radiographically. Treatment is by arthroscopic removal of the fracture fragment or, if large, repair by internal fixation. Prognosis is favorable, provided that there are no other concurrent injuries.

**Stress Fracture of the Proximocaudal Tibia.** Stress fractures of the tibia occur unilaterally or bilaterally almost exclusively in young Thoroughbred flat racehorses, resulting in acute onset severe lameness, that rapidly resolves with rest. Bilateral stress fractures may be present, despite unilateral lameness. There are usually no localizing clinical signs. There is usually no response to IA analgesia, although, surprisingly, there are anecdotal reports of occasional positive results. Diagnosis is usually reliant on nuclear scintigraphy. The caudoproximal aspect of the tibia is a predilection site in Thoroughbreds in Europe.
Radiographs may reveal pre-existing periosteal or endosteal callus, or occasionally a fracture line. Most horses respond satisfactorily to conservative management of rest for 3–5 mo.

**Fibula.** Fractures of the fibula are comparatively unusual, but cause acute-onset moderate to severe lameness. There are usually no localizing clinical signs and the response to IA analgesia of the FP or FT joints is generally negative. Diagnosis depends on nuclear scintigraphic and radiographic examinations (Fig. 12). Most fractures occur in the most proximal aspect of the fibula and are associated with intense, focal IRU. Radiographically care must be taken not to confuse a normal lucent line between separate ossification centers as a fracture. Conservative treatment is usually successful, but lameness is slow to resolve and radiographic healing may take 4–6 mo. Five of five horses made a complete functional recovery.

**Injury to the Origin of the Gastrocnemius Muscle.** Injury to the origin of the gastrocnemius muscle on the distal caudal aspect of the femur is rare and has been associated with a gait abnormality characterized by outward rotation of the calcaneus and inward rotation of the toe of the lame limb. Diagnosis has been based on scintigraphic identification of intense IRU in the distal caudal femur. In some horses, periosteal new bone has also been identified radiographically. Three of four horses returned to full athletic function after prolonged rest.

**The Pelvis**

In 29 horses, 2 yr of age or older, with hindlimb lameness associated with pelvic pain, examined between January 1999 and December 2001, SI joint pain and ilial stress fractures were the most common diagnosis (Table 3).

**Fractures**

The incidence of stress or fatigue fractures of the pelvic region in the mature horse is very low, except in horses which race over fences, which have a significant incidence of ilial stress fractures. The majority of fractures are the result of external trauma, e.g., a fall.

**Stress Fracture of the Ilial Wing**

Stress fractures of the ilial wing in mature athletes are seen almost exclusively in horses that race over fences. Lameness is usually acute in onset and severe, although may resolve rapidly with rest. There is usually rapid atrophy of the ipsilateral gluteal musculature. The tuber sacrale of the affected side may appear lower. It is unusual to be able to elicit pain by palpation.

Diagnosis may be confirmed by nuclear scintigraphy. Oblique views of the ilial wings are required. If the fracture is complete and involves the dorsal surface of the ilial wing the fracture may be demonstrable ultrasonographically.

Treatment by box rest and controlled exercise for 3 mo usually results in complete recovery, unless the fracture involved the SI joint. The training pro-
gram should be reviewed to identify any factors predisposing to injury.

**Fracture of the TI**

Fracture of the TI sometimes occur in event horses, which fall when jumping up onto a bank. They may also occur in any horses as a result of a fall on the flat. However, they have also been recognized in horses from other disciplines, with no known history of trauma. There is usually acute-onset relatively severe lameness. Mild, localized swelling is easily overlooked, unless the TI is suspected as a site of injury. The ipsilateral semimembranosus and semitendinosus muscles are usually sore to palpation. Atrophy of the muscles around the tail head often develops within 7–10d. Usually there is no palpable crepitus. In more chronic cases pain on palpation may not be evident, although the TI may appear asymmetrical, and the lameness may be only mild or moderate.

Diagnosis of a fracture of the TI can be confirmed with nuclear scintigraphy (Fig. 13). Dorsal oblique and caudal views are useful. There is usually both an increased uptake of the radiopharmaceutical and an abnormal pattern of uptake. In some cases it may be possible to determine whether the fracture is complete and if it has become significantly displaced. Discontinuity of the bone outline may also be confirmed with diagnostic ultrasonography. Radiographic examination can be performed, but is most easily done with the horse under general anesthesia.

