21 Back and pelvis

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CHAPTER CONTENTS

Introduction and historical perspectives

Historical reports of back disorders in horses provide few firm facts from the many lengthy accounts in old farriery and veterinary textbooks. In 1876 Lupton remarked that back injuries 'are among the most common and least understood of equine afflictions'.[1] In those days diagnosis was based simply on clinical observation (Fig. 21.1) and the opinions expressed were many and varied. These early writers were often excellent horsemen and were particularly knowledgeable on aspects of conformation. In relation to the incidence of spinal damage, Youatt believed that the short-backed horse showed less tendency to back problems and could be expected to carry more weight and possess greater endurance, but it did not have much potential for speed.[2] The long-backed horse was built for speed but was much more prone to weakness when ridden. Conformationally correct horses should have a gentle ventral curve immediately behind the withers, followed by a straight line to the lumbar region. An increase in this ventral vertebral curvature (i.e. lordosis) would increase the tendency to weakness and strain. Dorsal curvature (kyphosis), however, was considered to be a more severe defect, which seriously impaired usefulness and performance.

Back problems in horses cause a considerable degree of wastage and lost performance in almost all types of athletic horses. However, reports of their incidence are limited to a survey from general practice in the United Kingdom in the 1960s that showed an incidence of only 1% in 6588 horses.[3] This is probably an underestimate and no breakdown of these cases into the specific diagnosis was made, but a later review of 443 horses with back problems did categorize cases further into osseous, soft tissue and miscellaneous disorders.[4] Definitive diagnosis is often difficult due to vague clinical signs and the lack of good diagnostic imaging coupled with pathological reports.[5,6] This has inevitably resulted in widespread controversy engendering many unsubstantiated opinions about the incidence and clinical significance of back problems, which only increase the state of confusion. Much of this controversy has resulted from the general dearth of knowledge of the functional aspects of the equine thoracolumbar spine and scientific studies on the pathogenesis of back problems in horses. It is also clear that many horses perform poorly without an underlying back problem and many other horses perform surprisingly well in spite of one. In recent years there has been an encouraging progression of studies and biomechanical research to improve this situation.[7–12] There is also much more willingness for those involved with traditional methods of clinical medicine to work closely alongside those involved with spinal manipulative therapy and complementary medicine.[13] The purpose of this chapter is to try and combine all these aspects for the benefit and treatment of suspected cases of back pain.

Anatomic and functional considerations

Thoracolumbar vertebral column

Individual vertebrae are connected by an intricate system of ligaments and musculotendinous structures that provide stability while at the same time supporting movement of the vertebral column. The three principal mechanical functions of the vertebral column are:

1. protection of the spinal cord and associated nerve roots (i.e. vertebral arch)
2. providing support for weight bearing and soft tissue attachment (i.e. vertebral body and vertebral processes)
3. maintaining movement for flexibility and locomotion (i.e. articulations, ligaments, and muscles).

Fig 21.1 A test for rick of the back.[1]

The equine thoracolumbar vertebral region consists of an average of 24 individual vertebrae, based on the typical vertebral formula (C7, T18, L6, S5, Cd15–21).[14] However, variations in the number of vertebrae within the thoracolumbar vertebral region are common and are often compensated by a reduction or increase in the number of vertebrae in an adjacent vertebral region.

Vertebral motion segment

The structural and functional unit of the vertebral column is the vertebral motion segment. A vertebral motion segment consists of two adjoining vertebrae and interposed soft tissue structures (Fig. 21.2). The typical vertebra is characterized by a vertebral body, vertebral arch and vertebral processes that vary in each vertebral region according to structural and functional demands. The vertebral body is a ventral cylindrical structure covered dorsally by the vertebral arch, which includes bilateral pedicles and laminae. Vertebral processes include one spinous process, two transverse processes and two pairs of cranial and caudal articular processes on each vertebra. Mamillary processes are additional vertebral processes found only in the thoracolumbar region that provide added paraspinal muscle attachment sites. Dorsally, the articular processes create bilateral synovial articulations (i.e. zygapophyseal joints) that provide segmental stability and mobility to the vertebral motion segment. Ventrally, the vertebral bodies and intervertebral disks form fibrocartilaginous joints that also provide segmental vertebral stability and mobility. Additional connecting soft tissues include both short and long spinal ligaments and muscles. The vertebrae, vertebral articulations and ligaments are innervated segmentally by sensory branches of the dorsal rami and recurrent meningeal nerves. These nerves mediate nociception and proprioception within the vertebral column.

The vertebral motion segments of the upper cervical region (i.e. occiput-C1–C2) are a highly mobile, specialized joint complex. The cervical vertebrae have rudimentary spinous processes and characteristic transverse foramina for the passage of vertebral vessels. The thoracic vertebrae are characterized by tall spinous processes (highest at T5 or T6), costal articulations and an anticlinal vertebra at T15 or T16. The lumbar vertebrae have long, horizontally flattened transverse processes and intertransverse joints in the caudal region (L4–S1) that are unique to horses. The sacrum is usually made up of five fused segments and has bilateral sacroiliac joints for articulation with the pelvis. The caudal vertebrae are characterized by progressively rudimentary vertebral arches and vertebral processes.

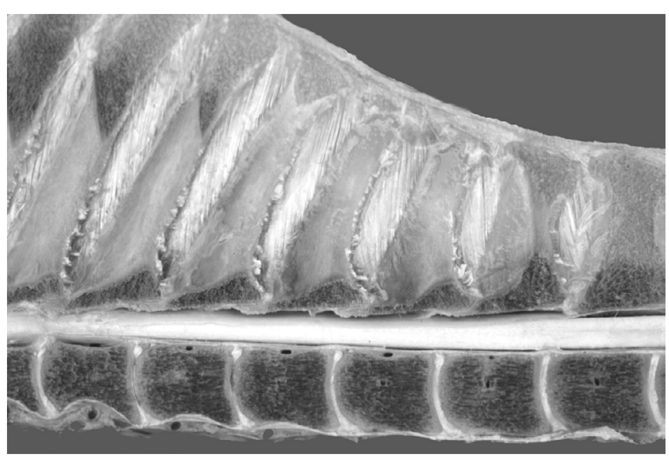

Fig 21.2 Sagittal section of the thoracic vertebral region (T8–T14) demonstrating osseous vertebral structures and supporting spinal ligaments.

Vertebral body and intervertebral disk

The vertebral bodies form the foundation on which the remaining vertebral structures are placed. The cranial vertebral body is convex in shape and the caudal vertebral body is concave (Fig. 21.2). Therefore, most equine intervertebral joints resemble a shallow ball-and-socket configuration, which provides stability without restricting mobility. Vertebral bodies provide support for weight bearing, connective tissue attachment and muscular attachment sites for the diaphragm and psoas muscles in the lumbar vertebral region. The intervertebral disks connect adjacent vertebral bodies and together are classified as fibrocartilaginous articulations. An intervertebral disk consists of an outer annulus fibrosus and central nucleus pulposus. The nucleus pulposus is rudimentary in the thoracolumbar vertebral regions compared to the cervical and caudal vertebral regions (Fig. 21.2). The dorsal and ventral longitudinal ligaments, and the costovertebral ligaments, provide additional reinforcement to the periphery of the intervertebral disk. The intervertebral disk is active in weight bearing, axial shock absorption and maintaining vertebral flexibility. The outer one-third of the intervertebral disk is innervated by both proprioceptive and nociceptive fibers.

Spinous processes

The spinous processes project dorsally from the vertebral arch and vary in size, shape and orientation in different vertebrae and vertebral regions (Fig. 21.3). The spinous processes function as a series of levers for muscle and ligamentous attachment that provide support and movement to the vertebral column. Spinal extension and rotation are produced by contraction of muscles attached to the spinous processes. The supraspinous ligament stabilizes the apex of the spinous processes and aids in resisting excessive spinal flexion. The spinous processes in the cranial thoracic vertebral region are angled caudally and elongated in the region of T2 to T12 to form the withers. The cranial thoracic vertebral region must provide a foundation for stability for and resist forces produced by the head, neck and forelimbs, whereas the caudal thoracic and lumbosacral vertebral region has to resist significant forces associated with the hind limbs and locomotion. The divergent spinous processes of the lumbosacral junction produce a wide interspinous space, compared with the adjacent interspinous spaces.[15–17] The lumbosacral spinous process divergence supports an increased range of motion at the lumbosacral junction without the risk of spinous process impingement.

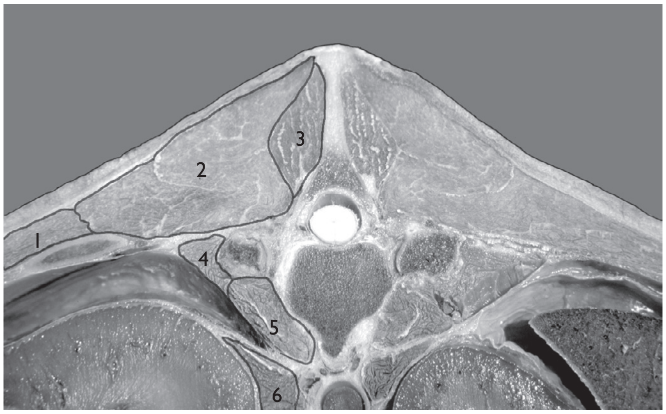

Fig 21.3 Transverse section at the T18 vertebral region. Outline of the muscles represented are: (1) iliocostalis, (2) longissimus, (3) multifidi, (4) psoas major, (5) psoas minor and (6) crus of the diaphragm.

Articular processes

Two pairs of cranial and caudal articular processes arise dorsolaterally from the vertebral arch. An articular surface on the articular processes contributes to the formation of bilateral synovial articulations (i.e. zygapophyseal joints). The articular surfaces in the thoracic vertebral region lie horizontally (i.e. dorsal plane) with the cranial articular surfaces facing dorsally and the caudal articular surfaces facing ventrally. Vertebral motion in the thoracic vertebral region is limited mostly to rotation and lateral bending. The lumbar vertebral region has articular surfaces that predominantly lie vertically (i.e. sagittal plane). Vertebral motion in the lumbosacral vertebral region is limited mostly to dorsoventral flexion. The articular processes function in support and movement of the vertebral arch. The amplitude and direction of segmental vertebral motion are related to the size, shape and orientation of the articular surfaces and functional status of the articulations.[15,16,18] Regional and overall spinal motion is due to the cumulative effects of small amounts of segmental vertebral motion. The zygapophyseal joint capsule has a dense outer fibrous layer, vascular central layer and an inner layer consisting of the synovial membrane. The zygapophyseal joint capsule is richly innervated with sensory nerve fibers from the medial branch of the dorsal rami of several adjacent nerve roots. Proprioception and nociception are two important neurologic functions of the zygapophyseal joints.[19,20] Multilevel spinal innervation of the zygapophyseal articulation produces non-localized pain patterns, which contribute to the difficulty of identifying and localizing back problems.[21]

Transverse processes

The transverse processes provide support and movement to the vertebral column via muscular and ligamentous attachments. Transverse processes are used as lever arms by the deep spinal muscles to maintain posture and to induce rotation and lateral bending.[21] In the thoracic region, the transverse processes contain articular surfaces that contribute to the costotransverse articulations. The lumbar vertebral region has elongated, horizontally flattened transverse processes that provide attachment sites for the large dorsal paraspinal muscles and ventral psoas muscle group. Species of the genus Equus have intertransverse synovial articulations between the transverse processes of the last two or three lumbar vertebrae and at the lumbosacral junction.[15,16] Biomechanically, the intertransverse joints aid in the transfer of propulsive forces from the hindlimbs to the vertebral column and provide resistance to lateral bending and axial rotation of the spine.

Sacroiliac joint

The pelvis articulates with the vertebral column at bilateral sacroiliac articulations, located at the junction between the ventral wing of the ilium and the dorsal wing of the sacrum (Fig. 21.4). Dynamically, the sacroiliac joints aid in locomotion via transfer of hind limb propulsive forces to the vertebral column.[22] The articular surfaces of the sacroiliac joint are nearly flat and closely apposed to support small amounts of gliding movements. The sacroiliac joint is typically L-shaped with the convex border directed caudoventrally. The sacroiliac joint capsule is thin and closely follows the margins of the sacroiliac articular cartilage. The sacroiliac joint is supported by three bilateral sets of strong sacroiliac ligaments that act to support weight of the caudal vertebral column. The dorsal sacroiliac ligaments, consisting of a dorsal and lateral portion, connect the tuber sacrale to the sacrum. The interosseous sacroiliac ligaments are the most robust of the sacroiliac ligaments, spanning

Fig 21.4 Transverse section at the lumbosacral and sacroiliac articulations. Outline of the muscles represented are: (1) gluteus medius, (2) sacrocaudalis dorsalis, (3) iliopsoas (psoas major and iliacus). The tuber sacrale and the interosseous and ventral sacroiliac ligaments are also shown.

the space between the ventral wing of the ilium and the dorsal wing of the sacrum and function as a sling to support the entire mass of the caudal trunk. The ventral sacroiliac ligaments connect the ventral wings of the sacrum to the ilium. The sciatic nerve, cranial gluteal nerve and cranial gluteal artery and vein travel through the greater sciatic foramen, immediately ventromedial to the sacroiliac articulation, which need to be taken in consideration during caudal approaches for injecting the sacroiliac joint.

Spinal ligaments

A series of long and short spinal ligaments contribute to vertebral column stability. Three separate longitudinal spinal ligaments span the length of the vertebral column and provide regional vertebral stability. The nuchal ligament in the cervical vertebral region continues as the supraspinous ligament in the thoracolumbar vertebral region and joins the tips of the spinous processes. The dorsal longitudinal ligament connects the dorsal vertebral bodies within the vertebral canal and acts to reinforce the intervertebral disk (Fig. 21.2). The ventral longitudinal ligament attaches to the ventral vertebral bodies and blends with fibers of the intervertebral disk. The short spinal ligaments interconnect individual vertebral structures and function to protect the spinal cord and to provide segmental vertebral stability. Interspinous ligaments connect adjacent spinous processes. The ligamenta flava span the space between adjacent vertebral laminae and contain a high proportion of elastin. Specialized costovertebral and costotransverse ligaments provide additional stability to the thoracic vertebral region and ribs. The intertransverse ligaments connect adjacent transverse processes in the lumbar vertebral region and limit lateral bending. The intervertebral disk can be considered a specialized connective tissue structure that connects adjacent vertebral bodies.

Intrinsic spinal muscles

Muscles that attach only to the axial skeleton are considered intrinsic spinal muscles. The spinal musculature can be categorized into epaxial or hypaxial muscle groups based on their location relative to the transverse processes of the vertebral column. The epaxial muscles lie dorsal to transverse processes, are segmentally innervated by dorsal branches of spinal nerves and produce spinal extension and lateral bending. Hypaxial muscles lie ventral to transverse processes, are segmentally innervated by ventral branches of spinal nerves and produce spinal flexion and lateral bending. The thoracolumbar fascia is an aponeurosis that serves as an attachment site for many spinal and proximal limb muscles. The thoracolumbar fascia is strong and attaches to the thoracolumbar spinous processes and the cranial edge of the ilial wing. At the lumbosacral junction, the thoracolumbar fascia consolidates along the dorsal midline to form bilateral robust tendons that insert onto the cranial aspect of the tubera sacralia. The largest group of epaxial muscles is organized into three parallel columns. These include (from lateral to medial) the iliocostalis, longissimus and spinalis muscle groups (Fig. 21.3). The iliocostalis muscles are a thin muscle group that attaches to the angle of the ribs and the tips of the lumbar transverse processes. The longissimus muscles are by far the largest and longest group of back muscles. These muscles primarily attach to the dorsal spinous and transverse processes of the thoracolumbar vertebral region and the wing of the ilium and help to support the weight of saddle and rider. The spinalis muscles cover the lateral aspects of spinous processes of the withers and may be compromised by a narrow saddle. The transversospinalis muscle group is the deepest and most medial muscle group (Fig. 21.3) and is largely composed of multifidi muscles in the thoracolumbar vertebral region. The multifidi muscle group is a series of short musculotendinous units that originate from transverse, articular and mamillary processes and insert on adjacent spinous processes. These short muscles span 2–4 vertebrae and are segmentally innervated by dorsal spinal branches.

The epaxial muscles produce spinal extension when activated bilaterally, and lateral bending and rotation when activated unilaterally. Superficial muscle groups usually span one or more vertebral regions, whereas deep spinal muscles usually only span a few vertebrae.[22] The spinal musculature is important for movement, posture and flexibility. The superficial spinal muscles are usually more dynamic and play a role during regional vertebral motion, energy storage and force redistribution during locomotion.[22] Deep, short spinal muscles have more of a static function and are active in segmental stabilization, proprioception and posture.

Extrinsic spinal muscles

Muscles that have attachments on both proximal limbs and the axial skeleton can be considered extrinsic spinal muscles (or shoulder girdle or pelvic girdle limb muscles). The general function of the extrinsic spinal muscles is to induce proximal limb movements required in locomotion or to assist vertebral mobility, depending on whether the vertebral column or limbs are held stationary relative to each other. The shoulder girdle muscles can be categorized into dorsal or ventral muscle groups.[23] The dorsal muscles of the shoulder girdle act to suspend the forelimbs from the neck and trunk. The dorsal shoulder muscles include the brachiocephalicus, omotransversarius, trapezius, rhomboideus, cutaneous trunci and latissimus dorsi. The ventral muscles of the shoulder girdle function in suspending the neck and trunk from the forelimbs. The ventral shoulder muscles include the subclavius, superficial pectoral, deep pectoral and serratus ventralis.

The pelvic girdle muscles are best characterized as cranial-caudal and lateral-medial muscle groups.[23] The cranial muscles of the pelvic girdle function in hind limb protraction and hip flexion. Muscles in this group include the sartorius, iliopsoas, tensor fasciae latae and rectus femoris. The caudal muscles of the pelvic girdle produce hind limb retraction and hip extension. Muscles in this group include the biceps femoris, semitendinosus and semimembranosus. The lateral muscles of the pelvic girdle mostly cause hind limb abduction and include the superficial, middle and deep gluteal muscles. The medial muscles of the pelvic girdle produce hind limb adduction and include the gracilis, pectineus and adductor muscles.

The hypaxial or sublumbar muscles include the psoas minor, psoas major and iliacus. The psoas minor and psoas major originate on the ventral vertebral column (T16 to L6) and insert on the pelvic inlet and lesser trochanter of the femur, respectively. Together, the psoas major and iliacus form the iliopsoas, the largest flexor of the coxofemoral joint (Fig. 21.4). If the hindlimb is stabilized, then the iliopsoas muscle induces flexion of the lumbar spine and pelvic flexion about the sacroiliac articulations.

Diagnostic challenges

Back problems – a syndrome

The general description of a horse having 'back problems' is not particularly useful from either a diagnostic or therapeutic perspective. Affected horses could have differing combinations, severity, chronicity, distribution, and locations of soft tissue, articular, neurologic or even behavioral issues related to chronic pain and discomfort. From this perspective, a horse could also be described as having 'lameness' or 'colic', which signifies that a potential disease process is present but it is does not specify in any way the pathophysiology or affected tissues, which is often a prerequisite for providing a definitive diagnosis and focused treatment.

A proposed approach for describing the vague and sometimes complex clinical features associated with back problems in horses is to define back problems as a syndrome. A syndrome is typically defined as a collection of clinically recognizable features that often occur together and the presence of one of these features should alert the practitioner to the possibility of the presence of other findings. Within a syndrome, the reason that the clinical signs occur together typically has not yet been discovered (i.e., pathophysiology). The majority of musculoskeletal injuries are characterized by signs of acute inflammation, which include heat, swelling, pain, altered function, and in some cases redness. Chronic musculoskeletal injures are also characterized by altered function and chronic pain (i.e., lameness) and swelling most likely due to effusion, fibrosis or osteophytosis. Therefore, the syndrome of acute back problems includes signs of heat, pain and altered function (e.g., stiffness, muscle hypertonicty) and occasional swelling due to the deep location of most spinal structures. All of these signs are clearly observable and measurable with existing objective outcome measures such as infrared thermography, pressure algometry, myotonometry, goniometry or other measures of spinal range of motion. Chronic back problems are characterized by signs of stiffness and chronic pain, which may include behavioral issues in some horses. The presence of any one of these clinical signs within the axial skeleton should then alert the examiner to the possibility of the existence of other related signs of back problems or spinal dysfunction.