Treatment by restriction to box rest usually results in a satisfactory outcome, although very occasionally sequestration of the fracture fragment occurs, necessitating surgical removal.

Occasionally a horse presents without obvious lameness, but with reduced performance and a tendency to jump drifting consistently to one side, due to pushing off unevenly with each hindlimb. This has been in association with reduced muscle development over one of the TI, and increased uptake of technetium 99m MDP in the TI. The outline of the TI appears irregular ultrasonographically.

**Fracture of the Greater Trochanter of the Femur**

Fracture of the greater trochanter of the femur is an unusual injury, causing severe lameness. There is a tendency for the fracture fragment to be displaced cranially, due to the pull of the attachments of the deep and middle gluteal muscles.

There are usually no localizing clinical signs, unless the horse is very poorly muscled and the greater trochanter is readily palpable. The diagnosis is based on nuclear scintigraphic examination, with or without diagnostic ultrasonography. The prognosis for return to athletic function with conservative treatment is guarded.

**Fracture of the Sacrum**

Fractures of the sacrum may be complete or incomplete and result in bilateral hindlimb lameness. If the fracture is complete the contour of the hindquarters when viewed from the side changes, so that there is abnormal angulation of the rump. There may be associated neurological signs, including flaccid paralysis of the tail, reduced sensation around the tail head, urine dribbling in a mare, and loss of anal tone. The onset of neurological signs may be delayed for several weeks after the primary fracture. The fracture may be palpable per rectum. The fracture may be confirmed both radiographically and with diagnostic ultrasonography per rectum. The

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**Table 3. Distribution of Lesions in 29 Horses with Hindlimb Lameness Associated with the Pelvic Region, January 1999 to December 2001**

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI joint disease*</td>
<td>10</td>
</tr>
<tr>
<td>Ilial stress fracture</td>
<td>7</td>
</tr>
<tr>
<td>Fracture or enthesopathy of the third trochanter of the femur</td>
<td>3</td>
</tr>
<tr>
<td>Fracture of a TI</td>
<td>4</td>
</tr>
<tr>
<td>Dorsal SI desmitis</td>
<td>2</td>
</tr>
<tr>
<td>CF joint OA</td>
<td>2</td>
</tr>
<tr>
<td>Luxation of the CF joint, secondary to a comminuted ilial shaft fracture</td>
<td>1</td>
</tr>
</tbody>
</table>

*SI joint disease was also diagnosed in an additional 27 horses that presented with poor performance, back stiffness and pain, and poor hindlimb engagement.*
Recurrent Equine Rhabdomyolysis “Tying Up”

The spectrum of clinical signs associated with recurrent equine rhabdomyolysis (RER) ranges enormously. A horse may present with mild bilateral hindlimb stiffness, or loss of freedom of action, which may deteriorate slightly with work, without the horse becoming unduly distressed, but sometimes having a prolonged recovery period after work. Such horses may have no palpable firmness of the hindquarter musculature, nor pain induced by firm palpation and a normal pattern of sweating. The horse may be able to compete, but perform below expectations. These clinical signs are not unique to equine rhabdomyolysis and may be seen in horses with severe thoracolumbar discomfort associated with impinging spinous processes or OA, or pain associated with the SI joints.

Alternatively, a horse may start to jump poorly, e.g., during the cross-country phase of a 3-d event and pull up with a unilateral hindlimb lameness, with no localizing clinical signs, and which resolves within 24 h. In contrast, a different horse may have recurrent acute onset, severe episodes, often provoked by competition, e.g., during the speed and endurance phase of a 3-d event, which may be so bad as to result in recumbency.

The incidence of RER depends to some extent on the discipline in which the horse is involved, occurring most commonly in racehorses, endurance horses, and event horses. It is relatively unusual in show jumpers and dressage horses, but occasionally occurs in competitive Thoroughbred-type ponies. In all these horses the results of muscle biopsies usually indicate that there is no evidence of abnormal glycogen metabolism as in polysaccharide storage myopathy, which occurs more commonly in draft and draft cross-breeds and Quarterhorses. There is evidence in the Thoroughbred that RER may be an heritable condition, as an autosomal recessive trait with variable expression. A familial trait has also been observed in some part Thoroughbred event horses. However, many cases in both 3-d event horses and endurance horses do not become apparent until the horse is middle aged, or even older. The condition is manifest more frequently in mares than in stallions or geldings.

Diagnosis is based on measurement of raised serum muscle enzymes (CK and AST) after exercise. The degree of muscle-enzyme elevation frequently does not correlate with the severity of clinical signs. Interpretation is not always straightforward because asymptomatic endurance horses frequently have extremely high levels of CK and AST during and after a ride. Horses with low-grade RER, which occurs daily, will often have constantly raised levels of CK and AST, even if rested. Nuclear scintigraphy can be useful in horses with low-grade hindlimb stiffness and poor performance, to validate a suspected diagnosis of RER, to evaluate blood flow to the hindlimb musculature, and to exclude any other concurrent musculoskeletal lesions. In association with RER in some, but not all cases, abnormal uptake of technetium 99m-MDP is seen in the affected muscles in the bone phase of the scan, appearing usually as diagonal streaking, but in more severe longstanding cases there may be large areas of intense uptake of the radiopharmaceutical in the affected muscles. Lesions are not restricted to the gluteal muscle mass, but may also affect quadriceps, biceps femoris, semitendinosus, semimembranosus, and longissimus dorsi muscles. Lesions may be symmetrical or asymmetrical. However, normal uptake of the radiopharmaceutical does not exclude RER.

Muscle biopsy is used to determine whether there is any evidence of polysaccharide storage myopathy. Feeding a high-fat and low-carbohydrate concentration diet in these horses may reduce the frequency and or severity of attacks after a period of 3–6 mo. Measurement of fractional excretion of electrolytes (sodium, potassium, calcium phosphorus, and chloride) can be useful to identify those individuals that seem unable either to absorb, or to utilize normally, specific dietary electrolytes, and which might benefit from dietary supplementation. For accurate interpretation of results, it is important that the horse is consuming its normal diet and has recovered from any recent acute attack of equine rhabdomyolysis when blood and urine samples are collected. A mid-stream urine sample should be collected, preferably freely voided rather than a catheterized sample. Results are only valid if serum creatinine is within the normal range and the fractional excretion of creatinine is normal. Results should be compared to the normal ranges for a horse on a similar diet, because results for horses eating an oat- and hay-based diet are different for those on a cube-based diet, or a diet high in alfalfa. Fractional excretion ratios for potassium will tend to be high if the horse is allowed access to pasture. Low values for fractional excretion ratios for sodium or calcium indicate that the diet should be supplemented with sodium chloride, or either calcium carbonate or calcium gluconate, respectively. Appropriate dietary supplementation may help to prevent further attacks.

Management practices may also help to prevent attacks in some horses. These include daily work with a long slow warm-up period, turn out as much as possible, and avoidance of undue stress, especially in highly strung, nervous individuals. However, some cases, especially those resulting in daily low-grade clinical signs that are not stress provoked, prove intractable to successful management.

Muscle Injury

Muscle soreness is frequently unassociated with any recognizable histopathological changes within the muscle and is often secondary to some other cause of lameness, due to the altered way in which the horse...
is moving. Muscle soreness can often be induced by overuse of an undertrained muscle, and can result in localized soreness and stiffness for several days. Focal intense muscle spasm and pain can cause sudden-onset reduction in performance and, if primary, is usually relieved by manipulation to relieve the muscle spasm, producing rapid amelioration of clinical signs.

Focal muscle soreness associated with localized swelling may be due to intramuscular haemorrhage, muscle fiber tearing, or rhabdomyolysis. Diagnosis of the cause may be determined by measurement of serum muscle enzyme concentrations and by ultrasonographic evaluation. Haemorrhage will result in an area of diffuse increase in echogenicity within the muscle. This should be differentiated from hyperechogenic regions that are the result of chronic muscle fibrosis. Serum muscle enzyme concentrations are usually not elevated in those cases of haemorrhage, muscle fiber tearing, or fibrosis.