Back pain perception

Quantifying the degree of pain in horses and establishing the precise site of pain has always been difficult[24] and horses with back pain are no exception. The situation is further complicated as the major clinical sign recognized by owners in many horses with a back problem is impaired or poor performance and not overt thoracolumbar pain. On the other hand, many horses apparently perform satisfactorily in spite of some low-grade back pain. To add to this confusion, some horses appear to be naturally sensitive or 'thin-skinned' and resent being groomed or palpated along the back. In these patients, both owners and clinicians may interpret an evasive response to innocuous stimuli (i.e., allodynia) as a sign of back pain. Another difficulty in the assessment of back pain involves the condition known as 'cold back' in which there is apparent hypersensitivity over the back with a transient stiffness and extension (lordosis)) of the trunk as the rider gets into the saddle. There are usually no other demonstrable clinical signs, although in severe cases the horse may buck and rear when first mounted and ridden. In some instances the thoracolumbar spine is notable flexed (kyphosis) and the epaxial muscles are severely hypertonic. The initial stiffness from being saddled or mounted usually subsides within a few minutes and thereafter no effect on performance is noted. Whether this condition is actually painful, associated with some previous back pain or illi-fitting saddle or is merely a matter of temperament is unclear.

Many of the difficulties in clinical diagnosis of back problems would be solved if some meaningful criteria for the assessment of pain and an objective system of quantifying it could be established. The origin of primary back pain is irritation of the dorsal nerve roots and the branches of the spinal nerves. The back, like most tissues of the body, is innervated nerve endings that are particularly sensitive to tissue dysfunction (Fig. 21.5). Nociceptive receptors include plexiform and free ending arrangements of unmyelinated nerve fibers. Nociceptive fibers are distributed throughout the skin and subcutaneous tissues, adipose tissues, fasciae and ligaments, periosteum, dura mater, adventitia of blood vessels and fibrous capsules

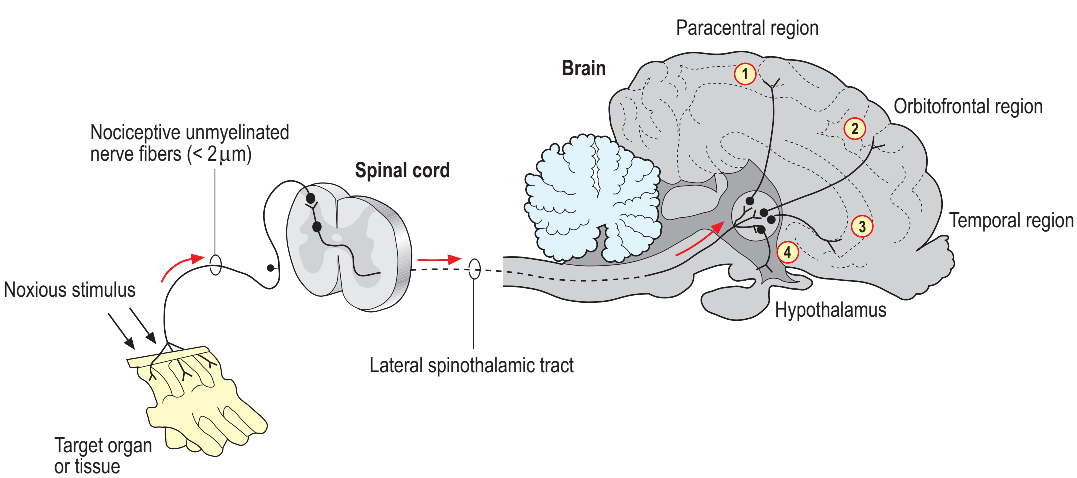

Fig 21.5 Pain pathways associated with the thoracolumbar spine.

of interneural articulations and sacroiliac joints. In normal circumstances this receptor system is relatively inactive but it is activated when chemical, mechanical or other damaging factors are applied to the tissues containing the unmyelinated nerve endings. Primary back pain therefore results from trauma or irritation of these nociceptive receptor nerve endings. Various other pain syndromes are recognized in humans and include secondary, referred and psychosomatic low back pain, but their importance in the horse is unproven as yet.

Another important factor to be considered is the marked variation in response to pain. Even in humans a meaningful measurement of 'pain threshold' is unrealistic as patients can vary in the intensity of their experience of pain from day to day and even at different times during the day. In horses, temperament is considered an important factor in the assessment of both acute and chronic pain. It is suggested that the reduced performance is sometimes due to the horse attempting to guard its back even though the clinical signs of pain have abated some time previously. Some credence has been given to this idea by the induction of back pain in trotting horses and recent research into motor learning and compensatory gait mechanisms.[25] The principal sign of primary induced back pain is not lameness, but stiffness and reduced performance.

Difficulties of palpating the anatomical structures involved

Many of the lesions associated with back problems involve osseous structures of the thoracolumbar spine that are difficult, if not impossible, to palpate effectively (e.g. vertebral bodies, articular and transverse processes). In the thoracolumbar spine it is only possible to palpate the apicess of the dorsal spinous processes. Locating the site of pain within the epaxial muscles is also difficult as typical palpation procedures may precipitate spasm or contraction of the entire longissimus muscle and an overall exaggerated or guarded response. The longissimus muscle runs the entire length of the trunk from its origin at the caudal cervical spine to the insertion on the wing of ilium and sacral spinous processes. The sacroiliac and lumbosacral joints are also virtually impossible to palpate, except partially along their ventral aspects via rectal palpation. The supraspinous ligament and a portion of the dorsal sacroiliac ligaments are readily palpable, but unfortunately other vertebral or pelvic ligaments (e.g. interspinous, ventral sacroiliac, etc.) are not accessible.

Dearth of appropriate pathological studies

There have been no systematic pathological studies on a large series of back cases in horses. There have been a number of studies on congenital deformities[26,27] and reports on diskospondylitis.[28,29] Some investigations on acute and chronic sacroiliac disease have been reported.[30,31] Much has been written about the clinical and surgical treatment of over-riding or impinged dorsal spinous processes (i.e. kissing spines),[32] but very little research has been done on its etiopathogenesis. The widespread use of ultrasonography to diagnose soft tissue injuries of the epaxial structures has dramatically increased the ability to diagnose desmitis within the supraspinous and dorsal sacroiliac ligaments, but no pathological studies have been completed to confirm these clinical findings.[33–35]

Frequency of multiple lesions at multiple sites

Many back problems in horses are associated with chronic or longstanding injuries. It is also common for there to be more than one spinal lesion that contributes to the clinical signs and poor performance. A breakdown of diagnoses of one of the authors' cases (LBJ) from 1992 to 1997 shows a total of 395 diagnoses made from 268 cases presented for examination of the back to a referral clinic (Box 21.1). It is particularly common for cases of over-riding or impinged dorsal spinous processes to be associated with injury of the supraspinous ligament, sacroiliac disease or low-grade hock lameness. Therefore confirmation of such secondary lesions can have important implications for the management and prognosis of horses with primary back problems.

Types of back problems

A serious stumbling block to progress in the diagnosis and treatment of equine back problems is the wide range of opinions that exist. This is true not only within the veterinary profession, but between veterinarians and physical therapists, horse owners and trainers. The lack of authenticated reports and specific studies in this field makes it impossible to set standards for definitive diagnosis and therefore clear guidelines for treatment. The primary clinical sign of back problems in horses is a loss or reduction in performance, whatever the underlying pathogenesis; other clinical signs may be more difficult to precisely define.

Opinions vary as to whether horses genuinely suffer from back problems at all or whether the signs exhibited are referable to damage elsewhere in the skeleton. In our experience genuine back problems do occur, but in a variety of forms (Table 21.1). First, there are those with identifiable lesions in the thoracolumbar spine or epaxial structures (i.e. primary back problems). A second important category are those due to secondary back problems that occur as a result of the pressure or strain exerted from lesions in the appendicular or axial skeleton (i.e. particularly fore- or hind limb lameness). Finally, there is a category of apparent or alleged back problems which, despite popular opinion, have limited anatomic or pathophysiologic evidence to support their occurrence (Table 21.2). This group of 'back problems' forms the basis of much controversy between veterinarians and other professionals (e.g. chiropractors) or non-professionals (e.g. lay practitioners). These difficulties are exacerbated by the fact that many horses suffer low-grade and chronic lesions. Malalignment or displacement of the caudal thoracic or lumbar dorsal spinal processes is reputed to be a common cause of back trouble in horses.[36] One or more spinous summits are said to become laterally displaced (i.e. 'out of place') and these can apparently be replaced by sharp pressure at the appropriate site (i.e. 'put back into place'). From an anatomic point of view this claim is not acceptable; these structures are not moveable like this either in life or at post-mortem. In spite of the tendency for intervertebral disks to degenerate with age in the thoracolumbar spine, they do not appear to cause any clinical signs similar to those seen so commonly in humans and in dogs. Nerve 'pinching' and peripheral nerve lesions are often claimed to be important causes of back problems, but as yet there has been no scientific evidence to substantiate this belief in horses. However, anecdotal necropsy evidence does support the existence of spinal nerve compression at

Box 21.1 Distribution of the general categories of chronic back problems (1992–97)

Total number of horses	268
Primary back problem	268
Secondary back problem	105
Tertiary back problem	32
Total diagnoses	395

Table 21.1 Differential diagnoses to consider for a horse with potential back problems

TYPE OF BACK PROBLEM	GENERAL CATEGORY	SPECIFIC LESION OR PROBLEM
Primary back problem	Soft tissue injury	Longissimus muscle strain Supraspinous ligament sprain or desmitits Dorsal sacroiliac ligament sprain or desmitits Exertional rhabdomyolysis (tying up) Non-specific soft tissue injury
	Osseous injury	Conformational or developmental abnormality Over-riding or impinged dorsal spinous processes Osteoarthritis (e.g. articular processes) Vertebral fracture Spondylosis Diskospondylitis Spinal neoplasia (primary and secondary)
	Neurologic disorders	Equine protozoal myeloencephalitis (EPM) Equine degenerative myeloencephalopathy (EDM) Equine herpesvirus myeloencephalitis (EVH-1) Equine motor neuron disease (EMND)
	Tack associated	Poor saddle fit or excessive pressure
	Idiopathic	No clinical abnormalities detected
Secondary back problem		Hindlimb lameness (e.g. spavin), Forelimb lameness Neck problem (e.g. stenotic myelopathy) Acute sacroiliac injury Chronic sacroiliac disease Pelvic fracture
Presumed back problem		Bad temperament Lack of ability (rider or horse) Lack of fitness Improper tack fit or use Dental problems

Table 21.2 Conditions alleged to cause back problems in horses for which there is currently no definitive scientific evidence

GENERAL CATEGORY	SPECIFIC LESION OR PROBLEM
Vertebral subluxation	Subluxation of thoracolumbar vertebral bodies or articular processes Misalignment of thoracolumbar dorsal spinous processes
Intervertebral disk injury	Intervertebral disk prolapse or herniation
Peripheral neuropathy	Compromise of thoracolumbar spinal nerves at the intervertebral foramen

the lumbosacral junction (i.e., L6 ventral spinal nerve) due to bony proliferation and osteophytosis at the associated intervertebral foramen adjacent to the medial aspect of the L6-S1 intertransverse joints, which would be expected to produce similar clinical signs to 'sciatica' or lumbar spinal nerve compression in humans.

Frequency of spontaneous recovery

Many of the problems causing poor performance in horses are long-standing (i.e. many weeks or months in duration) and there is a tendency for these cases to recover spontaneously. In a survey of cases followed over two years, a 65% recovery rate was reported irrespective of the diagnosis and the treatment or management regime.[5] The prevalence of spontaneous recovery therefore can hamper elucidation of diagnosis and make evaluation of treatment regimes difficult.

Relationship of back pain to lameness

Lameness is not a typical feature of horses suffering primary back problems. However, secondary back pain is often associated with lameness as the underlying condition causing poor performance. Most primary back cases exhibit only low-grade hind limb lameness, which is often bilateral and most commonly associated with hock injury. A study in which back pain was induced using lactic acid injections into the longissimus muscles did not produce any signs of hindlimb lameness.[25] However, in other studies that evaluated naturally-occurring clinical cases of thoracolumbar or sacroiliac pain, the prevalence of limb lameness varied from 35% up to 74–85%.[37–39] Conversely, in horses presented for primary limb lameness, the prevalence of back problems varied between 23–32%.[38,39] Therefore, it appears that a large percentage of horses with back pain have concurrent lameness versus a smaller proportion of horses with lameness also have back pain. The clinical significance of this is that practitioners that focus solely on back problems (e.g., equine chiropractors) are likely not addressing concurrent lameness issues if they are not collaborating with limb lameness specialists. Conversely, practitioners that focus solely on limb lameness without considering the potential adverse effects on spinal function are likely not providing comprehensive treatment of musculoskeletal pain and poor performance.

Causes of sacroiliac joint pain or injury have been postulated to be the result of sacroiliac or lumbosacral osteoarthritis, sacroiliac desmitis or sprain, sacroiliac subluxation or luxation, pelvic stress fractures, complete ilial wing fractures or sacral fractures.[40] Additional differential diagnoses include thrombosis of caudal aorta or iliac arteries, exertional rhabdomyolysis, trochanteric bursitis and impinged dorsal spinous processes in the lumbar vertebral region.[41] Horses with presumed thoracolumbar vertebral problems may also have concurrent chronic sacroiliac joint injuries. In a report on 443 horses with back problems, chronic sacroiliac joint problems were identified in 15%.[4] Clinical signs of lower hind limb lameness may overlap and mimic signs of presumed sacroiliac joint pathology. It is important that a thorough and complete lower limb lameness evaluation is completed prior to or in conjunction with a proximal hind limb or sacroiliac joint work-up.

Diagnostic protocol to assess back problems

A standardized protocol should be used to systematically examine horses with potential back problems (Box 21.2).

Box 21.2 Diagnostic protocol for the evaluation of horses with potential back problems

Case history

- Signalment and use of the horse
- Onset and duration of clinical signs
- Response to treatment, particularly NSAIDs and manipulation
- Temperament and ability to perform
- Assessment of management and training routine
- Evaluation of predisposing factors
- Experience of the rider

Clinical examination

- Visual inspection of conformation, posture and musculoskeletal symmetry
- Gait evaluation: in hand, lunged, ridden, or driven
- Evaluation of concurrent lameness
- Neurologic evaluation
- Postexercise palpation and manipulation
- Soft tissue and osseous palpation
- Regional and segmental joint manipulation
- Rectal palpation
- Examination of tack, particularly saddle fit

Diagnostic imaging

- Radiographic examination – osseous pathology

Standing: lateral view of the thoracolumbar (T2–L4) and sacrocaudal (S2-Cd4) regions

General anesthesia: ventrodorsal view of the lumbosacral (L4–S5) region

- Ultrasonography – articular or spinous processes, supraspinous or sacroiliac ligament desmitis
- Nuclear scintigraphy – active inflammation or bone turnover
- Thermography – back or gluteal muscle injury, altered vasomotor tone
- Linear tomography – sacroiliac joint pathology

Laboratory examination

- Hematology
- Biochemistry: muscle-derived enzymes (AST and CK), before and after exercise test
- Serology: vitamin E and selenium levels, viral isolation
- Cerebrospinal fluid analysis
- Muscle biopsy

Additional diagnostic aids

- Diagnostic injections of interspinous spaces, articular processes or sacroiliac joint
- Electrical muscle stimulation
- Therapeutic trial of NSAIDs – effect on performance
- 'Slap test' for evidence of cervical vertebral stenosis causing hindlimb ataxia

History

The value of obtaining a thorough clinical history cannot be overestimated, as the clinical signs and behavioral changes of thoracolumbar disorders are many and varied.[42] Details dating back to the time when the owner first acquired the horse are extremely helpful in deciding whether or not one is dealing with a genuine back problem. In this regard, information on management, tack and performance should always be sought.

Acute versus chronic onset

The history in acute back injuries is usually straightforward as some traumatic incident will have been noticed. For example, young horses with multiple fractures of the dorsal spinous processes from T2 to T10 often have a history of rearing up and falling over backwards onto the withers. Most acute cases involve soft tissue injuries and strain of the longissimus muscles is particularly common.

Chronic problems are commonly encountered when no obvious initiating incident is recognized. One consistent feature of a long-standing back problem is an alteration in the horse's behavior or temperament. This may be insidious in onset and it may take some time before the owner fully appreciates that the change has taken place (e.g. a normally good-natured horse becomes sour and rather fractious to handle or there may be a loss of enthusiasm to work). There also seems to be a correlation between nervous or temperamental horses and the presence of back problems.

Use of the horse

There also seems to be an association with the type of back injury and the type of work the horse is involved in. Jeffcott reported that the differences in incidence of specific back problems varied quite noticeably according to whether the horse jumped at speed, jumped competitively or was not used for jumping at all.[5] Acute sacroiliac strain or subluxation was more prevalent in horses jumping at speed, whereas impinged or over-riding dorsal spinous processes were most common in showjumpers. The incidence of soft tissue damage was much the same in both of these groups and age was not nearly such an important factor in equine back disorders as it is in humans. Spondylosis appeared more frequently in mares, whereas over-riding dorsal spinous processes was most often seen in short-backed Thoroughbred geldings.

Sacroiliac pain is common in dressage horses and causes impaired performance, usually without lameness. Standardbred harness racing also shows a high incidence of sacroiliac and hindquarters problems but over-riding or impinged spinous processes are rare. Back injuries in reining, barrel racing and rodeo horses are not common but are usually associated with muscle injuries. In endurance horses back problems resulting from long periods of extreme exercise and saddle-induced injuries are common.

Concurrent lameness and loss of performance

Positive clinical signs at exercise may include uni- or bilateral hindlimb lameness, a loss of enthusiasm for work or an inability to stride out at fast paces. Owners will often mention a stiffness in the hindlimb action and a loss of suppleness of the back when ridden, although the action when loose in the paddock appears satisfactory. Jumping with a fixed hollow back is frequently encountered or there may well be a reluctance to jump, particularly combination-type fences. The horse may also lose its fluidity and timing during jumping and become tense, tending to rush over the fences. Signs of head shaking and an increased tendency for tail swishing are other occasional features found in horses with back problems.

Medication and treatment

Since many back problems are chronic in nature, the horse may well have received multiple treatments before your examination. It is therefore important to know what type of medications or therapy have been tried and whether or not they provided any improvement. A clinical trial of phenylbutazone (2 g, p.o., b.i.d. for 4–5 days) is often used to assess the inflammatory component of a back problem. The use of non-steroidal anti-inflammatory drugs (NSAIDs) will often produce an improvement in osseous or articular pathologies although this may be partial and short-lived. A similar clinical trial of methocarbamol (15–44 mg/kg, p.o., s.i.d.) will help some horses with muscle-related back soreness or hypertonicity. Inquiries into the response to rest or changes in activities, such as cross-training, are often helpful in assessing the mechanism of action of the back problem. Some horses, like humans, appear to get burnt out when asked to do repetitive or monotonous disciplines without any changes in routine. Many forms of physiotherapy or spinal manipulative treatment may give temporary improvement, but a lasting success is unlikely without establishing a definitive diagnosis of the back problem.

Management and training ability

It is common for owners to blame poor competitive ability on a problem in the thoracolumbar spine when it is simply due to poor schooling or equitation. It is now well recognized that the most consistent feature in a back problem is a loss of performance, particularly in the ability to jump effectively. Acute soreness in the back muscles is often associated with falling or some other traumatic incident, but a history of obvious pain in the thoracolumbar spine is not always reported, particularly in long-standing cases. Horses with severe back pain may have difficulty in standing to urinate or defecate or there may be a reluctance to lie down or to roll. There may also be resentment to placement of a blanket or to grooming over the loins and hindquarters. In some cases the farrier may note resentment to having a hind limb picked up or difficulty in standing while being shod.