Damage to deep muscles of the hindquarters is difficult to identify because there are frequently no localizing clinical signs to alert the clinician to the possible site of damage. Thermographic evaluation can be useful to help to identify superficial muscle injury.

Some horses with reduced performance have pain on palpation of the psoas muscles per rectum. This may be primary or secondary to lumbosacral, or SI pathology and is an indication for nuclear scintigraphic evaluation of the pelvic region and ultrasonographic examination of the lumbosacral vertebrae.

Fibrotic Myopathy
Fibrotic or ossifying myopathy usually involves the semitendinosus and semimembranosus muscles, resulting in a pathognomonic gait at the walk. The cranial phase of the stride is abruptly halted and the foot is slapped to the ground. Clinical signs are usually sudden in onset. Careful clinical examination usually reveals a region of palpably firm muscle. Ultrasonography is used to determine the extent of fibrosis or mineralization. Treatment by tenectomy of the tendon of origin of semitendinosus may be successful in my experience.

Less commonly recognized are more minor muscle tears, associated with localized muscle soreness, detectable by careful palpation. There are no characteristic gait abnormalities. In some, but not all horses, structural abnormalities of the muscle may be identified ultrasonographically.a

SI Joint Injury
The diagnosis of SI joint disease has tended historically to be a “dustbin diagnosis,” frequently made by exclusion, when the clinical signs could not be explained by any other condition. The high incidence of pathological degenerative lesions found in the SI joints of Thoroughbred racehorses60 and in mixed-breed horses60 indicates that degenerative disease of the SI joint is likely to be a significant clinical problem, but definitive diagnosis remains difficult.

Pathological changes of the SI joint include lippening, cortical buttressing, and osteophyte formation, together with enlargement of the joint surfaces. These are thought to be a response to chronic instability of the joints, although no evidence of ligamentous laxity has been identified60,62. Erosion of the articular cartilage may also occur, but joint ankylosis has not been documented. A positive association has been recognized between the severity of the impingement of thoracolumbar dorsal spinous processes and lumbar transverse processes, and the severity of SI lesions and also between the severity of articular process degeneration and the degree of SI pathology.

A separate entity of entheseophyte formation at the site of attachment of the SI ligaments has been described unassociated with pathology of the SI joints.62 Their clinical significance has not been well defined, but I have recognized this condition in several dressage horses with severely restricted hindlimb impulsion and back stiffness.

Subluxation of the SI joint is comparatively very rare62,63 and is the result of acute, traumatic disruption of the dorsal SI ligament and the SI joint capsule. It should be differentiated from an acute ilial wing fracture, resulting in depression of the ipsilateral tuber sacrale.

The prominence of the TS varies between horses and in part reflects the conformation of the back and hindlimbs. However, poor development of the epaxial muscles in the lumbar region, due to the horse not using its back and hindlimbs properly, may make the TS appear more prominent. Poor muscle development may either be a reflection of pain, or of the horse’s previous training: if the horse has never been asked to engage the hindlimbs properly and work through its back, these muscles will not be well developed.

Many apparently clinically normal horses have some degree of asymmetry of the height and or shape of each tuber sacrale. Careful clinical appraisal of a small proportion of these horses may reveal subtle hindlimb gait abnormalities, and mild discomfort induced by either pressure applied over the TS, or picking up one hind limb and swaying the horse on the other. These findings are more likely to be detected in horses that are not fully fit, and are often ameliorated when the horse is fitter and has greater muscle support. They may reflect mild instability of the SI joints, but are not necessarily synonymous with degenerative change.

Osteoarthritis of the SI joints may be present despite symmetry of the TS. It is usually a bilateral condition and is rarely associated with unilateral hindlimb lameness. It often manifests as reduced performance, failure to properly engage the hindlimbs, and back stiffness. Signs are often markedly accentuated when the horse is ridden. In mild
cases, the loss of hindlimb power and lack of supple-
ness through the horse’s back may be much easier for
the rider to feel than for an observer to appreci-
ate. Gait irregularities may be most apparent as
the horse changes direction through a tight circle.
Specific movements such as half pass, or sequence
flying changes may be difficult. The horse may be-
come progressively more unwilling to work under
saddle.

A comprehensive clinical evaluation is essential to
preclude other conditions that may present simi-
larly, such as bilateral distal hock joint pain. It
may be necessary to preclude the hindlimbs as a
potential source of pain by performing perineural
analgesia of the tibial and fibular nerves and IA
analgesia of the FT and FP joints of one hindlimb, to
see if lameness becomes apparent in the contralat-
eral limb.

Nuclear scintigraphic examination may facilitate
diagnosis both by helping to preclude the presence of
other significant causes of poor hindlimb action and
by giving a positive indication of abnormalities of
the SI joints.10,64 Profile analysis and quantitative
evaluation by using regions of interest are required
for accurate diagnosis.80 The results should ideally
be compared with horses of both similar age and
work history, because there appears to be significant
variability between clinically normal horses. This
appears to be both an age- and discipline-related
change. In a normal horse, uptake of the radio-
pharmaceutical is bilaterally symmetrical. Exces-
sive motion during image acquisition can result in
images that are not of diagnostic quality and may
mimic abnormalities. Therefore, images ideally
should be acquired dynamically and a motion-cor-
correction program should be used.10 Abnormalities
are recognized as both abnormal patterns of uptake
of the radiopharmaceutical and abnormal ratios of
uptake between each SI joint region and a standard
reference site (Fig. 14). Care must be taken to dif-
correction between uptake in the TS and uptake
associated with the region of the SI joints.

Radiographic examination requires general an-
esthesia and can be frustrating because superim-
position of abdominal viscera can preclude evalua-
tion of the SI joints. However, detection of
joint-space irregularities or spur formation on the
caudal aspect of the joints are poor prognostic
indicators.

Ultrasonographic examination should be per-
formed both transcutaneously to evaluate the dorsal
SI ligaments8,65 and per rectum,8 to eliminate path-
ology of the lumbosacral vertebrae.

Management is essentially palliative and progno-
sis is generally inversely correlated with the sever-
ity of clinical signs. Local infiltration of a sclerosing
agent, P2G, or a combination of cortico-
steroids (methyl prednisolone acetate, 200 mg) and
Sarapin appears to provide relief in some horses.
Some horses benefit from treatment with nonsteroi-
dal anti-inflammatory drugs, which provide partial
pain relief enabling the horse to work better and
develop increased muscle strength. Daily work on
the lunge by using side reins or a chambon, together
with exercise in a cage horse walker in which the
horse is free and not tied, and no ridden exercise for
several weeks may be of significant benefit. Acu-
puncture therapy helps some horses. The response
to shock-wave treatment is currently being as-
essed. Affected horses should be maintained in
work at all times, in order to maintain muscular
fitness.

SI joint disease may occur in association with
other conditions; therefore, careful appraisal of the
whole horse is essential if a successful management
strategy is to be achieved. Nuclear scintigraphic
evaluation should include the thoracolumbar region.
Concurrent impingement of dorsal spinous pro-
cesses (DSPs) in the mid or caudal thoracic or cran-
ial lumbar regions may occur, with or without
associated pain. Infiltration of local anesthetic
solutions between, or around, the impinging DSPs may
be necessary to determine their contribution to the
clinical problem. Careful evaluation of the syno-
vial articulations, especially close to the thoracolum-
bar junction, is also important. Occasionally SI
disease has been seen together with OA of the cox-
ofemoral joints. This warrants a very guarded
prognosis.

Desmitis of the Dorsal SI Ligament
Desmitis of the dorsal SI ligament has been recog-
nized in horses that have presented with back pain
or unilateral hindlimb lameness, with or without
focal pain on palpation.8,65 In my experience, in an
acute injury there is usually localized heat and
swelling, with a variable degree of lameness. Usu-
ally lesions have been restricted to one side and have
been characterized ultrasonographically by enlarge-
ment of the ligament and disruption of normal ar-
chitecture, with hypoechogenic regions seen in
transverse images and loss of parallel alignment of
echoes in longitudinal images. Rarely, there may be
entheseophyte formation on the tuber sacrale.
Such lesions have been seen either alone or in con-
junction with other causes of back pain.