A history of resentment to any weight on the horse's back is sometimes reported with a tendency to collapse behind when ridden. Saddling up may become a problem, particularly when the girth is tightened. The horse may buck when first mounted, although this is usually due to temperament rather than back pain. The owner may also note reluctance to move backwards or reining back when being ridden. Dramatic signs of bucking and rearing are not usually associated with acute back injuries as it is too painful for the horse to fully flex or extend the trunk.

Query into the size and the time spent in stalls, paddocks, or turnout in pasture is indicated for any horse with back problems. In humans, a primary contributing factor for recurrent back problems is bed rest and inactivity.[43] Horses that are stalled for the majority of the day or large portions of the year do not have the opportunity to maintain back flexibility, which may contribute to back stiffness and dysfunction. In addition, horses that are turned out in paddocks with knee-deep mud, large rocks, poor footing or steep hills may aggravate pre-existing back problems.

Rider ability

Equestrian competition involves two athletes – the horse and the rider. There is no question that poor riding can either predispose to a back problem or exacerbate an existing one. Inexperienced or poor riders may blame the poor performance of their horse on a back problem when in fact the blame lies with them. It is also crucial that the saddle used not only fits but is also appropriate for the type of work or competition being undertaken.

Predisposing factors

The conformation and intended use of the horse can have an important bearing on the injury involved. For example, specific spinal malformations (e.g. lordosis and scoliosis) tend to predispose to injury through the inherent weakness of the thoracolumbar spine.[5] These conditions place extra strain on the epaxial muscles of the back that can lead to recurrent soft tissue injuries. The majority of horses do not have severe gross deformities, but conformational defects are common. Horses which are short-backed with restricted flexibility of the spine tend to exhibit more vertebral lesions than the longer backed horses, which have relatively more suppleness and seem to be more prone to muscular or ligamentous strain. Large-framed horses with comparatively weak hindquarters appear to be more susceptible to sacroiliac problems.

Age and gender of the horse are not nearly as important as predisposing factors as they are in humans. The highest incidence of back problems in horses is during middle age, 5–10 years of age,[4] although older horses, like elderly humans, are susceptible to loss of vertebral column flexibility, joint degeneration and loss of muscle strength. Aged horses also have increased healing times and increased chances of having chronic conditions or abnormal musculoskeletal compensations from prior injuries.

Management problems

There are a wide range of management issues that may lead either to a back problem or a suspected one from poor performance. Many of these issues may be due to inexperience or ignorance by the owner and result in inappropriate management, producing signs suggestive of back pain.

Temperament

Horses with an excitable temperament seem to be more prone to back-related problems. This may simply be due to low pain threshold or hypersensitivity, but hyperexcitability often results in excessive tension or spasm of the back muscles. This in turn reduces spinal flexibility and causes impaired impulsion from the hindquarters, which is seen clinically as poor hindlimb action and performance. These horses may become uncontrollable and buck and kick violently rather than settle down to exercise properly. A careful examination is required in these horses to be confident there is no underlying spinal pathology or pathoanatomic explanation for the perceived avoidance behavior suggestive of back pain. In addition to employing diagnostic imaging, a short course of analgesics (e.g. NSAIDs) is useful as some improvement would be expected if any musculoskeletal inflammation or injury exists.

Cold back

The signs of a cold back are usually exhibited when the saddle is put on, the girth tightened or as the rider mounts. The horse will then extend or flex its back and be very stiff as it moves off. In most cases these signs disappear quickly and within a few minutes the horse's performance is satisfactory. There is no doubt that horses with a cold back worry owners a great deal. In our experience, many of these cases are not associated with underlying pathological findings and are therefore thought to be temperamental or behavioral in origin. There are many different ways to manage these horses, including using saddle pads, warming the horse up before saddling (e.g. lungeing) or medicating mares with estrogen.

Mares in season

Owners sometimes report that mares in estrus have associated back pain and poor performance. It is often difficult to substantiate these claims, although some mares do improve during the winter or if medicated with estrus-suppressive drugs (e.g. altrenogest). Rectal palpation and evaluation of abnormal ovarian structures are indicated in any mare with recurrent or refractory back problems.

Schooling and work regime

Failure to keep a horse properly fit for its purpose may lead to fatigue or muscle strain. Horses can be bored with a dull work schedule and become soured or reluctant to work. This can easily be misinterpreted as poor performance related to a back problem.

Dental problems and bitting

General management of the teeth is part of good equine husbandry. Any problem in the mouth, from sharp teeth to an inappropriate bit, can lead to evasion when working. Affected horses often have a raised head carriage, tension or stiffness of the back muscles and poor hindlimb impulsion.

Inspection

Visual inspection is an important initial aspect of examining horses with back problems. General temperament and behavior are evaluated for signs of pain or discomfort. Horses with back problems often have a sudden change in behavior and become easily irritated by previously innocuous stimuli. Pinning the ears, swishing the tail, refusal to move or exaggerated movements away from everyday objects (e.g. curry comb or saddle pad) are signs of changes in behavior.

Evaluation continues with observation of the patient from a distance while turned loose in the stall or paddock while assessing the use and co-ordination of the limbs and trunk. The exam is focused on evaluating the dynamic characteristics of the musculoskeletal system. Owners may report that the head or neck is carried in an abnormal position, the trunk is held rigid or the horse refuses to move or bucks when asked to go forward. The horse should be able to readily raise and lower its head and neck and bend the trunk to either side. Neck injuries can present as the inability to lower the head and neck to graze or, just as common, the consistent inability to raise the head and neck above a certain level. Both instances often have a history of substantial head or neck trauma associated with getting the head or neck trapped in a fence or pulling back or flipping over in the cross-ties. It is important to note the general body conditioning of the horse and to differentiate poor condition (i.e. cachexia) from specific wastage of the longissimus, gluteal and thigh musculature. The presence of any lumps, scars, saddle marks on the back or any undue curvature of the spine must also be noted as they may have some bearing on the underlying condition.

A more detailed examination of the back is best carried out with the horse restrained in stocks (Fig. 21.6). It is important that the horse is not stressed or tense, as this will make assessment of back pain even more difficult. If the horse resents the stocks it is better to carry out the examination in the stable. For in-hand evaluation, the horse should be standing quietly and comfortably with all four limbs on a firm, level surface. The horse is then evaluated for the static characteristics of the musculoskeletal system, which include conformation, posture and muscular and osseous symmetry.

Conformation

Conformation is defined as the static or structural relationship of body segments, whereas postural analysis involves the dynamic or functional assessment within and between body regions. Vertebral column conformation is evaluated with special attention to neck development, height and shape of the withers, length of the trunk relative to the height and osseous pelvic symmetry. Conformationally, it is thought that short-backed horses have a higher incidence of osseous disorders, whereas long-backed horses are more prone to soft tissue injuries.[6]

Posture

The posture is evaluated for head and neck carriage, development and symmetry of the trunk, tail carriage and a preferred or shifting stance. Alterations in trunk posture include lordosis, kyphosis and scoliosis. Abnormal spinal curvatures are often readily visualized and are common primary presenting complaints. Altered spinal posture has both structural and functional etiologies that can

Fig 21.6 Examination of the horse's back while restrained in stocks. The clinician uses a set of steps to facilitate palpation and manipulation of the thoracolumbar spine.

often be differentiated based on history, onset and duration of the condition. Congenital vertebral malformations often produce structural changes in the trunk conformation, whereas developmental injuries produce functional changes in the trunk posture. In adult horses, acute changes in spinal curvatures are often functional adaptations to back pain or muscle imbalances. Correction of the underlying problem often returns the trunk to its original posture. Excessive lordosis is often an age-related change in trunk posture and may be improved with induced trunk elevation (i.e. flexion) and abdominal muscle-strengthening exercises. Horses with sacropelvic injuries will often carry their tail off to one side, lack tail tone or movement or have an abnormal tail set.

Muscular symmetry

The pectoral region, dorsal scapular and wither region, epaxial and gluteal muscles are carefully evaluated for abnormal muscle development and left-to-right asymmetries. This is a crucial part of the examination and needs to be carried out in as objective a fashion as possible. Muscular asymmetries are often due to disuse or neurogenic atrophy.[42] Alterations in the pectoral or pelvic girdle muscles need to be localized to the affected muscles, to aid in the differentiation of a primary lower limb, upper limb or vertebral column dysfunction. Localized or segmental muscle atrophy of the epaxial muscles may be due to vertebral segment dysfunction or a consequence of poor saddle fit. Generalized back muscle atrophy needs to be differentiated from lack of muscle development (i.e. poor conditioning) and disuse atrophy associated with chronic hindlimb lameness. Neurologic diseases that produce local or regional muscle atrophy (e.g. equine protozoal myeloencephalitis) need to be ruled out in horses that present with back problems and gluteal muscle asymmetry. It is unwise to assume that instances of asymmetric hindquarters or a 'hunter's bump' are caused by sacroiliac damage.

Osseous symmetry

The dorsal midline of the back is viewed from above (by standing on a mounting block behind the horse) with the horse standing squarely on all four limbs to see if the back is straight and evenly developed bilaterally. Any lateral curvature of the spine suggests a degree of muscle spasm on one side (i.e. spastic scoliosis). The presence of a 'hunter's bump' may be seen although it is not necessarily associated with overt clinical signs of a back problem. It is associated with a prominence of the tuber sacrale due to atrophy of the longissimus and gluteal muscles (Fig. 21.7). Changes in the height of the tuber sacrale should be assessed relative to the apex of the second sacral spinous process (S2). Visual acuity is high and even slight (<5 mm) deviations can be perceived. Confirmation of pelvic bone asymmetry can also be performed by palpating the main skeletal features (i.e. tuber sacrale, tuber coxae and tuber ischii) while standing directly behind the horse or by getting two assistants to identify the osseous landmarks for left and right comparisons. Guidelines are:

- unilateral gluteal muscle atrophy on one hindquarter without pelvic bone malalignment: suspect hindlimb lameness (hock or stifle) or acetabular damage
- elevation of one tuber sacrale with or without gluteal muscle atrophy: suspect thickening and damage to dorsal sacroiliac ligament or stress fracture of wing of ilium on opposite side (i.e. lowered quarter)
- lowering of tuber sacrale with muscle atrophy and lowering of the ipsilateral tuber coxae: suspect ipsilateral chronic sacroiliac disease or ipsilateral complete ilial wing fracture
- lowering of tuber coxae without lowering of tuber sacrale or tuber ischii: suspect fracture of the tuber coxae
- lowering of tuber ischii without deviation of tuber sacrale or tuber coxae: suspect fracture of tuber ischii.

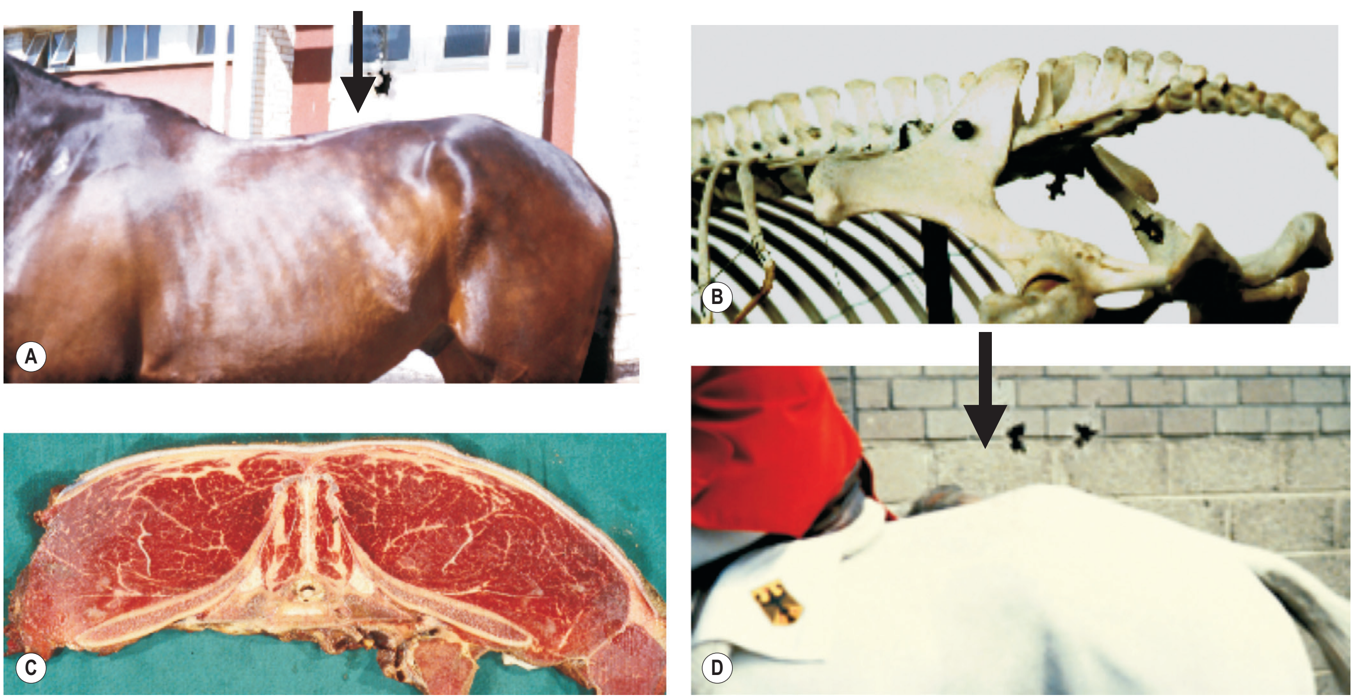

Fig 21.7 Photograph of a hunters' bump and associated muscle wastage in the lumbar and gluteal regions. **(A)** Five-year-old Thoroughbred gelding with prominent lumbar spinous processes. **(B)** Horse's skeleton showing the pelvic and lumbosacral region with the lumbar and sacral spinous processes. **(C)** Transverse section of the quarters showing the wings of ilium and normal musculature of the region. **(D)** Fourteen-year-old showjumper with prominent tuber sacrale and poor muscling of quarters.

Evaluation of tack fit and use

Saddle fit

A frequent cause of back discomfort can be either an inappropriate saddle used or the saddle not fitting properly. Most poorly fitting saddles produce pressure or pinching over the caudal withers region, hence the appearance of white hairs in the midline. Horses change shape, particularly the contour of the back, when they are out of work (i.e. deconditioned) or if they have an increase in bodyweight. Many saddle-fitting techniques provide a static assessment of the fit of the saddle to the shape and contour of the withers and back. Unfortunately, saddles do not come in a wide variety of sizes for individual fit and comfort, like clothes or shoes for humans. Most horses have to conform to only a few different tree widths and saddle types. Ideally, the saddle should fit comfortably and provide as large an area of contact as possible to help to distribute the rider's weight across the withers and back musculature. Computerized pressure pads help to provide both a static and dynamic assessment of saddle fit, pad thickness and placement, rider influences and changes in pressure associated with different gaits.

Assessment of saddle fit begins with checking the tree for straightness, symmetry and intact bars. The panels are evaluated for left-to-right symmetry and any lumps or depressions that might contribute to uneven pressure. The gullet should be 2–3 fingers wide to provide clearance for the dorsal spinous processes and to provide uniform weight distribution on the panels. The best saddles have wide panels that provide maximal weight distribution of the rider over the thoracolumbar epaxial musculature. Deep palpation of the entire fleece surface of the Western saddle should be done to identify any sharp points from nails or loose conchos.

The owner is asked to place only the saddle, without any pads, on the horse's back in the usual position. The analogy of properly fitting shoes (i.e. saddle) and the appropriate socks (i.e. saddle pad) to your feet works well for assessing saddle fit in horses. The chances are that if the shoe does not fit your foot then adding socks will not, in most instances, make the shoe fit any better. Optimally, there should be 2–3 fingers width of dorsal clearance between the pommel at the front of the saddle and the spinous processes of the withers. If there is less clearance, then the additional weight of the rider in the saddle will most likely reduce the space and cause direct contact and dorsal wear of the pommel on the withers. Greater than three fingers width of clearance is indicative of too narrow a tree that will cause increased lateral pressure on the withers. The rider may also feel unstable in the saddle due to an elevated center of gravity relative to the horse.

Most saddles are positioned with the front panels over the caudal border of the scapula. During locomotion, the scapula normally rotates caudally as the forelimb is fully protracted. If the panels are not flared outward slightly to accommodate the scapula, then the scapula cannot rotate caudally during limb protraction. This results in a shortened stride of the forelimbs. This is a common fault of many Western saddles with rigid, non-flared front panels. The contact between the front panel and the caudal scapula should be constant and uniform. An analogy of the desired pressure is the contact felt with your hand as it slides between the seat of the chair and the bottom of your thigh when you are sitting down. Saddles that are too wide will have increased pressure and contact at the dorsal withers, but the bottom of the panel will gape and protrude away from the lateral scapula. Saddles with too narrow a tree will have severe focal pressure on the dorsal scapular cartilage and you will not be able to fit your hand between the saddle and the scapula, even without the weight of the rider in the saddle. A simple correction on most horses is to slide the saddle back 0.5 to 1″ off the dorsal scapula. The seat should remain level to maintain rider comfort and to prevent unnecessary cranial or caudal displacements of the rider.

Saddle pads

The use of extraneous saddle pads or wedges is often a sign of potential saddle fit problems. When it comes to saddle pads, less is often better. The saddle pad should be tented up into the gullet of the saddle so that it provides clearance over the withers and dorsal spinous processes. Unfortunately, gel pads and other specialty pads often do not extend to the ventral edge of the front panel and cause a step defect and concentration of forces at the edge of the pad, which usually occurs directly over the caudal border of the scapula. Properly fitting saddles and pads can be evaluated by the dirt or sweat marks present on the saddle pad. Proper fit is identified by the presence of a symmetric or butterfly-shaped dirt pattern, indicative of uniform panel contact over the dorsum of the withers and back. Asymmetric, clean or dry spots on the saddle pad suggest bridging or uneven saddle contact. Blankets, if not fit properly, can also cause severe wear injuries over the withers.

Restraint devices

Evaluation of proper tack fit and use requires that the horse and rider are evaluated while participating in their specific equestrian activities. Harness racing utilizes a plethora of restraint devices, such as stickers, overchecks and hobbles, that need to be assessed as potential contributors to back problems. Additional tack that needs to be evaluated is the appropriate use and fit of the noseband or cavesson, standing or running martingales, draw reins and the chambon during lungeing exercises. Most of these devices are used to correct altered body positioning or use associated with pain or avoidance, inexperience, inability or the induction of artificial gaits. If horses are sound and have good flexibility and strength, then most of these devices are unnecessary.

Gait evaluation

A careful examination at exercise is an important part of the clinical assessment of a horse with a potential back problem. Gait analysis for back problems focuses on evaluating regional vertebral mobility and pelvic motion symmetry, in addition to the typical lameness assessment. Gait analysis may help to rule out lower limb disorders and rule in vertebral dysfunction although limb lameness has been reported in up to 85% of horses with back problems.[37] Motion asymmetries, restricted vertebral or pelvic mobility, not tracking straight or lack of propulsion are a few characteristics that are evaluated. Tape on the vertebral column midline may help to visualize subtle lateral bending motion asymmetries or scoliosis. Tape on the tuber coxae may help to visualize subtle pelvic motion asymmetries.

Exercise in hand

The horse is first walked and then trotted on a loose rein in hand in a straight line to detect any obvious abnormalities in gait. Many horses with chronic back trouble show a restricted hind limb action with poor hock flexion and a tendency to drag the toes of one or both hind limbs. If there is moderate to severe pain, a wide straddling hind limb gait is usually seen, but in horses with a low-grade problem the action behind will be very close (i.e. plaiting). Next, the horse is turned as short as possible in both directions to induce lateral bending of the trunk. If back pain is present and there is loss of suppleness, turning is often difficult, resulting in rather jerky movements and spasm of the back muscles. On backing there is sometimes an initial reluctance to move, then the head is raised, the back arched more than usual and some spasm of the back muscles occurs. Another sign of discomfort is the dragging of the forelimb toes on moving backwards. Horses with chronic sacroiliac joint injury will often resent being backed up or down a slope. Severe lameness in one or both hind limbs is not usually a feature of a thoracolumbar disorder and diagnostic nerve blocks should be used to differentiate this from a genuine back problem. Mild shifting lameness or simply an unevenness of action of one hind limb is much more commonly seen in horses with back problems. Flexion tests (i.e. spavin test) rarely have any effect on the gait in horses with primary back problems, but are very useful in identifying secondary hock or stifle problems.

Lungeing exercise

A session of 10–15 minutes exercise on the lunge line in a sand ring helps to critically assess a horse's gait. This also provides an opportunity to see any improvement or deterioration in the action as the horse warms up. Horses with stiff backs often show exaggerated contractions or spasms of the longissimus muscles with each stride although this is also seen in horses that are unfit. Horses with restricted hind limb gait often show poor tracking of the hindfeet (i.e. placement of the hindfeet behind the imprint of the ipsilateral forefoot) and a tendency to drag or plait with the hindtoes. The head carriage may be elevated and the horse looks uncomfortable in work. A poor action is usually best seen at the trot. Some horses with back pain will lunge only at a collected canter. Some difficulty is often seen when changing gait (i.e. transitions) along with an inability to lead on the correct leg (i.e. disunited). The action behind appears to lack impulsion and swishing of the tail is often a feature. However, tail swishing is not always indicative of back pain. Placing a surcingle around the thorax and tightening it has also been used to demonstrate acute or active back pain.

Ridden or driven exercise

Evaluation of the response to placing a saddle and being ridden is important for a complete assessment of horses with back problems. Inspection of the tack for proper use and fit is always suggested on initial examination. Saddles and restraint devices should be evaluated for proper fit, padding and positioning on the horse. It is useful to see the horse saddled up and to note if there is any pain or resentment to tightening the girth or when mounting. A horse may have a 'cold back' when mounted, but this does not necessarily imply an underlying spinal problem. The horse should next be ridden in its intended use or discipline by its regular rider, if possible, during a routine training exercise to assess back and limb use at the walk, trot and canter. Showjumpers should also be jumped over the type of fences that usually cause the most challenge (i.e. combination-type fences). For harness racing horses it is of great benefit to have the horse driven so as to assess the performance and trotting or pacing gait at fast exercise.

Post-exercise examination

After allowing the horse to cool down, it should be exercised in hand again to see if there is any change in the action. This is particularly useful in horses with a low-grade exertional myopathy (i.e. mild rhabdomyolysis or tying up) as they show increased stiffness of the hock and hindquarters.

Orthopedic evaluation

The objective of carrying out an orthopedic evaluation of suspected back cases is to be able to rule out or identify concurrent cervical problems and distal limb lameness, and so assist in confirming a primary thoracolumbar or lumbosacral condition.

Cervical conditions

Neck pain or stiffness will often be associated with poor performance, thoracolumbar stiffness and restricted hind limb impulsion. Systematic palpation of the cervical region may pinpoint a painful region. Flexion and lateral bending of the neck, either manually or by offering food or a treat to induce cervical bending, will confirm neck stiffness. Further diagnostic tests, including scintigraphy, radiography and thermography, are indicated to confirm diagnosis of a neck problem.

Forelimb lameness

Gait evaluation in a straight line and on the lunge line should highlight the presence of forelimb lameness. Hoof testers, flexion tests and diagnostic nerve or joint blocks assist in identifying and localizing the site of forelimb lameness.

Hindlimb lameness

Gait evaluation may be more difficult particularly if lameness is mild and bilateral (e.g. hock or stifle). Horses with chronic sacroiliac joint injuries often have compensatory stiffness and pain in the proximal hindlimb.[41] Induced hock flexion (i.e. spavin test) is often negative in horses with back problems.[31] In many cases the use of nuclear scintigraphy will help in identifying areas of increased bone activity that may be the seat of lameness. Hoof testers, flexion tests and diagnostic nerve or joint blocks should confirm that you are not dealing with a primary back problem.

Neurologic evaluation

The majority of horses with back problems do not have concurrent neurologic disorders. If a neurologic disease is suspected, then a thorough neurologic evaluation should be pursued before any further back evaluation or imaging modalities are completed. A neurologic examination is indicated in the evaluation of horses with back problems to rule out traumatic, infectious and toxic etiologies. Postural reactions also help to assess the proprioceptive status (i.e. ataxia), weakness or spasticity, which often occur in spinal cord compromise.[44] Suspect horses are moved in tight circles to evaluate fore and hindfoot placement and backed up to assess willingness, strength and co-ordination of the hind limbs. Walking up and down curbs or over ground poles also helps to assess foot placement. Horses with back pain may drag the hind limbs.[42] Once a neurologic disease has been diagnosed or treated, any residual back problems should be assessed in light of the past or current neurologic signs.

Medical evaluation

Rectal palpation

Rectal palpation is an important diagnostic test in horses with back problems. Soft tissue injuries, osseous pathology and articular instability of the sacropelvic region may not be evident externally, but only palpable internally. It is also possible to rule out urogenital or gastrointestinal causes of back pain (e.g. colic, infection, masses). The psoas major and psoas minor muscles are palpable at the ventral aspect of the lumbar vertebrae. The iliacus and psoas major together form the iliopsoas muscle, which lies along the lateral wall of the pelvic inlet. These hypaxial muscles are evaluated for pain, swelling (i.e. hemorrhage) or asymmetry, and muscle hypertonicity. In horses with vague, upper hind limb lameness, the terminal aorta and iliac arteries also need to be examined for the presence of strong and regular pulses or possible thrombi.

Osseous palpation during rectal examination is useful for evaluating pelvic or sacral fractures, pelvic canal symmetry and lumbosacral or sacroiliac degenerative joint disease. Acute pelvic fractures produce substantial pain and possible crepitus with rocking of the pelvis side-to side. Bony callous or bony asymmetries palpable on the shafts of the ilium or ventral sacrum are indicative of prior fractures. The ventral aspects of the caudal lumbar vertebrae are evaluated for irregular bony proliferation, indicative of spondylosis. The sacroiliac joints lie deep to the bifurcation of the iliac arteries, at the dorsolateral pelvic canal. Some horses with acute sacroiliac joint injuries will strongly resent deep palpation either unilaterally or bilaterally over the sacroiliac joint region. Rectal palpation while walking or during externally induced pelvic motions (e.g. dorsoventrally or laterally) helps to directly assess lumbosacral and sacroiliac joint motion internally. Rectal palpation for chronic sacroiliac joint subluxation is usually unrewarding and not diagnostic unless bony proliferation, excess sacroiliac joint motion or joint crepitus during externally applied movements is identified.[41]

Laboratory analysis

A thorough laboratory diagnostic work-up, when clinically indicated, is important for the appropriate differential diagnosis and rehabilitation of horses with back problems. Two common serum enzymes indicative of skeletal muscle injury or inflammation include creatine kinase (CK) and aspartate aminotransferase (AST). Lactate dehydrogenase (LDH) is not as specific for skeletal muscle injury but the elevation of specific isoenzymes does have diagnostic value.[45] In most instances, these enzymes are not elevated in horses with primary back problems. In suspect horses, a submaximal exercise tolerance test can be performed in a treadmill or after trotting for 10 minutes.[42] Baseline serum samples are taken prior to exercise and compared to four-hour (peak CK) and 24 hour (peak AST) postexercise values. Urinalysis is indicated if exercise-associated muscle damage (i.e. exertional rhabdomyolysis) is suspected in horses with back muscle pain or hypertonicity. The presence of myoglobinuria is indicative of recent or active ongoing muscle injury.[45]

Hematology is indicated in suspected vertebral osteomyelitis and diskospondylitis to evaluate the presence of anemia, hyperproteinemia, hyperfibrinogenemia, leukocytosis or neutrophilia.[44] Cerebrospinal fluid (CSF) analysis and culture is useful if meningitis is also present. Electrolyte imbalances can be found in exhausted endurance horses, especially when coupled with dehydration or poor thermoregulation. To rule out hyperkalemic periodic paralysis (HYPP), serum potassium levels or the submission of whole blood for genetic testing may be indicated in Quarter Horses with muscle fasciculations and weakness.[45] Serum vitamin E (α-tocopherol) and selenium levels are important in the pathogenesis of nutritional myodegeneration (white muscle disease), sporadic exertional rhabdomyolysis and equine degenerative myeloencephalopathy (EDM). In suspect horses, whole-blood analysis of selenium-dependent glutathione peroxidase (GSH-Px) may also be indicated to assess the selenium status.[45]

Viral isolation and PCR techniques on nasopharyngeal swabs or peripheral blood samples are indicated in suspected outbreaks of equine herpesvirus myeloencephalitis (EVH-1).[44] Paired serum titers can reveal elevated or increasing titers in suspect horses. Serology (e.g. titer or Western blot) may also be indicated in horses with a history or clinical presentation suggestive of Lyme disease or equine protozoal myeloencephalitis (EPM). However, due to difficulties in serology interpretation, synovial tissue biopsies and CSF immunoblot analysis are preferred tests. CSF analysis may reveal elevated protein levels, xanthochromia or pleocytosis in cases of EVH-1, polyneuritis equi, EPM and equine motor neuron disease (EMND). CSF creatine kinase may also be elevated in horses infected with EPM or EMND.[44]

Muscle biopsies may be indicated to rule out EMND, polysaccharide storage myopathy (PSSM) and recurrent exertional rhabdomyolysis (RER).[46] Muscle biopsies provide assessment of muscle fibers, neuromuscular junctions, nerve branches, connective tissue and blood vessels.[45] Both light and electron microscopy, combined with histochemistry, are required for the diagnosis and prognostication of muscle disorders. Dietary analysis is indicated in horses with RER and PSSM. High grain diets may need to be replaced with fat supplementation, rice bran and access to high-quality hay.

Physical examination

The focus of the physical examination of the vertebral column is to identify if a back problem exists and to localize the injury to either soft tissue, osseous or neurologic structures. Traditional orthopedic and neurologic evaluations are important adjunctive assessments used to rule out other, more common causes of lameness and neurologic disorders. The spinal examination also helps to determine if the back problem is acute or chronic and if the vertebral dysfunction is segmental and localized or regional and diffuse.

Subjective assessment and grading of back problems

Vertebral dysfunction is most often characterized by localized pain, muscle hypertonicity, reduced joint motion and subsequent functional disability. The challenge, as with any musculoskeletal injury, is to identify the specific musculoskeletal structures affected and quantify the associated disability or altered function. The most common categorization of musculoskeletal injury consists of mild, moderate or severe degrees. Further quantification should include attempts to localize the vertebral levels and potential tissues affected and may involve the use of a 0–10 scale in an attempt to objectively monitor changes in pain, muscle hypertonicity, reduced joint motion or functional disability (Table 21.3). Subjective parameters can then be assigned a numerical value that can be assessed before and after treatment. The progression or regression of the individual parameters can then be recorded over time since most clinical back problems tend to be chronic or recurrent in nature.

Regional joint motion

Joint range of motion can be assessed either regionally via induced vertebral movements or segmentally via mobilization of individual vertebral motion segments. Vertebral range of motion is evaluated to detect whether a particular movement is normal, restricted or hypermobile. Regional causes of vertebral movement restrictions may include Intra-articular pathology (i.e. osteoarthritis), periarticular soft tissue adhesions, musculotendinous contractures or protective muscle spasms.

Table 21.3 Subjective assessment and grading of spinal dysfunction

GRADE	SCALE	PAIN	MUSCLE HYPERTONICITY	JOINT STIFFNESS	OVERALL FUNCTIONAL ABILITY
Absent	0	No clinical evidence of pain	No clinical evidence of muscle hypertonicity	No clinical evidence of joint stiffness	Full functional capability
Mild	1	Mild pain Precipitate with firm pressure only	Mild muscle hypertonicity Precipitate with firm pressure only	Mild joint stiffness No resistance to any induced movement	Mild restriction in ability Able to work at the walk and trot
	2	Localized pain Deep structures affected Soft tissue OR osseous structures Chronic pain condition	Segmental muscle hypertonicity Unilateral muscle hypertonicity One muscle group affected No fasciculations induced with firm palpation	Segmental joint stiffness Unilateral joint stiffness Good overall flexibility Reduced dorsoventral OR lateral bending	Able to perform while ridden Work limited during canter, gallop or jumping Unable to do advanced maneuvers Noticeable dysfunction during certain activities
	3	Occasional, mild reaction to grooming	Hypertonicity varies with applied pressure	Stiffness due to muscular restrictions	Mild incoordination present
Moderate	4	Moderate pain Precipitate with moderate pressure Regional pain	Moderate muscle hypertonicity Precipitate with moderate pressure Regional muscle hypertonicity	Moderate joint stiffness Tolerates some induced movements Regional joint stiffness	Moderate restriction in ability Able to work adequately at the walk. Difficult to perform with rider
	5	Superficial OR deep structures affected Several soft tissue AND osseous structures. Chronic OR acute pain condition	Unilateral OR bilateral muscle hypertonicity Two different muscle groups affected Fasciculations induced with firm palpation	Unilateral OR bilateral joint stiffness Limited flexibility in one *OR* more directions Reduced dorsoventral *AND* unilateral bending	Work limited to walk or trot only Unable to do lateral work or inclines Performs activity with much effort
	6	Consistent, moderate reaction to grooming	Hypertonicity worse with applied pressure	Stiffness due to connective tissue restrictions	Moderate incoordination present
Severe	7	Severe pain Precipitate easily with mild pressure or touch Generalized pain	Severe muscle hypertonicity Precipitate easily with mild pressure or touch Generalized muscle hypertonicity	Severe joint stiffness Resents any induced movements Generalized joint stiffness	Severe restriction in ability Able to stand comfortably Unable to perform with rider
	8	Superficial *AND* deep structures affected Multiple soft tissue *AND* osseous structures. Acute pain condition	Bilateral muscle hypertonicity Multiple muscle groups affected Spontaneous fasciculations present	Bilateral joint stiffness Poor flexibility in multiple directions Reduced dorsoventral *AND* bilateral bending	Work limited to walk only Unable to back up Resents all activities
	9	Consistent, strong avoidance response	Constant, severe muscle spasms	Stiffness due to Intraarticular restrictions	Severe incoordination present
Incapacitated	10	Severe, generalized, unrelenting pain All soft tissue and osseous structures affected	Severe, generalized, constant muscle spasms All muscle groups bilaterally affected	Severe, generalized joint stiffness No flexibility induced in any direction	Unable to perform at any level Unable to stand comfortably

Active range of motion

The diagnostic evaluation of regional active range of motion (AROM) involves using a carrot or other treat to induce flexion, extension and lateral bending of the neck and trunk. The willingness, coordination and amount of vertebral motion are compared bilaterally. Resistance, struggling to grasp the treat and left-to-right range of motion asymmetries are documented. Similar procedures can be used therapeutically as stretching exercises to increase neck or trunk range of motion.

Active lateral bending range of motion

The horse is positioned parallel against the stall wall to stabilize the trunk and pelvis and to provide a surface for the horse to lean against if needed during the active stretches. The positioning also helps to prevent the horse from chasing the treat holder around the stall during the evaluation. The treat is directed towards the elbow and held against the lateral girth region. This motion assesses mid to lower neck flexibility in lateral bending and rotation. Normally, horses should be able to readily touch their nose to the girth and hold the stretch for five seconds. The treat is then advanced along the ribs towards the point of the hip (i.e. tuber coxae). This motion assesses trunk flexibility in lateral bending. Normally, horses should be able to readily touch their nose to the point of the hip and hold the stretch for five seconds. Horses with back pain or stiffness will not be able to reach their nose to their tuber coxae and notable left-to-right asymmetries in range of motion will be seen if a back problem only affects structures on one side of the body. The distance of the nose from the tuber coxae can be measured (e.g. 10″ or able to reach the 15th rib) and changes assessed over time.

Active flexion range of motion

A treat is directed cranially between the forelimbs and towards the front feet. This motion assesses flexion flexibility of the mid to lower neck and withers. The clinician needs to place a hand on the ipsilateral carpus to prevent knee flexion during the range of motion assessment. Normally, horses should be able to readily touch their nose between the front feet and hold the stretch for five seconds. Those with pain or stiffness in the withers or back will not be able to reach their nose to their front feet and will flex one or both of their knees to compensate while reaching for the treat.

Passive range of motion

Passive range of motion (PROM) is assessed by measuring the amount and characteristics of joint motion beyond the active joint ranges of motion. These procedures require muscle relaxation so that passive joint motion can be induced and evaluated. However, there may be a high risk of injury if the excessive forces are applied to the body regions, without protective muscle tone. This is especially true when evaluating joint range of motion while under sedation or anesthesia. Most passive joint range of motions are assessed segmentally in non-sedated horses with more refined and detailed mobilization techniques (see later section).

Active assisted range of motion

Active assisted range of motion (AAROM) or spinal reflexes are often assessed with firm pressure applied to specific body regions that secondarily induce characteristic vertebral column movements. Diagnostically, the induced movements are graded as reduced, normal and exaggerated. Therapeutically, the induced movements are often held for a set period of time to induce stretch of hypertonic muscles and creep relaxation of shortened connective tissue (i.e. fascia or ligaments) or to strengthen weak or unco-ordinated agonist muscles via concentric contractions.

Wither elevation

Firm pressure applied along the ventral midline at the level of the sternum and cranial linea alba will induce elevation of the withers via isometric contraction of the thoracic portion of the serratus ventralis muscle. Pressure is applied with the fingertips or fingernails of one or both hands. Normally, horses will readily elevate the withers and midthoracic vertebrae (T7–T17) approximately 3–4 cm and hold the position for 5–10 seconds. Horses with cranial thoracic pain or stiffness will not be able to elevate the withers and will resent the applied pressure. Caution needs to be applied to horses with girth sensitivity or pain, since they often resent the applied pressure and may kick out with a hind limb. This exercise is often indicated therapeutically to induce relaxation of a hypertonic spinalis muscle associated with poor saddle fit (i.e. too narrow a tree).

Trunk elevation

Firm pressure applied bilaterally along the muscular groove between the biceps femoris and semitendinosus muscles induces elevation of the back via isometric contraction of the rectus abdominis muscle. The muscular groove is located approximately 10 cm (4″) lateral to the base of the tail. Pressure is applied bilaterally with equal pressure from the fingernail of the index fingers or needle caps, if needed. A variation of the technique involves the application of firm manual compression at the sacrocaudal junction but the response is often less consistent or dramatic. Normally, horses should readily elevate the thoracolumbar vertebrae (T12–L5) approximately 10–12 cm. The induced movement should be controlled and co-ordinated and able to be held for 20–30 seconds. Horses with back pain or stiffness will not be able to elevate the trunk and will resent the applied pressure. Other horses may immediately flex their pelvis and slightly hop upwards on the hind limbs or step away from the applied pressure. This exercise is similar to muscular efforts required during collection while performing certain dressage movements. It is often indicated therapeutically to induce relaxation of the thoracic or lumbar longissimus muscle hypertonicity associated with back pain, poor collection and coupling of the lumbosacral region and lack of impulsion from the hind limbs.

Spinal reflexes

Firm pressure applied unilaterally along the length of the longissimus muscles will induce localized contraction of the stimulated back or croup musculature. Light pressure with a needle cap or ballpoint pen is applied either along the long axis of the spine or transversely across the longissimus or middle gluteal muscles. There seems to be some confusion as to the clinical significance of the observed response to the applied stimuli. Some clinicians place significance on exaggerated or rapid movement away from the applied pressure, which is believed to be indicative of muscle pain. However, horses often have differing amounts of skin sensitivity or inconsistent responses to various stimuli, which may not be reliable indicators of back pain.[42] Some clinicians believe that resistance or lack of movement away from the applied pressure is clinically significant and indicative of severe muscle guarding or pain and the horse is unable or unwilling to move its back despite the applied pressure. In the author's opinion, the procedure often appears to be an unnecessary and noxious stimulus for most horses with back pain. Other, less noxious means of assessment are more informative in most horses with back pain. The procedure should be reserved for very stoic horses, where a question exists about the ability to actively lateral bend or flex and extend the trunk.