New Bone on the Caudal Aspect of the Wing of
the Sacrum
A small number of mature competition horses used
for dressage or show jumping have presented with
insidious onset loss of hindlimb action, progressing
to unwillingness to maintain a proper trot. These
horses have appeared considerably worse when rid-
den compared to evaluation in hand or on the lunge.
The horses have shown abnormal sensitivity to pal-
pation in the general areas of the SI joints. How-
ever, careful analysis of nuclear scintigraphic
images has shown relatively normal uptake of the
radiopharmaceutical in the region of the joints
themselves, but increased uptake abaxial to the
joints. The horses have responded very poorly to
treatment with nonsteroidal anti-inflammatory or other analgesic drugs. Postmortem examination has revealed spurs of new bone on the wings of the sacrum just caudal to the auricular surface, but not involving the SI joint itself. This has been seen in association with fusion of the transverse processes of caudal lumbar vertebrae and osseous proliferation involving intervertebral foramina or synovial articulations.⁶⁺,⁶²

Aorto-Iliaco-Femoral Thrombosis
Aorto-iliaco-femoral thrombosis is a relatively uncommon cause of exercise induced hindlimb lameness of variable severity.⁶⁶ Clinical signs may be sudden and severe in onset, or subtle initially and slowly progressive. Horses of all ages may be affected. The incidence is higher in male horses than mares. The pathogenesis is unknown.
IN DEPTH: UPPER HIND LEG LAMENESS

Clinical signs vary depending on the site(s) of thrombus formation, its size, and the degree of vessel occlusion. Lesions occur most commonly at the terminal aorta, but may also involve both the internal and external iliac arteries and the femoral arteries, either unilaterally or bilaterally. Lesions restricted to the femoral artery have not been documented. In mild cases, the horse may present with poor performance, early fatigue, or slight loss of hindlimb action during a work period. If the lesion(s) is predominantly unilateral the horse may show episodic hindlimb lameness, induced by work. In more advanced cases, there may be progressive shortening of hindlimb stride with exercise, followed by the development of distress and sweating, except over the hindlimbs. If the horse is allowed to stop, it may repeatedly flex its hindlimbs and stamp the feet to the ground. The affected limbs feel cool and delayed filling of the saphenous veins may be seen, with reduced pulse amplitudes in the dorsal metatarsal artery. Clinical signs usually resolve if the horse is allowed to stand still for a few minutes.

In advanced cases, it is usually possible to palpate a thrombus per rectum in the terminal aorta, which feels abnormally firm. Pulses in the iliac arteries may be reduced or absent. In less advanced cases, diagnostic ultrasonography is required to identify the lesion. Ultrasonography is also useful to determine the extent of the lesions. Examination of part of the femoral artery can be performed transcutaneously on the medial aspect of the crus. Doppler ultrasonography of this part of the femoral artery can help to determine if a more proximal lesion is present.

First-pass radionuclide angiography can be used to determine blood flow in the aorta and iliac arteries and also the femoral arteries. However, the sensitivity of the technique for detection of subtle lesions has yet to be determined.

The aims of treatment are to try to prevent further thrombus formation and to develop a collateral blood supply for adequate perfusion. There are no available drugs that will alter a pre-formed thrombus. Treatment rationale has been based on pain relief, and the use of anti-inflammatory drugs, platelet inhibitors, anthelmintics, fibrinolytic agents, and anticoagulant drugs. Those most commonly used include phenylbutazone (2.2 mg/kg BID for 2 mo), aspirin (5 mg/kg SID for several months), and isoxsuprime (1 mg/kg BID for 3 mo). Successful treatment is presumably based on the development of an effective collateral blood supply.

I have successfully managed some mild cases with long-term aspirin therapy, but more severe cases are usually refractory to treatment. Only 2 of 29 horses returned to their former athletic function, with resolution of clinical signs, following medical treatment. Surgical removal is feasible, although the rate of recurrence is quite high.

Coxofemoral Joint

The CF joint is relatively rarely a source of pain causing lameness in the horse.

Osteoarthritis. Osteoarthritis of the CF joint is an unusual cause of hindlimb lameness in the horse, usually occurring unilaterally, but occasionally bilaterally. It may occur secondary to dysplasia, rupture of the teres ligament or trauma.