Blunt pressure applied unilaterally to the epaxial musculature will induce three characteristic and repeatable spinal reflexes. The first portion of the reflex occurs as a stimulus is applied to the saddle region (T10–L3). Normally, the horse will respond with an induced contralateral lateral bending and extension of the trunk away from the applied stimulus. Horses with back pain may have an exaggerated response and will rapidly and dramatically move away from the applied stimuli. Other horses, presumably due to excessive muscle guarding or nervousness, will not move away from the applied stimulus and will resist moving their trunk in the characteristic pattern of contralateral lateral bending and extension. The second portion of the reflex occurs as a stimulus is continued along the cranial croup region (L4–S3). Normally, the horse will respond with an induced extension of the lumbosacral joint. Horses with back pain may have an exaggerated response and will rapidly and dramatically move away from the applied stimulus. Horses with hypertonic or injured iliopsoas muscles would theoretically resent any induced extension of the lumbosacral junction due to secondary stretching of the iliopsoas muscles. The third portion of the reflex occurs as a stimulus is continued along the caudal croup region (S4–tuber ischii) along the muscular groove between the biceps femoris and semitendinosus muscles. Normally, horses will respond with an induced flexion of the lumbosacral joint and ipsilateral lateral bending of the trunk towards the applied stimuli. Horses with back pain may have an exaggerated response to the applied stimuli and will rapidly and dramatically immediately flex the pelvis and step away from the applied pressure. Bilateral application of pressure in the same location will induce flexion of the lumbosacral joint without lateral bending, as described above.

Soft tissue palpation

Any palpation of the musculoskeletal system requires a quiet and co-operative patient. Horses that are moving around and not willing to stand quietly are difficult to assess fully for back problems. The horse's response to being approached and its anticipation of palpation are often used as an indication of potential back pain or hypersensitivity. Many owners will report a change in behavior (i.e. pinned ears, swishing tail) as a horse with back pain anticipates being touched or having the saddle placed on its back. Other complaints include a newly developed sensitivity to being groomed in one particular location on the trunk. The hallmarks of vertebral segment dysfunction include localized pain and abnormal paraspinal muscle tonicity.[47]

Palpation is often a reliable technique used to localize and identify soft tissue and osseous structures for changes in texture, tissue mobility or resistance to pressure.[6,48] The soft tissue layers are evaluated from superficial to deep without simply increasing digital pressure but also shifting attention with discrete palpatory movements. Shapes of structures, transitions between structures and attachment sites may also be palpated.[43] Soft tissue texture and mobility can be compared between the skin, subcutaneous tissues, thoracolumbar fascia and muscle.

Skin and subcutis

Acute back pain and inflammation will produce local areas of palpable heat, whereas chronic back problems can be identified by focal regions of colder temperatures, relative to the surrounding or contralateral tissues. Thermography provides an objective measure of temperature variations within the superficial tissues of horses with back problems. The hair, epidermis, dermis and subcutaneous tissues should be evaluated systematically with detailed palpation and observation for potential contributing factors to back pain or discomfort. The hair coat is evaluated for changes in hair texture or alopecia, which are often indicative of abnormal saddle or blanket wear. Asymmetric dirt or sweat patterns after removal of the saddle pad are also important indicators of poor saddle fit. A common presenting complaint for horses with back problems is localized sensitivity to routine grooming or brushing.

The skin around the withers should be evaluated for evidence of acute injuries associated with poor saddle fit or improper blanket wear, which are characterized by localized hair loss, open skin lesions (saddle galls) and signs of inflammation. Chronic saddle fit or blanket wear lesions are identified by the presence of white hairs and scar tissue over the dorsal or lateral aspects of the withers. In some horses, localized sites of edema or hives may occur after riding with a poor-fitting saddle or pad.[42] The epidermis should be evaluated for scabs, scrapes, lacerations, fly bites (ventral dermatitis), sarcoids and dermatophilus (rain scald), which may be primary causes of back pain or are irritated with saddle or girth placement. The dermis is palpated over the trunk region for eosinophilic granulomas or melanomas. Eosinophilic granulomas may regress spontaneously or enlarge and become ulcerated with continued friction in the saddle region. The subcutaneous tissues are palpated for edema or cellulitis, masses, fat deposits and the mobility of the skin over the underlying loose connective tissue. Chronic scar tissue, adhesions and fibrosis may produce back pain if the affected tissues are restricted or pulled on during locomotion or trunk movements. Blood vessels, nerves and lymph nodes are important structures that reside within the subcutaneous tissues.

Connective tissue palpation

Connective tissue structures, such as the fascia and ligaments, are systematically evaluated for clinical signs of acute or chronic injury.

Fascia

The dense connective tissue that forms the superficial and deep fascia is systematically evaluated for masses, rents, scar tissue and tonicity. The overlying skin and subcutaneous tissues are mobilized by a firm, broad contact. The superficial fascia is assessed for smoothness and uniform tonicity or compliance. The superficial fascia typically forms a superficial covering of muscle bellies, whereas the deep fascia forms folds of connective tissue between muscle bellies and anchors to deeper osseous structures. Severe or deep trauma to the myofascial tissues (e.g. kicks, deep lacerations or abscesses) can produce residual fibrosis that limits adjacent muscular activity and fascial extensibility. The thoracolumbar fascia is the most prominent fascia of the trunk and is particularly evident at the thoracolumbar junction as it blends medially with the supraspinous ligament. In the lumbar region, the thoracolumbar fascia attaches to the cranial aspects of the tuber sacrale and iliac wing, deep to the overlying middle gluteal muscle.

Spinal ligaments

The spinal ligaments are systematically palpated for masses, fiber disruption, fibrosis and signs of desmitis (i.e. swelling or pain). The nuchal ligament forms a broad attachment to the dorsal apexes of the spinous processes of the withers and continues caudally as the supraspinous ligament. The supraspinous bursa lies between the nuchal ligament and the T3–T5 dorsal spinous processes. The supraspinous bursa is not normally palpable, unless distended or possibly infected (i.e. fistulous withers). Firm digital pressure is applied dorsally and laterally to the nuchal and supraspinous ligaments and ligamentous attachments at the dorsal spinous processes. The entire length of the supraspinous ligament is palpated by lateral compression between the index finger and thumb. The induction of spinal flexion will cause the supraspinous ligament to be more prominent and readily palpable.

Pelvic ligaments

Unfortunately, most of the pelvic ligaments are inaccessible due to their location deep to the gluteal musculature or within the acetabular region of the hip. The dorsal portion of the dorsal sacroiliac ligament and the caudal portion of the sacrosciatic ligaments are the only palpable ligaments of the pelvic region. The dorsal sacroiliac ligaments are palpable in the croup region as two large round ligaments that originate on the caudal aspect of the tuber sacrale and converge caudally on the sacral spinous processes. Firm digital pressure is applied dorsally and laterally to the dorsal sacroiliac ligaments, bilaterally and individually, to lateralize any localized pain or swelling, indicative of desmitis. The caudal attachment of the sacrosciatic ligament at the tuber ischii is palpable and should be evaluated for pain and symmetry in tonicity. Horses that consistently carry their tail off to one side or have a history of sacral fractures may have palpable differences in sacrosciatic ligament tonicity. The trochanteric bursa is located between the tendon of the accessory gluteal muscle and the greater trochanter of the femur. Like other bursae, it is not palpable unless inflamed or distended. Trochanteric bursitis often presents as upper hind limb lameness and not as a back problem.

Muscle palpation

The trunk and pelvic musculature is evaluated systematically from superficial to deep with detailed palpation of abnormal muscle tonicity, pain or fasciculations. Muscle palpation is done with light but firm pressure applied by a broad contact with the entire hand, not only the fingertips, which may unduly localize the applied pressure and precipitate a pain response (i.e. false positive). Regional muscle tone and development of the neck, trunk and proximal limb musculature is assessed and compared left to right. Muscles are then individually identified and evaluated for masses, fibrosis, swellings or depressions. Individual muscles and their attachments are assessed unilaterally and then compared bilaterally for tonicity and the response to manual palpation (i.e. sensitivity). Local or regional alterations in temperature or texture are carefully palpated for signs of active inflammation.

Muscle development

Muscle evaluation begins with observation and palpation of the neck, shoulder, pectoral, wither, trunk, gluteal and thigh muscle development and symmetry. Muscle atrophy can be due to partial or complete denervation, disuse, malnutrition or immune-mediated disorders.[45] Obese horses are often difficult to palpate due to poor muscle development and indistinct myofascial borders. Epaxial muscle development is assessed by laying a hand transversely across the longissimus and middle gluteal muscles. Horses with exceptional back muscle development should have a palpable convexity or outward curvature of the muscles along the entire distance from the withers to the croup. Deconditioning or poor flexibility may contribute to epaxial muscles that are palpably flat between the dorsal spinous processes and the ribs laterally. Horses with chronic back problems or poor saddle fit will have a palpable concavity or inward curvature of the epaxial muscles at the withers or along the trunk. Asymmetries in muscle development may be palpable cranial to caudal, medial to lateral or left to right. The thoracic portion of the spinalis muscle is the most commonly affected muscle in the wither region. The longissimus muscle is the most commonly affected trunk muscle. The middle gluteal and the vertebral portions of the biceps femoris, semitendinosus and semimembranosus muscle are common areas to visualize or palpate muscle asymmetries in the pelvic region.

Muscle tonicity

The general muscle tone varies between horses and breeds. Nervous or excited horses will have overall increased muscle tone, whereas stoic, depressed or systemically ill horses will have reduced or sometimes flaccid muscle tone. Arabians tend to carry more muscle tone, whereas most Warmbloods or draft breeds will allow deep palpation of their generally relaxed muscles. Muscle tonicity is an indirect measure of muscle activity or contraction. Electromyography (EMG) provides a direct assessment of muscle activity but it is not readily available in most clinical situations and it is often difficult to perform and interpret.[45]

Muscle tonicity is categorized as hypotonicity, normal tonicity and hypertonicity. Normal epaxial muscles are not contracted in a quietly standing horse, but are relaxed and malleable. Muscle hypotonicity or flaccidity is indicative of neuropathies, such as disuse or denervation atrophy. Muscle hypertonicity is the most commonly palpable abnormality in horses with acute or chronic back problems and can have either neural or myopathic origins.[45] Generalized muscle hypertonicity may affect a small portion of a muscle (i.e. trigger point), an entire muscle belly or a regional group of muscles. Muscle spasms are an acute, severe form of muscle hypertonicity, with substantial pain and loss of muscle function. Detailed palpation and a thorough knowledge of muscular anatomy will help to identify which muscle or muscles are primarily affected, and which adjacent muscles are likely to have secondary guarding due to common biomechanical or neurologic factors. In general, localized muscle hypertonicity is considered an acute or primary back problem whereas regional longissimus muscle hypertonicity is often associated with a chronic hind limb lameness or systemic disease.

Trigger points are characterized as localized bands or foci of muscle contracture and pain within a muscle belly.[49,50] Muscle contractures are not associated with normal neural firing and subsequent depolarization of the muscle membrane.[45] Trigger points occur in consistent and predicable locations, presumably due to alterations in local muscle function caused by changes in posture or biomechanics. In horses with back or pelvic problems, focal hypertonic muscle bands with a lower pain pressure threshold (i.e. increased sensitivity) can often be found in the middle gluteal muscle. The clinical significance of trigger points in the middle gluteal muscle is difficult to determine since they do not always correlate with the presence or severity of lameness or back problems.

Muscle spasms or splinting are characterized as involuntary, pronounced and unremitting muscle contractions in response to severe and unrelenting pain (e.g. colic) or metabolic disturbances (e.g. electrolyte imbalances or exertional rhabdomyolysis). Horses with acute or severe back pain may present with muscle splinting but other underlying medical conditions that may be more life threatening or critical need to be ruled out immediately. Muscle splinting severely restricts the ability to evaluate trunk mobility and the palpation of underlying soft tissue structures. Therefore, medical treatment of the primary problem or the administration of muscle relaxants is often required before a complete evaluation of the vertebral column can be accomplished.

Muscle pain

The assessment of muscle pain is often subjective and is dependent on the evaluator's tactile skills and interpretation of clinical significance. The clinical assessment of acute versus chronic pain is relatively straightforward but determination of the exact etiology and appropriate treatment regime are diagnostically challenging. Acute muscle pain is characterized by heat, firm swelling or edema, substantial hypertonicity and pain and dysfunction of the affected muscle region. Acute muscle pain may be due to direct trauma (e.g. kick or other blunt trauma) or metabolic disorders (i.e. exertional rhabdomyolysis). The thoracic portion of the spinalis muscle is a common site of muscle pain, associated with a poor-fitting saddle (i.e. too narrow a tree). Chronic muscle pain has a more neurogenic basis and is due less to direct inflammatory mediators.

Horses with acute sacroiliac joint injuries may have localized sensitivity to palpation of the gluteal musculature and surrounding soft tissues in the dorsal croup region.[31] Protective muscle spasms may be palpated in the adjacent middle gluteal musculature and the vertebral portions of the biceps femoris, semitendinosus and semimembranosus muscles. A localized region of edema may occasionally be palpated over the lumbosacral junction[40] but this is not a specific finding related to sacroiliac joint injury.

Pressure algometry

In humans, the diagnosis of chronic fatigue syndrome or fibromyalgia is often based on the presence of decreased pain thresholds at a set number of standardized musculoskeletal locations. The clinical syndrome of myofascial pain in horses is common and quite similar to humans. Unfortunately, we often have a poor understanding of the etiopathogenesis and the objective assessment of muscle pain. Pressure algometry of soft tissue structures provides an objective measure of muscle or ligamentous mechanical nociceptive thresholds (i.e. the minimum force that causes discomfort or pain).[51] It utilizes a force gauge and plunger to measure left-to-right asymmetries or identify subnormal values.[50] In horses, normal mechanical nociceptive threshold values for soft tissue landmarks are typically 20–30 pounds/cm^2. Horses with myofascial pain often have mechanical nociceptive threshold values of less than 10 pounds/cm^2.

Guarding of the back is an exaggerated response to typically innocuous stimuli or sudden movements. This abnormal response is commonly seen in nervous horses or those with back pain. Pronounced muscle guarding with movement away from any anticipated contact or placement of the saddle is considered abnormal. Horses should not react adversely to any grooming or superficial or deep muscle palpation[42] although a few sensitive horses may have a mild, temporary avoidance to deep muscle palpation. Any exaggerated attempts to avoid palpation or the presence of prolonged muscle contractions or fasciculations should be considered abnormal. Horses with back pain and muscle soreness may have localized areas of muscle fasciculations depending on the amount and type of pressure applied.

Muscle fasciculation

Muscle fasciculations are usually indicative of profound muscle weakness, electrolyte imbalances, or primary muscle pathology although, muscles may fasciculate at characteristic locations distant to an area of palpation.[42] In humans, this is indicative of referred pain, which is difficult to truly assess in horses due to the lack of verbal feedback. In horses with back or gluteal muscle pain, it is common to find areas of muscle fasciculations in the mid-lumbar longissimus muscles when firm, localized pressure is applied to hypertonic or painful areas (i.e. trigger points) within the middle gluteal muscles. This is an intriguing response since the motor innervation of the reactive lumbar longissimus muscles is provided segmentally by dorsal branches of the spinal nerves of L2–L4 and the middle gluteal muscle is innervated by ventral branches of the spinal nerves that contribute to the cranial gluteal nerve (L6–S2).

Osseous palpation

Osseous palpation involves evaluating osseous structures for pain, morphology, asymmetries and alignment. Individual thoracic, lumbar and sacral spinous processes are palpated for a painful response with firm digital pressure applied to the osseous structures of the dorsal midline.[52] Typical signs of discomfort include tossing the head upwards, extension of the back or withers away from the applied pressure or localized secondary muscle spasms. Algometry (pain pressure thresholds) of osseous landmarks provides an objective measure of bony pain and allows monitoring of the effectiveness of treatment protocols. Normal algometry values for osseous landmarks are higher than soft tissue values and typically exceed 30–40 pounds/cm^2. Horses with bone pain often have osseous algometry values less than 10 pounds/cm^2.

Dorsal spinous processes

The morphology of individual dorsal spinous processes is compared to adjacent spinous processes. It is common to palpate seemingly higher, wider or laterally displaced dorsal spinous processes. However, unless there is also localized pain or muscle hypertonicity adjacent to the affected dorsal process, then the spinous process deviation is probably not clinically significant. Individual spinous process deviation is common, but it is not often associated with spinous process fracture or vertebral malposition (i.e. bone out of place), as is commonly thought. Overlapping or malaligned dorsal spinous processes are often caused by spinous process impingement, developmental asymmetries in the neural arch or isolated dorsal spinous process deviation of unknown etiology.[53,54] Palpably taller or wider dorsal spinous processes occur presumably due to avulsion fractures or osseous proliferation within or at supraspinous ligament insertion sites (i.e. enthesopathies). Radiographs, ultrasonography and scintigraphy are useful modalities to document the cause of palpable differences in dorsal spinous processes.

Tuber sacrale

The tuber sacrale of the pelvis are palpated for height asymmetries and pain response to manual compression. Unilateral or bilateral prominence of the tuber sacrale may be noted, but is not usually clinically significant unless associated with clinical signs of localized pain or inflammation or positive findings on diagnostic imaging (e.g. scintigraphy). In acute sacroiliac injuries, asymmetry in gluteal muscle development is uncommon, unless pronounced osseous pelvic asymmetry is also present. Firm digital pressure applied to the dorsal aspect of the tuber sacrale has been reported to produce a variable and inconsistent pain response.[55] In the author's opinion, dramatic and consistent pain responses have been produced in affected horses with specific provocation tests that are useful to establish a presumptive diagnosis of sacroiliac joint injury or pelvic stress fractures.

The procedure involves simultaneous manual compression of the dorsal aspects of both tuber sacrale, which induces a bending moment on the iliac wing and presumably compresses the sacroiliac articulations (Fig. 21.8). Normally, horses will not have any response or only a mild response to the applied pressure. Mild contraction of the lumbar longissimus muscles and slight extension of the lumbosacral joint is normal for most horses. Acutely affected horses may have a dramatic reaction to this manipulation and will demonstrate severe longissimus muscle contractions and sudden collapse of the hind limbs which is indicative of pelvic injury or sacroiliac joint pain.[42] Practitioners should gradually apply increasing pressure since affected horses may actually collapse in the hind

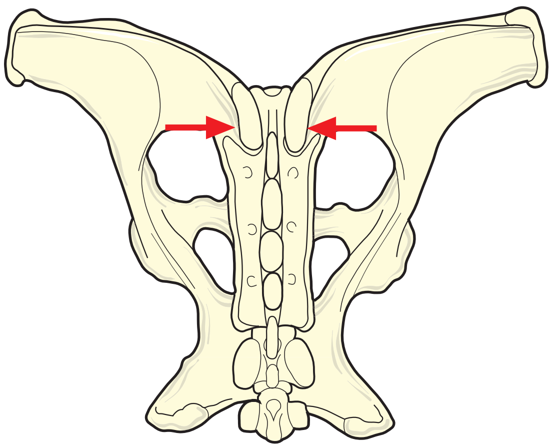

Fig 21.8 Forces applied during a sacroiliac joint provocation test (dorsal view). Firm pressure is applied bilaterally with both hands, compressing the dorsal aspects of the tuber sacrale.

limbs and fall to the ground if excess force is applied to the painful tuber sacrale. This test is not specific for sacroiliac joint pathology, as horses with incomplete or stress fractures of the ilial wing may respond even more dramatically to the applied pressure.

The apex of the second sacral spinous process is a reliable landmark used to evaluate relative tuber sacrale displacement. Normally, the dorsal apices of the tuber sacrale and the second sacral spinous process lie in close apposition and follow the contour of the croup. Using palpation, ultrasound or radiographs, a physical discrepancy in height can often be identified between the dorsal profile of the sacral spinous processes (which should remain constant, unless fractured) and the potentially ventrally or dorsally displaced unilateral or bilateral tuber sacrale. In this manner, either unilateral (i.e. tuber sacrale height asymmetry) or bilateral tuber sacrale displacement (i.e. hunters' or jumpers' bumps) can be diagnosed, depending on whether one or both tuber sacrale are elevated relative to the apices of the sacral spinous processes. Tuber sacrale height asymmetry is evident in sacroiliac joint subluxation (the higher side is affected) and complete ilial wing fractures (the lower side is affected). Bilateral tuber sacrale displacement has an unknown clinical significance and may be present in many high-level competition horses.[40] Theoretically, the hunters' or jumpers' bumps may provide a longer lever arm for the strong longissimus and thoracolumbar fascia to produce extension at the lumbosacral joint, resulting in increased impulsion and range of hindlimb motion with subsequent improved performance.

Pelvis

Lateral compression of the tuber coxae and tuber ischii is indicated in horses with acute pelvic lameness to help rule out complete pelvic fractures. Palpation or auscultation of the dorsal pelvic region during repetitive side-to-side movements also assist in the diagnosis of pelvic crepitus. Normally, the tuber sacrale move in unison during locomotion. A palpable or visible independent movement of the tuber sacrale at a walk or during treadmill locomotion is indicative of sacroiliac joint luxation or a complete pelvic fracture. Horses with acute sacroiliac joint injuries may also resent flexion of the contralateral hind limb. Rectal palpation is also indicated to assess osseous morphology (e.g. displaced fracture fragments or callus) and soft tissue pain or swelling (i.e. hemorrhage) in horses with suspected pelvic fractures.

Segmental vertebral joint motion

A vertebral motion segment is the functional unit of the spine and includes two adjacent vertebrae and the associated soft tissues that bind them together. To utilize palpation in the evaluation of the musculoskeletal system fully, an understanding of how joint motion is assessed is required.[43] Joint motion can be categorized into three zones of movement: physiologic, paraphysiologic and pathologic. The physiologic zone of movement includes both active and passive ranges of motion and is the site where joint mobilization is applied. Moving an articulation from a neutral position first involves evaluating a range of motion that has minimal, uniform resistance. As the articulation is moved toward the end of that range of motion there is a gradual increase in the resistance to movement (i.e. joint end-feel). End range of motion starts when any change in resistance to passive joint manipulation is palpable. Joint end-feel is evaluated by bringing the articulation to tension and applying rhythmic oscillations to the joint to qualify the resistance to movement. The normal joint end-feel is initially soft and resilient and gradually becomes more restrictive as maximal joint range of motion is reached. A pathologic or restrictive end range of motion is palpable earlier in passive joint movement and has an abrupt, restrictive end-feel when compared with normal joint end-feel. The paraphysiologic zone of movement occurs outside the joint's normal elastic barrier and is the site of joint cavitation and manipulation. The anatomic barrier of the joint marks the junction of the paraphysiologic and pathologic zones of movement. The pathologic zone of movement lies outside the limits of normal anatomic joint integrity and is characterized by joint injury (e.g. sprain, subluxation or luxation).

Combining the evaluation of segmental joint range of motion and the presence or absence of pain at the extremes of motion, diagnostic interpretations can be implied.[56] Normal joint motion is painless, suggesting that articular structures are intact and functional. Normal joint mobility that has a painful end range suggests that a minor sprain of the associated articular tissues is present. Painless joint hypomobility suggests that a contracture or adhesion is present. Painful hypomobility suggests an acute strain with secondary muscle guarding. Painless hypermobility may indicate a complete rupture and a painful hypermobility suggests a partial tear of the evaluated structure.

Mobilization

Mobilization is used to evaluate each individual vertebral and pelvic articulation for loss of normal joint motion and overall resistance to induced motion. The goal of palpating joint movement is to evaluate the initiation of motion resistance, the quality of joint motion and end-feel, and the overall joint range of motion (ROM). Similar palpatory findings can be noted in other soft tissues such as skin, connective tissue, muscles or ligaments.[48] Each vertebral segment is evaluated for altered mobilization findings in flexion and extension, right and left lateral bending and right and left rotation. Segmental causes of vertebral movement restrictions include soft tissue (e.g. capsular fibrosis, muscle spasms or contractures) and osseous (e.g. malformations, osteoarthritis, ankylosis) pathologies. Vertebral segments with altered mobilization findings (i.e. joint stiffness) can occur with or without localized muscle hypertonicity and pain. Comparisons of mobilization findings before and after manipulation or stretching exercises are made to evaluate the vertebral motion segment response to treatment.

Wither mobilization

Lateral forces are applied to individual dorsal spinous processes of the withers (T3–T12) to assess lateral bending and rotation of individual thoracic vertebral motion segments. The practitioner stands facing the withers. To stabilize the cranial and caudal vertebral segments, the bases of both hands are applied to the ipsilateral surface of the spinous processes adjacent to the vertebra being evaluated. The index fingers contact the contralateral surface of the dorsal spinous process to be assessed. A compressive force is applied between the index fingers and base of the hands to induce slight rotation of an individual thoracic spinous process. Normally, 3–4 mm of spinous process movement is palpable, without any evidence of pain or muscles spasms in response to the applied force. In horses with wither discomfort due to poor saddle fit, an obvious pain response (e.g. a rapid elevation of the head, depression of the withers) and local muscle hypertonicity will be precipitated with the applied pressure. In chronic forelimb lameness (e.g. laminitis), individual spinous process motion will not be detectable and the entire withers will move as a unit due to presumed chronic fibrosis and muscle guarding.

Trunk lateral bending mobilization

Lateral forces are applied to individual dorsal spinous processes of the trunk (T13–L6) to assess lateral bending and rotation of individual thoracolumbar vertebral motion segments. The practitioner stands facing the trunk. The base of the tail is grasped in the caudal hand, which provides side-to-side motion during the procedure. The base of the cranial hand is positioned against or between the spinous processes of interest. A lateral bending moment (i.e. wiggle) is induced as the cranial hand rhythmically pushes laterally and the caudal hand pulls laterally. The cranial hand is repositioned at the sequential dorsal spinous processes from cranial to caudal in order to assess lateral bending and rotation at individual thoracolumbar vertebral segments. Normally, a slight springy end-feel of joint motion is palpable at each motion segment, without any evidence of pain or muscle spasms in response to the applied force. In horses with back problems, restricted vertebral motion or stiffness is palpable and there is evidence of local pain and muscle spasms in response to the applied pressure. In general, acute or primary back problems produce segmental stiffness, pain and muscle hypertonicity. Chronic or secondary back problems produce regional stiffness, pain and muscle hypertonicity or atrophy.

Rib mobilization

Lateral compressive forces are applied to the individual ribs and costochondral junctions to assess pain and mobility. The base of the hand is positioned over individual ribs as a medial motion is induced, similar to expiration. The hand is repositioned at the sequential ribs and costochondral junctions from cranial to caudal. The amount of rib motion, resentment and secondary muscle spasms are noted during the induced movements. Normally, a slight springy feel is palpable at each rib, without any evidence of pain or muscle spasms. In horses that are girthy, cinchy, or have back problems, restricted rib motion or stiffness is palpable and there is evidence of local pain, resentment and muscle spasms in response to the applied pressure.

Trunk flexion-extension mobilization

While standing on an elevated surface, ventrally directed forces are applied rhythmically over individual dorsal spinous processes to assess flexion and extension of individual thoracolumbar (T13–L6) vertebral motion segments. The palm of one hand is placed over the dorsal aspect of the spinous process of interest. The other hand grasps the wrist and both hands apply a ventral force equally. An extension moment and rebound flexion (i.e. bounce) is induced as the hands rhythmically push ventrally. The hands are repositioned at sequential dorsal spinous processes from cranial to caudal. Normally, a slight springy end-feel of joint motion is palpable at each motion segment, without any evidence of pain or muscle spasms. In horses with back problems, restricted motion or stiffness is palpable and there is evidence of local pain and muscle spasms in response to the applied pressure.

Lumbosacral flexion-extension mobilization

Ventrally directed forces are also applied rhythmically over the tuber coxae to induce extension of the sacroiliac and lumbosacral articulations. The practitioner stands facing the pelvis. The fingers are placed over the dorsal aspect of the tuber coxae to induce the ventral motion. A normal response to the induced movement is fluid vertical motion of the lumbosacral region with 1–2 cm of dorsoventral displacement over the lumbar dorsal spinous processes. Horses with pelvic or lumbar dysfunction will have a noticeable pain response, resent the induced movement or will have protective gluteal or sublumbar muscle spasms that limit the induced movement. The vertically directed force primarily induces movement at the lumbosacral junction, but sacroiliac joint motion and potential injury must also be differentiated with this procedure.

Sacroiliac ligament stress tests

The sacroiliac ligaments are not readily palpable in horses. However, specific forces applied to the pelvic prominences (i.e. tuber sacrale, tuber coxae or tuber ischii) or the sacral apex can provide an indirect method to assess the structural and functional status of the supporting ligaments.

Dorsoventral sacroiliac ligament stress tests

Sacroiliac ligament injury can be identified by rhythmically applying a ventrally directed force over the lumbosacral dorsal spinous processes in an effort to stress the supporting sacroiliac ligaments. This procedure requires the practitioner to get up on an elevated surface (i.e. mounting block) so that the two separately applied forces can be directed vertically over the L6 and S2 dorsal spinous processes, respectively. Horses with sacroiliac ligament injuries would be expected to resent the induced movement over the L6 dorsal spinous process since it specifically stresses the interosseous sacroiliac ligament (i.e. ligamentous sling of the sacropelvic junction). Horses with lumbosacral vertebral joint dysfunction (i.e. localized pain, reduced joint motion and muscle hypertonicity without structural pathology) may also resent this procedure. Rhythmically applied ventrally directed forces over the dorsal spinous processes at the sacrocaudal junction would be expected to specifically stress the dorsal portion of the dorsal sacroiliac ligament. A positive response to this test combined with positive ultrasound findings of desmitis of the dorsal sacroiliac ligament would be highly suggestive of clinically significant dorsal sacroiliac ligament injury.

Lateral sacroiliac ligament stress test

Sacral apex deviation can be assessed by applying simultaneous, but opposite directed, lateral forces to the tuber sacrale and the sacrocaudal junction (Fig. 21.9). Sacroiliac joint or ligament injuries can also be localized by evaluating pain and ligamentous laxity in the sacroiliac joint. These procedures are similar to valgus-varus stress tests used to evaluate the collateral ligaments of the distal limb articulations. Care should be taken not to apply excessive force due to the long lever arm action of the sacral apex on the sacroiliac ligaments, which can unduly stress unstable or partially torn ligaments or aggravate an acutely inflamed sacroiliac joint. The proposed mechanism of action of these tests is to use the base of the tail and sacrum as a handle to apply a lateral (horizontal plane) stress to the sacroiliac joint as the wing of the ilium is stabilized.

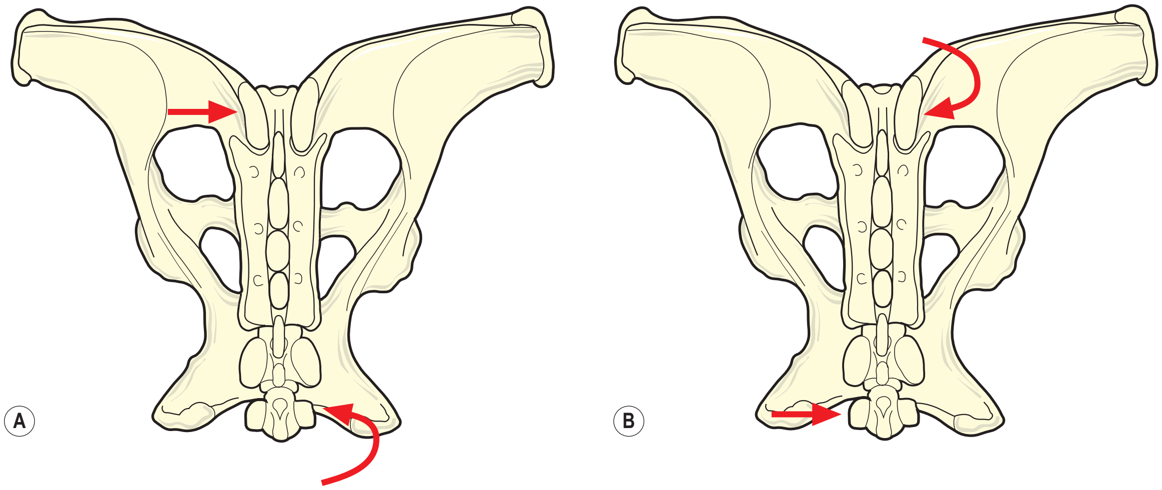

Fig 21.9 Forces applied during a sacroiliac ligament stress test (dorsal view). **(A)** Firm pressure is applied by both hands, pushing with the hand at the ipsilateral tuber sacrale away from the examiner while simultaneously pulling with the hand at the tail head toward the examiner. **(B)** Firm pressure is applied by both hands; pulling with the hand at the contralateral tuber sacrale toward the examiner while simultaneously pushing with the hand at the tail head away from the examiner.

The technique involves two parts. First, the base of the hand closest to the horse's head is placed over the lateral aspect of the tuber sacrale. The hand closest to the tail grasps the base of the tail head (Cd2–3). The sacroiliac joints are then evaluated as firm pressure is simultaneously applied by both hands, pushing with the hand at the tuber sacrale away from the examiner and pulling with the hand at the tail head toward the examiner (Fig. 21.9A). Theoretically, this maneuver produces compression of contralateral and distraction of ipsilateral sacroiliac articular surfaces.

The second portion of the technique involves repeating the procedure and reversing the direction of the applied forces (Fig. 21.9B). The fingers of the hand closest to the horse's head are placed over the contralateral tuber sacrale and the base of the hand closest to the tail is placed against the ipsilateral base of the tail head (Cd2–3). The sacroiliac joints are again evaluated as firm pressure is applied by both hands, pulling with the hand at the tuber sacrale toward the examiner and pushing with the hand at the tail head away from the examiner. Theoretically, the contralateral sacroiliac articular surfaces are distracted and the ipsilateral sacroiliac articular surfaces are compressed. A pain response to the induced movements may be identified either unilaterally or bilaterally, depending on the extent of inflammation or injury present. In general, sacroiliac joint compression would be expected to aggravate osteoarthritic changes, whereas joint distraction would be expected to stress any injured or inflamed sacroiliac ligaments.

Proximal limb evaluation

In horses with back or pelvic problems, the proximal limbs are often affected either primarily or secondarily. Primary thoracic or pelvic girdle muscle or joint dysfunction is often evident as lameness in the affected limb. However, back or pelvic problems can also induce secondary proximal limb dysfunction that needs to be differentiated. Muscular or osseous asymmetry of the shoulder or pelvic regions are often indications of limb dysfunction or lameness. The pectoral region is viewed cranially to assess muscular symmetry. The dorsal scapula and wither region are viewed caudally from an elevated surface to assess bilateral symmetry and muscle development related to proper saddle fit. The croup or gluteal region is also viewed caudally to assess symmetry and muscle development. Horses with pelvic lameness or EPM often have noticeable gluteal muscle atrophy or asymmetry. The tuber sacrale are assessed for osseous asymmetry associated with pelvic fractures, sacroiliac joint subluxation or developmental factors. Changes in the height of the tuber sacrale should be assessed relative to the apex of the second sacral spinous process (S2).

Abnormal tonicity of the thoracic or pelvic girdle muscles is identified by hypotonicity or flaccidity, and hypertonicity associated with local trigger points or regional muscle spasms. The proximal limbs are also evaluated for normal ranges of motion or flexibility. In the forelimb, the scapulothoracic and shoulder joints are evaluated. In the hindlimb, the sacroiliac and coxofemoral joints are assessed. The fore- and hindlimbs are individually examined in protraction, retraction, abduction, adduction and flexion for resistance to the applied movements, joint stiffness or muscle hypertonicity. Horses with back or pelvic problems will resent certain movements, have reduced limb motion and will not actively extend and stretch the limbs. Normally, horses will actively stretch their fore- and hindlimbs when positioned in protraction and retraction. Extension of the hindlimb caudally will apply a stretch to the hindlimb protractor muscles, which include the iliopsoas, rectus femoris and tensor fascia latae. Injury to these muscles will produce resentment to passive stretching of the hindlimb. Iliopsoas muscle injury or hypertonicity can also be confirmed with rectal palpation.

Diagnostic injections

The use of injections of local anesthetics into painful or inflamed musculoskeletal structures is the basis of lameness evaluation. Fortunately, the same principle can be applied to painful soft tissue, articular or osseous structures of the back and pelvis.

Muscle

Injection into areas of perceived muscle pain or reactive acupuncture points helps to assess the contribution of muscle pain to the observed back problem, cause of poor performance, vague gait abnormalities or resentment to placement of the saddle.[42] Before and after comparisons of the muscle response to applied pressure (i.e. pressure algometry) or changes in gait help to confirm the clinical significance of the muscle pain to the primary presenting complaint. In humans, trigger point therapy relies on the use of intramuscular injections of local anesthetic to reduce focal areas of muscle pain and hypertonicity. Similar techniques have been applied in horses with mixed results, which are mostly related to the inability to adequately define and measure muscle pain and dysfunction.

Interspinous spaces

Injections of local anesthetics into narrowed interspinous spaces or areas of interspinous pseudoarthrosis can be used diagnostically and therapeutically to assess the influence of over-riding or impinged spinous processes on back pain. The clinical significance of impinged spinous processes is often difficult to assert based solely on radiographic findings, since impinged spinous processes are often diagnosed in horses without obvious back pain. Firm digital palpation of affected dorsal spinous processes often produces a localized painful response (e.g. cutaneous trunci reflex or active extension of the back). Confirmation of the clinical significance of potential impinged spinous processes can be achieved with injections of local anesthetics. At sites of severe impingement or proliferation, it is often impossible to pass a needle directly on midline into the interspinous space. In this instance, a paramedian approach to the interspinous space provides lateral access to the area of pathology, which reduces the need to advance a needle through a collapsed interspinous space, although bilateral injections of the affected interspinous spaces are required. Nuclear scintigraphy is also an important adjunct in the definitive diagnosis and localization of impinged spinous processes as a contributing cause to back pain. Therapeutically, interspinous injections with anti-inflammatories (i.e. corticosteroids) provide variable effectiveness and durations of pain relief and normal spinal function.

Articular processes

Articular process osteoarthritis is a common pathology and an important contributor to back pain. Like articular limb lameness, intra- or periarticular injections of the articular processes can assist in the localization and treatment of the presumed back pain. Periarticular injections of articular processes in the thoracolumbar spine can be used both diagnostically and therapeutically. Ultrasound guidance is recommended due to the deep location and close proximity to the spinal neurovascular structures that exit the intervertebral foramen.[33] Intra-articular injections of the articular processes are difficult due to the small articulation and sparse joint capsule; therefore periarticular injections are often performed. A 15 cm spinal needle can be used with ultrasound guidance to assess the articular process joint capsule in most horses.

Sacroiliac joint

The ante-mortem diagnosis of sacroiliac osteoarthritis is often frustrating and based on exclusion of other possible causes of hindlimb lameness.[31,57] In humans, periarticular injections of the sacroiliac joint are easy to perform, safe and seemingly effective in controlling pain associated with sacroiliac joint osteoarthritis.[58–60] The deep overlying croup musculature and seemingly inaccessible anatomic location of the sacroiliac joint has limited the clinical application of Intra-articular or periarticular sacroiliac joint injections in horses.[31,57,61] Injection of the general sacroiliac region for diagnostic and therapeutic purposes has been performed, but inappropriate needle placement or the use of too short needles explain why most techniques have had suboptimal diagnostic or therapeutic effects.[40,62,63]

A medial approach to the sacroiliac joint provides the most direct, safe and consistent periarticular injection technique (Fig. 21.10).[64] Periarticular injections are made as close as possible to the caudomedial sacroiliac joint margin due to the high prevalence of degenerative changes affecting the caudomedial sacroiliac joint margin.[54,65] Important neurovascular structures to be avoided include the sciatic nerve and the cranial gluteal nerve, artery and vein that pass through the greater sciatic foramen, directly caudal to the sacroiliac joint.[66] Osseous topographic landmarks used to identify the needle entry site and the direction of needle advancement include the contralateral tuber sacrale and the ipsilateral tuber coxae and greater trochanter of the femur. The midpoint of the distance from the cranial aspect of the tuber coxae and the cranial aspect of the greater trochanter is used as a target for needle advancement. The needle entry site is 2 cm cranial to the contralateral tuber sacrale. The needle entry site and the midpoint of the tuber coxae and greater trochanter are connected with white tape to indicate the direction of needle advancement. A 25 cm, 15 gauge spinal needle is bent slightly in the direction of the bevel of the needle to match the medial curvature of the iliac wing. The needle is inserted with the bevel facing toward the targeted sacroiliac joint and advanced along the medial aspect of the iliac wing until it firmly engages the dorsal surface of the sacral wing, near the medial border of the sacroiliac joint. Poor performance or vague proximal hind limb lameness associated with sacroiliac osteoarthritis can be diagnosed and treated with this reliable and easy-to-use injection technique.[64]

Diagnostic imaging

Radiographic examination

For diagnosing lower limb lameness, radiographs are usually the first imaging modality used. However, due to difficulties associated with radiographing the equine back, other diagnostic imaging modalities may be used initially to localize the presumed inciting cause of back pain or dysfunction.