Lameness varies from moderate to severe. The horse will both resent flexion of the limb and be unwilling to stand on the limb for long periods with the contralateral limb picked up. The degree of gluteal muscle disuse atrophy may be more than that associated with pain in the more distal part of the limb. Lameness may be characterized by a tendency for the horse to move on three tracks. IA analgesia usually results in improvement in lameness, but it is rarely alleviated fully.

Nuclear scintigraphic evaluation may be helpful in highlighting the CF joint as abnormal, especially if the results of IA analgesia are equivocal. However, it is important to be aware that loss of muscle over the hindquarter of the lame limb may confound interpretation and it is, therefore, important to evaluate ratios of uptake of the radiopharmaceutical in the region of the CF joint and another standardized location and compare this with values for normal horses. Be aware that the uptake associated with the CF joint is much less than that of the cranial and caudal parts of the greater trochanter of the femur.

Definitive diagnosis of OA requires radiographic examination and high-quality radiographs can only be achieved with the horse in dorsal recumbency, under general anesthesia. Abnormalities include periarticular osteophyte formation, new bone formation along the femoral neck, lucent zones in the subchondral one of either the acetabulum or the femoral head, and loss of congruity between the acetabulum and the femoral head (Fig. 15). Care should be taken not to confuse the depression in the femoral head and underlying radiolucent zone at the site of insertion of the teres ligament as a lesion.

IA medication of a CF joint with radiographic abnormalities has yielded disappointing results. The prognosis for return to athletic function is guarded.

Luxation of the Coxofemoral Joint, with or without Secondary Upward Fixation of the Patella. Luxation or subluxation of the CF joint is an unusual injury. It can occur as a primary injury or secondary to an unstable fracture of the ilial shaft. The trauma causing luxation can also result in articular fractures of the acetabulum. Permanent upward fixation of the patella may develop as a sequel, due to the displacement of the femur. The femur is displaced proximally; therefore, the greater trochanter of the femur appears higher on the lame limb. However, this can be very difficult to assess because the horse is usually reluctant to bear weight...
on the limb. Upward fixation of the patella results in an abnormally straight hindlimb stance and an inability to flex the limb. The diagnosis can be confirmed by radiography and with high output X-ray machines diagnostic radiographs can be obtained with the horse standing; however, it may be difficult to determine if there are concurrent fractures. The prognosis for athletic function is hopeless.

**Rupture of the Teres Ligament.** Rupture of the teres ligament is the result of trauma. It has been seen in a horse that tried to get up prematurely from general anesthesia while the limbs were still restrained in hobbles. Lameness is severe, with the horse being unwilling to bear weight on the limb. Secondary OA rapidly ensues. Definitive diagnosis is only possible postmortem. The prognosis for athletic function is hopeless.

**Displacement of the Femoral Head.** Displacement of the femoral head has been seen occasionally in young horses with severe lameness and reluctance to bear weight on the limb. Diagnosis is confirmed radiographically. The prognosis is hopeless.

**Fracture or Enthesopathy of the Third Trochanter of the Femur**

Fracture of the third trochanter of the femur is a relatively unusual injury, resulting in acute-onset, severe lameness that often improves quite rapidly with box rest. In a lean, poorly muscled horse it may be possible to elicit pain by palpation, but in a well-muscled warmblood type this is usually not possible. There are no particular gait characteristics. Nuclear scintigraphy is particularly valuable for tentative diagnosis of a fracture. There is intense, focal IRU (Fig. 16). Diagnosis may be confirmed radiographically, but good-quality radiographs can only be achieved under general anesthesia. Fractures are often longitudinal, occurring at the base of the trochanter. There is usually minimal displacement. Diagnostic ultrasonography has not been useful in my experience in helping to confirm the presence of a fracture. It is possible that some horses with IRU in the region of the third trochanter have enthesopathy of the attachment of the superficial gluteal muscles, but I have not been able to confirm this ultrasonographically. Treatment is box rest for 2 mo, followed by walking exercise for another month. Healing may occur by either osseous or fibrous union. Prognosis is good.

**References and Footnotes**

IN DEPTH: UPPER HIND LEG LAMENESS


10. Dyson, S., Branch, M., Murray, R. and Wood, J. Sacroiliac...


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a Dyson, S. Unpublished data

"Raisis, A. Personal communication 2000"