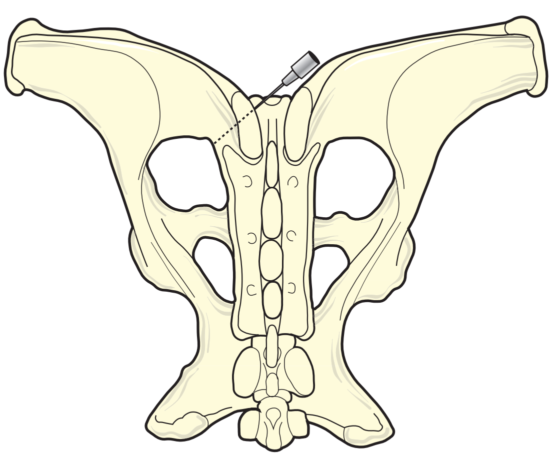

Fig 21.10 Diagram of a medial approach to the sacroiliac joint for diagnostic or therapeutic purposes (dorsal view). The needle is directed from the cranial aspect of the contralateral tuber sacrale toward the caudomedial aspect of the affected sacroiliac joint.

Standing position

It is possible to take good-quality lateral views of the thoracic (T1–T18) and cranial lumbar spine (L1–L4) in the standing position.[67] Using portable equipment, the dorsal apexes of the spinous processes for T2–L3 can usually be visualized. Powerful equipment is necessary for radiographic examination of the horse's vertebral column, because exposures of up to 150 kV and 500 mA may be required in large horses.[68] Exposure values will vary according to the system employed, but a few suggested radiographic techniques are given in Table 21.4.[69]

One of the major problems encountered in radiography of such a thick subject is the inevitable production of secondary radiation. However, there are a number of ways to minimize scatter. The tube can be mounted on an overhead gantry system and linked to a cassette holder on the far side of the horse. The primary beam can then be automatically directed to the center of the cassette and the beam size can be carefully collimated to the size of the film. This system makes it possible to use high-ratio and crosshatch grids with confidence to effectively reduce scatter. The fastest possible system of intensifying screens and film (e.g. rare earth screens) should be employed so that exposures can be kept to a minimum. Most radiographic film cassettes contain lead in the backing, but at exposures over 100 kVp, it is advisable to place an additional lead sheet behind the cassette to absorb backscatter. As the scatter is oriented perpendicular to the ground with a film-focus distance of 150 cm, an air gap exists between the spine and the cassette and this helps to reduce the amount of scatter reaching the film. There is a considerable difference in tissue attenuation between the tips of the spinous processes and the vertebral bodies; thus, at least two radiographs of the same region at different exposures must be taken or some form of beam filtration is necessary. Considerable improvement in radiographic quality can be obtained by filtering (dodging) part of the primary beam to help compensate for the marked variation in thickness of the horse's spine.[68]

The horse should be sedated prior to radiography to reduce the degree of movement and to allow the handler to stand well out of range of the beam. Stocks are also useful to prevent movement. Lead markers placed midline on the horse's back are useful for orientation on the radiographs. The horse must be standing completely square, as the spine rotates to some extent if one leg is non-weight bearing. For the dorsal apexes of the spinous processes, the beam should be centered 5 cm ventral to the dorsal skin surface; for the region of the vertebral bodies, it should be centered 15–20 cm below the dorsum depending on the size of the horse. The beam should normally be horizontal but for visualization of the dorsal articular facets in the cranial lumbar region, it is useful to angle the beam from a ventral to dorsal orientation at an angle of 20–30° to avoid superimposition by the transverse processes. As a grid is being used, the cassette must be tilted accurately at the same angle of 20–30°.[69]

Table 21.4 Suggested radiographic techniques for imaging the thoracolumbar spine

VERTEBRAL STRUCTURES OR REGION (PEAK)	KILOVOLT	MILLIAMPS	GRID
Spinous processes			
Withers (T3–T8)	75	30	No
Midthoracic (T9–T15)	70	55	Yes
Thoracolumbar (T16-L4)	85	80	Yes
Articular processes			
Midthoracic (T9–T15)	100 +	200–300	Yes
Vertebral bodies			
Thoracic (T5–T18)	75	55	Yes
Lumbar (L1–L5)	100 +	200–300	Yes

Under general anesthesia

It is not possible to take radiographs of diagnostic quality of the caudal lumbar (L3–L6) and sacroiliac regions in a standing horse. The horse must be anesthetized and placed on its back in the frog-legged position so that the cassette can be inserted beneath the pelvis for a ventrodorsal view. Even in very large horses (i.e. weighing over 700 kg), exposures above 150 kV are not required, although up to 500 mA have been used on some occasions. To limit scattered radiation, it is necessary to use crossed, high-ratio grids and to put additional lead on the back of the cassette to prevent backscatter.

Normal radiographic anatomy

The thoracolumbar spine of the newborn foal has a more pronounced curvature (i.e. dorsally convex) in the midthoracic region than does the adult horse.[69,70] The dorsal spinous processes appear short in relation to the length of the vertebral bodies, and in the midthoracic region they are blunt ended or spatula shaped, with wide interspinous spaces. The vertebral bodies have well-defined cranial and caudal epiphyses, but all the other ossification centers in the vertebral bodies and neural arch have fused before birth. During the first few months of life the thoracolumbar spine straightens out to some extent. In the mid and caudal region there is some alteration in shape of summits as well as a general lengthening and reduction in size of the interspinous spaces. At about 12 months of age, calcification of separate ossification centers on the summits of the cranial spinous processes occurs, and these persist without fusion into old age (i.e. 15 years or older). The tallest point of the vertebral column is at the withers, usually T4–T6. Areas of periosteal irregularity are frequently seen in the midportion of the thoracic spine, but these are of no clinical significance. The spines beneath the saddle region, T11–T17, are considerably shorter and more upright; the anticlinal vertebra is usually T15. Caudal to this, the spinous processes are increasingly slanted forward and the interspinous spaces are considerably narrowed. The summits are variable in shape, but they have cranially directed, often beak-shaped tips.

In the adult the thoracolumbar spine lies horizontal when the horse stands squarely on a level surface. The ventral portions of the vertebral bodies are clearly visible radiographically as far back as T16, because they form the roof of the thoracic cavity. It is difficult to see the articulations of the ribs and the articular and transverse processes unless oblique views are taken. Behind the diaphragm, the lumbar vertebrae as far back as L3 can be defined, as well as the articular and transverse processes. Closure of the vertebral epiphyses occurs at 3–3.5 years of age. In the region of the midback the width of the interspinous spaces varies and some impingement or Overriding of the spinous summits may occur. This is more often seen in Thoroughbreds than in other breeds and seems to be related to the conformation of the back; it is more common in stocky, short-coupled horses. The reduction or obliteration of the interspinous spaces, chiefly in the region from T13 to T18, is associated with local periosteal reaction and focal areas of radiolucency. The spinous summits sometimes overlap one another and become misshapen presumably because of the continued pressure from the adjacent spines. In one survey of clinically normal horses, 34% showed some degree of spinous process impingement.[70] There are few variations noted in the normal radiographic anatomy apart from the changes associated with impingement or over-riding dorsal spinous processes in the midback region. Other osseous findings (e.g. abnormal spinal curvature, osteoarthritis, vertebral fracture or spondylosis) are incidental or are rarely encountered.[103]

Primary indications for radiography of the pelvis include acute or severe pelvic asymmetries, upper hindlimb lameness and pelvic crepitus or fractures.[71] Ilial wing overlap and the deep anatomic location of the sacroiliac joint make radiographic imaging difficult at best. The radiographic features of chronic sacroiliac joint disease are minimal and include non-specific increases in the joint space and apparent enlargement of the caudomedial aspect of the sacroiliac joint.[31] Linear tomography has also been used to examine the lumbosacral and sacroiliac regions of horses, but limited access to equipment has restricted its clinical usefulness.[72] Positive findings include widening of the sacroiliac joint and irregular joint outlines with osteophyte formation at the caudal aspect of the joint. Osseous changes are common bilaterally, but may be more pronounced on the clinically affected side.[72]

Scintigraphic examination

A useful adjunct to clinical diagnosis in recent years has been the advent of nuclear scintigraphy for horses.[73–76] The technique involves intravenous injection of a radionuclide and detection of 'hotspots' of increased radioactivity in the bone phase by use of a gamma camera. Scintigraphy is helpful in detecting over-riding or impinged spinous processes, vertebrae fractures, osteoarthritis, spondylosis, stress fractures of the wing of ilium and some sacroiliac osteoarthritis. Scintigraphy is particularly valuable in identifying bony lesions at sites not accessible with conventional radiography.

The radiopharmaceutical most commonly used for equine scintigraphy is 99 m technetium-labeled methylene diphosphonate (^{99m}Tc-MDP). A weight-dependent dose between 3 and 6 GBq (100–150 mCi) of ^{99m}Tc-MDP is injected intravenously and images of the bone phase are obtained 2–3 hours later. Due to the initial high renal and bladder radioactivity, vascular phase and soft tissue phase images of the thoracolumbar spine cannot be obtained. Damaged skeletal muscle can be detected by abnormal soft tissue uptake of ^{99m}Tc-MDP during bone-phase imaging, but usually only if the horse has been strenuously exercised before the scintigraphic examination.[77]

For a complete examination, the horse should be imaged from both the left and the right; otherwise some subtle lesions, for example those located at the articular processes, can easily be missed. A high-resolution, low-energy, parallelhole collimator should be used; this gives a geometrical resolution of 4.4 mm at a distance of 5 cm from the collimator face. For the caudal thoracic and lumbar regions, the camera is positioned obliquely at an angle of 50–65° to the horizontal. This allows the distance between the camera and spine to be minimized. Positioning the camera horizontally above the spine results in superimposition of all the vertebral structures. The camera can be oriented perpendicular to the floor for views of the cranial thoracic spine. When the camera is positioned over the lumbar spine, the image quality may be improved by shielding the kidney using a lead sheet.

The images are acquired on the basis of either counts or time. One million counts or more are optimal for maximal resolution of the caudal regions of the equine back and the pelvis. This large number of counts requires several minutes of immobility on the part of the horse, however, and thus generally cannot be achieved without general anesthesia. Movement of the standing horse can be minimized by appropriate sedation and quiet handling of both the horse and camera. Blinders and cotton earplugs for the horse may help. Nuclear medicine software that is able to correct for motion is now available and this compensates for the slight swaying of the horse and respiratory movements.

Normal scintigraphy findings

In normal horses, regions of bone close to the skin surface such as the tuber sacrale and tuber coxae appear 'hotter' (i.e. increased radiopharmaceutical uptake) than adjacent bone structures, as there is less soft tissue attenuation. Other superficial sites that appear slightly 'hot' are the apices of the spinous processes, particularly at the withers. In good-quality images, the individual vertebra can be clearly distinguished. The spinous processes and articulations have a slightly higher uptake, but this should be equal for all joints in the region. On lateral oblique views, each rib is located cranial to its respective vertebra. As an aid to orientation, on left lateral views the 16th rib usually overlies the cranial pole of the right kidney.

Any scintigraphic abnormality appears as increased radiopharmaceutical uptake (a 'hotspot'), whereas areas of diminished uptake are difficult to detect due to poor image resolution. The most common sites for increased uptake are at the apices of the spinous processes, the articular processes or the sacroiliac region.

Nuclear scintigraphy is considered by some authors to be an accurate and diagnostically useful technique for identifying acute and chronic sacroiliac joint injuries.[55] Subjective evaluation or quantitative analysis of bone scans are typically able to identify asymmetric radioisotope uptake over the affected tuber sacrale. However, presumed normal horses, without a history of hindlimb or sacroiliac joint injuries, may also have asymmetric uptake over the tuber sacrale. A dorsal view of the sacrum is considered the most diagnostic image for evaluating and comparing the sacroiliac joints.[55] However, there is usually extensive overlap of uptake in the tuber sacrale and the sacroiliac joints on the dorsal view. Oblique views of the ilial wings are recommended to confirm left-to-right asymmetries in radioisotope uptake and to separate the tuber sacrale dorsally from the sacroiliac joint region ventrally,[78] although oblique views may be difficult to interpret due to inconsistent camera positioning on the left and right sides. The thick overlying gluteal musculature may also attenuate radiopharmaceutical uptake from an affected sacroiliac joint. Stress fractures of the ilial wing may be difficult to differentiate from sacroiliac joint injuries due to the common location and extension of the incomplete fracture line into the sacroiliac joint.[55,79,80]

Ultrasonographic examination

There has been considerable interest in recent years concerning the value of ultrasonography for evaluation of the epaxial structures, particularly the supraspinous and dorsal sacroiliac ligaments.[33,81]

Supraspinous ligament

A 7.5 or 10 mHz linear array transducer is used to examine the supraspinous ligament that runs dorsal to the thoracic and lumbar spinous processes. It is necessary to clip the hair over an area of approximately 20 cm in width extending from the withers to the base of the tail. The ligament has an echogenic, striated appearance similar to tendon. It is thinner and wider in the caudal withers region and becomes narrower and thicker in the lumbar region. It is always thinner as it runs over the spinous processes. The dorsal convex surface of the spinous processes can be clearly seen and impinged or over-riding spinous processes can be identified by visualizing narrowed interspinous spaces. There may also be evidence of false joint formation between impinging spines. The echogenicity of the ligament may vary somewhat and a more clearly defined fibrous pattern seen in the caudal thoracic and lumbar regions. In the withers (T6–T9) it is sometimes possible to see hyperechogenicity that may cast acoustic shadows. These are associated with the secondary centers of ossification on the dorsal tips of the spinous processes. A little caudal to this (T9–T12) it is possible to see hypoechoic areas that may be associated with cartilage metaplasia adjacent to the ligament insertion into the dorsal spinous process. This does not usually have any clinical significance. A high prevalence of ultrasonographic lesions have been reported in ridden, unridden and back pain horses with an increased incidence of lesions localized to the T14-T17 vertebral region.[35] Every horse within this study had at least one site (range 2 to 11) of supraspinous desmitis; however, no significant difference was found between the three groups in the number or location of abnormal images. Therefore, the presence of supraspinous desmitis on ultrasonography cannot always be considered a clinically relevant cause of back pain.

Dorsal sacroiliac ligament

The dorsal portion of the dorsal sacroiliac ligament can be visualized with a 7.5–10 mHz linear array transducer as it runs from the tuber sacrale to the summits of the sacral spinous processes.[82] The sacroiliac region is first viewed on midline in transverse section. The tuber sacrale are seen as hyperechoic convex lines on either side of the sacral spinous processes. The transducer is then moved laterally over the tuber sacrale so that the dorsal portion of the dorsal sacroiliac ligament appears as a crescent-shaped echogenic structure. Longitudinal views of the dorsal sacroiliac ligament are then examined. The ligaments are examined for alterations in echogenicity and fiber orientation, but particularly for any increase in size.

Additional pelvic and vertebral structures

It is possible to examine the dorsal surface of the iliac wing and caudal margin of the sacroiliac articulation to identify dorsal cortex irregularities associated with incomplete and complete ilial wing fractures.[83,84] Denoix has elegantly demonstrated the visualization of the thoracolumbar articular processes, transverse processes, lumbosacral and caudal lumbar intervertebral disk spaces and the sacroiliac joint.[33] The ventral sacroiliac ligament and the ventral joint margins of the sacroiliac joint can also be visualized on transrectal ultrasonography.[81] Ventral periarticular remodeling of the sacroiliac joint has been observed with transrectal ultrasound approaches. Muscle injuries are more difficult to detect ultrasonographically, although in severe cases of muscle strain an increased echogenicity with thickening of the connective tissue septae within the muscle may be identified.

Thermographic examination

Thermography has been used successfully as an aid to diagnose back problems. However, it is important to have the right equipment and to establish normal thermal profile parameters. Even so interpretation of infrared thermography imaging can be difficult. A single thermal study has little or no prognostic value. Von Schweinitz concludes:

> *Thermal imaging reveals important information about the neural outflow of the spine in terms of sympathetic tone. The thermal findings are a compilation of local tissue factors and vasomotor tone requiring care in interpretation. The relevance of disturbed vasomotor tone, especially persistent vasoconstriction, is well established in chronic back pain syndromes in man. Many of these syndromes involve disturbing sensory faults (e.g. allodynia, burning, aching) which can neither be directly communicated by our patients nor readily described by any other current diagnostic test.*[85]

Thermography provides quick, safe and non-invasive assessment of the whole patient. It takes into account a major aspect of homeostasis and prompts one to investigate all other thermally abnormal sites. With current diagnostic technologies, it often provides the only objective evidence confirming cases of equine back disease. Routine use of thermal imaging in equine poor performance syndromes confirms that thoracolumbar and sacral neuromuscular disease is a common condition.[85] Thermography has been used to diagnose muscle strain or inflammation in the sacroiliac and croup regions.[86] Horses with sacroiliac joint injuries are expected to have protective muscle spasms in the adjacent musculature. Palpation of muscle sensitivity has been correlated with abnormal thermographic images in most cases.[86]

Magnetic resonance imaging (MRI) and computed tomography (CT)

These are emerging modalities that have not yet been applied to the problems involving the thoracolumbar spine. However, the detail and quality of both skeletal and soft tissue structures elsewhere in the horse's body mean that once the technological difficulties have been overcome there is great potential for improved diagnostic ability for the thoracolumbar and lumbosacral spine.

Specific pathologic conditions

Clinical signs associated with spinal muscle pathology include atrophy, focal swelling and palpable tenderness of the epaxial muscles. Spinal muscle biopsies help to evaluate suspected back disorders, but are best used with a complete physical examination and imaging procedures. Spinal ligament injuries affect the supraspinous and sacroiliac ligaments. Osseous pathology has been observed at the vertebral processes, intervertebral articulations and sacroiliac joints in horses. Degenerative changes are common in many articular processes, intertransverse, lumbosacral and sacroiliac articulations. Osseous spinal lesions tend to affect multiple vertebral locations.

Vertebral anomalies and deformities

Developmental variations in the morphology of thoracolumbar vertebral bodies, processes and joints in horses are known to occur, but usually result in secondary rather than primary back problems.[14–16,26,53] Congenital abnormalities that affect the normal spinal curvature include scoliosis, lordosis and kyphosis. In newly born foals signs of scoliosis and lordosis are sometimes seen in association with other in utero postural deformities (e.g. limb contractures, bent face and torticollis). These may be severe and necessitate euthanasia or be mild when they show an apparent complete recovery. The condition of kyphosis (i.e. roach-back) is most frequently seen during the period of active growth after weaning although the underlying cause does not appear to be in the vertebral column. The problem may be associated with a progressive straightening of the hind limb conformation during a growth spurt or perhaps be secondary to a stifle or hock problem (e.g. osteochondrosis). The condition of congenital lordosis (i.e. dipped or sway-back) has been associated with hypoplasia of the cranial and caudal intervertebral articular processes in the cranial thoracic region T5–T10.[87] There is overextension of one or more of these articulations leading to the ventral curvature of the midthoracic spine. In older horses acquired lordosis is sometimes seen, particularly in brood mares after a number of pregnancies, but usually no clinical problems are associated with it.

All these vertebral deformities predispose to some weakness of the thoracolumbar spine, leading to poor performance and soft tissue injuries. Diagnosis can be confirmed by radiography revealing abnormal curvature of the vertebral column, principally in the cranial thoracic region (T5–T10) with lordosis, mid- to caudal thoracic region with scoliosis and the cranial lumbar region (L1–L5) with kyphosis.

Soft tissues injuries

Muscle strain

Damage to the epaxial tissues is undoubtedly the most common cause of back injury in the horse.[4] The main action of the longissimus muscle is to extend the back (i.e. to dorsiflex) or, if acting singly, to laterally bend the spine. The primary role of these muscles is to control the stiffness of the back rather than to actively assist locomotor movements. Strain or injury to all or part of the longissimus muscles most frequently occurs during ridden exercise because of a slip, fall or poorly executed jump. It may be caused through fatigue or inadequate fitness. The clinical signs are an acute onset of poor performance often accompanied by a change of temperament. Local swelling and heat of the muscles may occur, particularly in the lumbar region. The back is kept rigid and there is a restriction in the hindlimb gait at exercise, often with a wider than normal hindlimb stance. There may be difficulty in maintaining normal tracking action of the hindlimbs. Disunited canter and frequent breaking of stride are also frequently seen. Stiffness of the hindlimb and back is seen particularly in short turns, but no clear signs of lameness are evident. There is obvious pain on palpation and a marked reduction in flexibility of the thoracolumbar spine. In the acute stages some elevation (i.e. 2–4 times baseline levels) in the plasma levels of muscle-derived enzymes (CK and AST) will be noted after mild exercise. If the sublumbar muscles are involved, pain will be easily elicited on rectal palpation.

Classic signs of exertional myopathy (i.e. rhabdomyolysis) are not difficult to differentiate from muscle strain of the back. However, the atypical low-grade form of exertional myopathy is more difficult to diagnose as it can occur after varying amounts of exercise, but is more commonly seen in horses on a high-protein diet and in highly strung fillies or mares in excellent bodily condition. Diagnosis can usually be confirmed by determination of muscle-derived enzymes after exercise. In exertional myopathy, levels will be increased greater than five times over baseline values.

Polysaccharide storage myopathy (PSSM) has been recently diagnosed from longissimus muscle biopsies in showjumpers, dressage and draft horses.[46] The horses showed typical signs of a soft tissue back injury and biopsies from the longissimus lumborum muscles revealed high glycogen levels with abnormal deposits of amylase-resistant polysaccharide. This study indicates that muscle biopsy may be an important diagnostic aid in some chronic back problem cases.

Ligamentous damage

Clinical conditions affecting the spinal ligaments include mild, moderate or severe sprains. Severe injuries are characterized by complete ligamentous disruption and joint laxity (i.e. joint luxation). A fairly common site of thoracolumbar injury in Thoroughbred gallopers and jumpers is the supraspinous ligament which runs all the way down the middle of the back and is adherent to the summits of the thoracic and lumbar dorsal spinous processes. It is made up of a continuous ligament to which the multiple tendon insertions of the longissimus muscles contribute. The composite structure is subject to strain in the same way as the muscle injuries just described. The clinical signs are essentially similar, but tend to persist for longer and the ultimate prognosis is less favorable. The cranial lumbar region is the most common site of injury. The ligament is often visibly thickened above the spinous summits and pain is easily elicited on palpation. Reduced lateral bending of the thoracolumbar spine is seen in one or both directions. By taking low-exposure radiographs, the soft tissue thickening and some focal radiodensity in the ligament may be seen in long-standing cases. Detached flakes from the spinous summits are also noted on occasion and are associated with periosteal irregularity and sclerosis on the dorsal surfaces of the spinous summits. This may also be seen in the caudal withers' regions, but care must be taken not to confuse elevated periosteum with a vestigial center of ossification on the dorsal tips of the T3–T12 spines. Diagnosis can be assisted by ultrasonographic examination.[33,34] The prognosis for supraspinous ligament strain is usually guarded, largely because of the likelihood of recurrence. Some horses do recover but go on to develop signs of a 'cold back', which is defined as temporary stiffness and a dipped back, without affecting their competitive performance.

Other soft tissue lesions

These include such disorders as skin lesions (e.g. wounds, scars, warbles, pruritic conditions), which may cause secondary signs of back pain. Pressure or chaffing from an ill-fitting saddle, particularly in endurance competitions, may also be observed.

Thoracolumbar osseous pathology

Spinal disorders and sacroiliac joint injuries have been identified as significant causes of chronic poor performance in horses.[4,31,88] In humans, the most common known sources of back pain are related to the intervertebral disks, zygapophyseal joints and sacroiliac articulations.[89] Intervertebral disk disease is uncommon in horses, but significant and widespread degenerative changes of the thoracolumbar zygapophyseal joints and sacroiliac articulations have been reported, even in active racehorses.[54]

Articular pathophysiology

The zygapophyseal joints are synovial articulations that undergo joint capsule pathology and joint degeneration similar to other synovial joints. Articular degeneration usually progresses through three phases of pathology: dysfunction, instability and degeneration. Joint dysfunction is characterized by restricted joint motion, localized pain and inflammation, and abnormal paraspinal muscle hypertonicity. Restricted articular motion stimulates local biochemical alterations and the release of inflammatory products. The inflammatory process can alter the Intra-articular environment and further contribute to joint capsule pathology and periarticular fibrosis. Muscle hypertonicity may restrict joint motion and contribute to adhesion formation. Joint immobilization also produces bone demineralization, capsular adhesions and loss of ligamentous strength. Restoring joint motion can lead to normal joint function, depending on the amount and duration of the immobilization.

Joint motion is essential for the prevention of joint contracture and adhesion formation. Progressive joint immobilization is characterized by initial musculotendinous contractures, followed by capsular and periarticular adhesions and eventual intra-articular adhesions.

Joint degeneration progresses as the dysfunctional joint is unable to distribute normal biomechanical stresses. The instability phase of joint degeneration is characterized by cartilaginous, meniscal, capsular and ligamentous deformation and degeneration. Abnormal joint and paraspinal tissue biomechanics induce additional subchondral bone changes and joint derangement. Reduced or asymmetric motion in one vertebral motion segment may induce compensatory hypermobility in adjacent vertebral segments due to injuries to the joint capsule or ligamentous laxity. The increased joint mobility results in joint instability, joint derangement and secondary muscle hypertonicity. Joint instability also affects the neurologic influences of proprioception and the central neuromotor control of movement and posture. Potential radiographic findings of articular instability may include osteophyte formation or vertebral instability (i.e. listhesis). The spinal degenerative phase is characterized by attempts at stabilization of the degenerative tissues. Chronic joint immobilization can lead to fibrocartilaginous replacement of the joint cavity and eventual ankylosis. Radiographic signs of advanced osteoarthritis and osteophyte formation, spinal ligament ossification and spinal ankylosis can be visualized at this stage.

Articular process degenerative joint disease

As with any synovial articulation, loss of motion or aberrant joint physiology can be a primary source of pain.[21] Jeffcott states that degenerative joint disease of the articular processes (i.e. zygapophyseal joints) is common in older horses, but probably not clinically significant.[90] However, Denoix reports that zygapophyseal joint pathology at the thoracolumbar junction and lumbar vertebral region is one of the most common spinal disorders associated with back pain.[91] In a necropsy survey of 36 Thoroughbred racehorses, severe articular process degenerative changes were reported in 25% of specimens (Fig. 21.11).[54] Articular surface lipping, osteophytes, periarticular erosions, Intra-articular erosions and ankylosis (in order of increasing severity) were noted. Articular surface lipping and periarticular erosions of the articular processes were common at the thoracolumbar junction and cranial lumbar spine. Intra-articular erosions and ankylosis were restricted to the caudal lumbar vertebral segments, where vertebral mobility is normally limited.[92] Additional studies may help to show that the zygapophyseal joints are a clinically significant source of back pain in horses, as has been shown in humans.[89]

Impinged or over-riding spinous process

Spinous process overlap, without any evidence of osseous impingement, has been noted in horses.[54] In humans, isolated spinous

Fig 21.11 Dorsolateral view of the lumbosacral vertebral region (L2–S2) of a four-year-old racing Thoroughbred that fractured the right front sesamoids during a race. Varying degrees of spinous process impingement (white arrows), vertebral lamina stress fractures (black arrows), articular process ankylosis (L4–L6) and bilateral intertransverse joint ankylosis (L5–L6) are present.

process deviation is a common finding and can be related to vertebral rotation (i.e. scoliosis) or developmental asymmetries in the neural arch, but rarely is it associated with spinous process fracture or malposition of the entire vertebra.[93] Impinged or over-riding spinous processes (i.e. kissing spines) are reported to be the most common osseous cause of back pain in horses.[4]

Spinous process impingement in the thoracic spine occurs most commonly between T13 and T18, reportedly related to altered spinous process morphology.[53,94] Thoroughbreds have a higher prevalence of spinous process impingement or overriding compared with other breeds due to misshapen dorsal apices and narrower interspinous spaces.[4,53] Competitive jumping or dressage horses reportedly have a higher prevalence of thoracolumbar spinous process impingement related to ventroflexion or demanding spinal maneuvers.[4] However, dorsoventral vertebral mobility in the caudal thoracic spine has not been reported to differ from other adjacent vertebral regions, therefore increased dorsoventral movement may not fully account for the vertebral distribution of spinous process impingement.[92,94] Additional weight-carrying requirements have also been implicated because this vertebral region is covered by the saddle while being ridden,[37] although thoracolumbar spinous process impingement has been reported in Standardbreds and an extinct equine species, *Equus occidentalis*, which presumably have not had extraneous weight placed on their backs.[95] Aging has not been found to be a factor in the pathogenesis of thoracolumbar spinous process impingement.[4,53,94]

The diagnosis of impinged or over-riding spinous processes is difficult since apparently normal horses often have a high prevalence of osseous changes radiographically.

Vertebral lamina stress fractures

Stress fractures are usually characterized by bone-specific predilection sites, periosteal and endosteal callus, an incomplete fracture line that may progress to complete fracture, tendency to occur bilaterally, a predominance in athletes undergoing strenuous or repetitive activities, and a patient history of periodic, recurrent, low-grade lameness.[80,83,96] In a necropsy sample of Thoroughbred racehorses, 50% (18 of 36) of specimens had incomplete fractures and focal periosteal proliferation of the vertebral lamina, characterized as vertebral stress fractures (see Fig. 21.11).[79] Incomplete fractures of the vertebral lamina occurred consistently at the cranial aspect near the junction of a cranial articular process and the spinous process. Most vertebral stress fractures were continuous with vertical articular clefts of the cranial articular processes, which may provide a site for stress concentration and may contribute to the etiopathogenesis of equine vertebral stress fractures.[97] Thoracolumbar articular process morphology may also contribute to the development of vertebral lamina stress fractures. The articular processes of the caudal thoracic and lumbar portions of the spine (T16–L6) are deeply interlocking and restrict axial rotation.[16,94] Complete articular process fractures in this vertebral region are thought to result from excessive axial rotation.[94] Most specimens had one vertebra affected unilaterally, but several specimens had multiple vertebral lamina stress fractures and some were bilateral. Bilateral complete fractures of the vertebral lamina were noted in one specimen, so that the dorsal L6 vertebral arch and spinous process could be removed.

Spondylosis

Spondylosis is a degenerative disease of the vertebral joints that produces large osteophytes that bridge the ventral vertebral bodies. The exact cause of vertebral body osteophytes is unknown, but biomechanical and biochemical mechanisms have been proposed.[98] Abnormal joint loading produces microtrauma and degeneration of the annulus fibrosis and periarticular tissues. Portions of the annulus fibrosis and ventral longitudinal ligaments become ossified and produce partial bridging of the involved joints. As the osteophytes increase in size, nerve roots may be compressed at the intervertebral foramen or spinal cord compression occurs if the proliferation extends dorsally into the vertebral canal. The cycle of altered joint biomechanics and inflammatory mediators may continue until complete ankylosis and obliteration of the joint occurs. The forming vertebral osteophytes and the ankylosed vertebral bodies are susceptible to fracture due to the reduced ability to absorb or transfer normal locomotor forces through the ossified ligaments and fused vertebral joints. Several vertebral bodies are usually involved, especially in advanced stages.

Vertebral fractures

Spinous process fractures of the withers (T2–T9) are usually due to falling over backwards and landing on the highest point of the back. Conservative care is usually recommended. Proper saddle fit is difficult following fracture due to lateral displacement of the multiple fracture fragments. Spinous process fractures do not typically cause spinal cord compromise.[99]

Vertebral end-plate fractures occur more commonly in foals and are usually related to a fall or significant trauma. Vertebral body compression fractures have been reported in the thoracolumbar vertebral region (T1–T3, T9–T16 and T18–L6) and are frequently due to physical trauma, electric shock or lightning strike.[99–102] Depending on the severity of the vertebral fracture, minimal fracture displacement is usually found. A complete neurologic examination will help to localize the fracture site if spinal cord compromise is present.[103,104] Isolated hind limb paresis or paralysis with normal forelimb function suggests a spinal cord lesion caudal to T2.

Sacral fractures are a common cause of cauda equina injury. Horses that forcefully back into a solid object or fall backwards can fracture the sacrocaudal vertebral region and produce abnormal perineal neurologic signs. Careful palpation may help to localize a site of pain or vertebral asymmetry.

Neurologic diseases

Conditions that are primarily neurologic in origin must always be considered in differential diagnosis of a back problem. However, there are few disorders that can be specifically related to the thoracolumbar vertebral column.

Ataxia

The most common group of conditions are those that cause ataxia and proprioceptive deficits. These conditions include cervical vertebral stenosis (CVS or wobbler disease), equine protozoal myeloencephalitis (EPM), equine degenerative myeloencephalopathy (EDM) and equine herpesvirus 1 vasculitis (EHV-1). Some of the signs in these conditions will be similar to back problems mainly because of ataxia or incoordination resulting in stiffness or splinting of the back muscles. The hind action with varying degrees of proprioceptive deficit will cause stiffness (hypomelia), weakness and toe dragging. Horses with EPM may also exhibit some lameness and neurogenic atrophy of skeletal muscles. Other causes of ataxia that are usually seasonal are associated with ingestion of certain types of grass (e.g. rye grass, Bermuda and Dallis grass). For more information see Chapter 24.

Lower motor neuron diseases

The condition of stringhalt can produce severe and bizarre signs affecting the hindlimbs.[105] However, in milder cases stiffness and exaggerated action of one or both hind limbs may be seen. The specific etiology of this condition is not known, but morphologically it appears to be distal axonopathy.[106] Another long-established but little understood condition is that of 'shivering'. It is assumed to be of neurologic origin, but its etiology is completely unknown. The clinical signs involve muscle fasciculations of the back and hindquarters, particularly if a hindlimb is picked up and fully flexed. The condition rarely affects performance and does not appear to be the cause of a genuine back problem. 'Shivers' may also be confused with polysaccharide storage myopathy (see Chapter 6).

Other neurologic diseases

Lyme disease (borreliosis) may need to be considered in some locations where various species of ticks are present. The infective agent is a spirochete, *Borrelia burgdorferi*, which may cause neurologic signs of lethargy or aggression due to low-grade meningitis. Musculoskeletal pain is usually due to polyarthritis or intermittent lameness. Serological confirmation (i.e. IFA, ELISA and Western blot) is possible and response to treatment with amoxicillin or tetracycline for two weeks may support a diagnosis of Lyme disease.

Sacropelvic pathology

The ante-mortem diagnosis of sacroiliac joint injury in horses is difficult and often based on a diagnosis of exclusion.[55] Based on a review of the literature, osteoarthritis of the sacroiliac joint is the most prevalent disease process affecting horses with sacroiliac joint pain or dysfunction, although its clinical significance remains uncertain.[31,54,65,107] Degenerative changes tend to be bilaterally symmetric and localized to the medial aspect of the sacroiliac joint (Fig. 21.12).

Sacroiliac ligament desmitis has been documented ultrasonographically in the dorsal portion of the dorsal sacroiliac ligament.[34,81,82] A diagnosis of sacroiliac ligament desmitis is based on loss of normal echogenicity on a short-axis view and a decrease in parallel fiber pattern on the long-axis view. Complete sacroiliac ligament disruption is most likely due to substantial trauma, such as flipping over backwards or catastrophic musculoskeletal injuries associated with race training.[54] However, few cases of complete rupture of the sacroiliac ligaments have been reported in the veterinary literature.[54,108]

The pathogenesis of apparent spontaneous or insidious differences in tuber sacrale height needs to be further researched.[31] The presumed diagnosis of sacroiliac joint subluxation based solely on the presence of tuber sacrale height asymmetry is inappropriate.[58] Variable degrees of tuber sacrale height asymmetry occur frequently and may be due to chronic asymmetric muscular or ligamentous

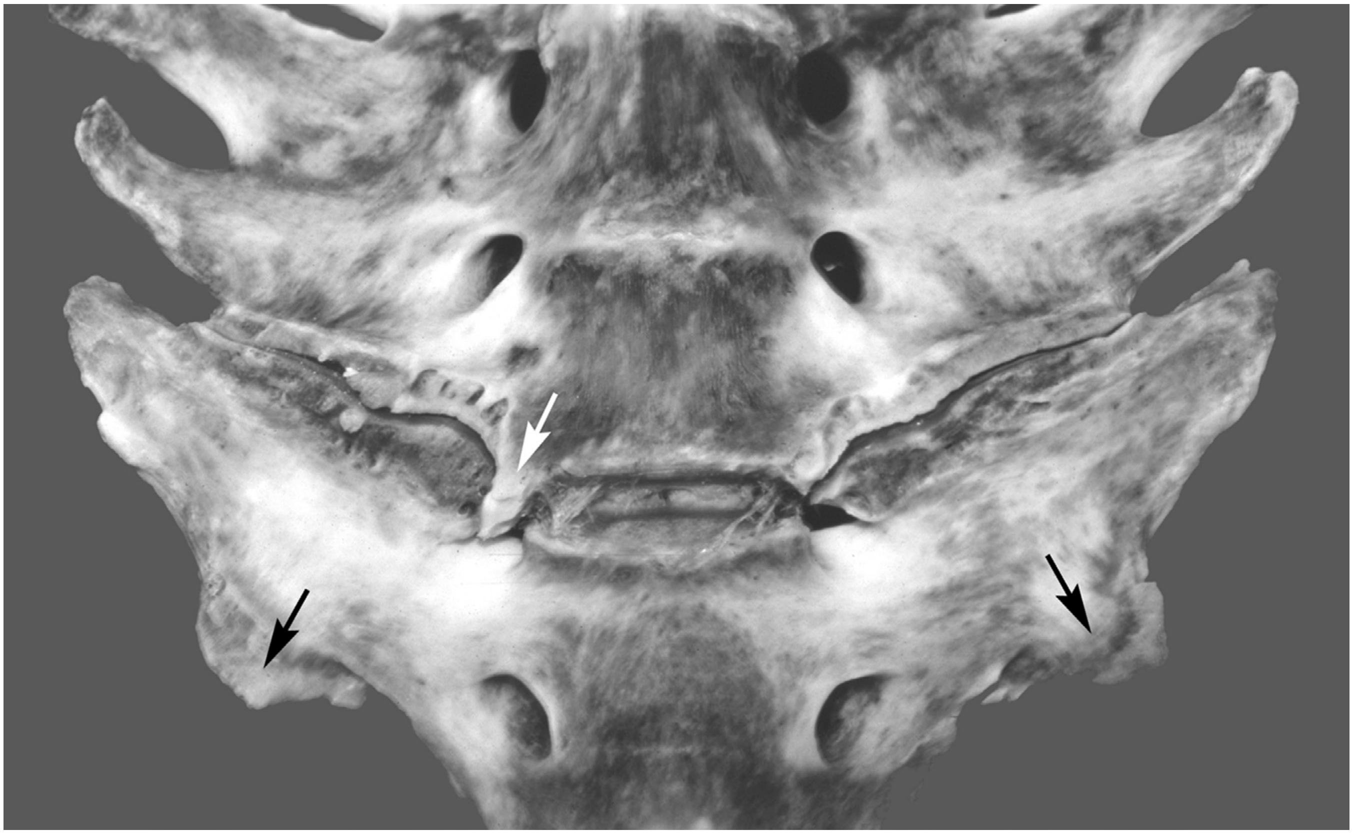

Fig 21.12 Ventral view of the lumbosacral vertebral region (L5–S2) of a 23-year-old Thoroughbred used for dressage. The horse had a clinical history of psoas muscle soreness and chronic pain localized to the lumbosacral junction. Bilateral intertransverse joint ankylosis (L4–L6), a large osteophyte at the right ventral lumbosacral intervertebral foramen (white arrow) and proliferative changes of the sacral articular surface of the sacroiliac joints (black arrows) are present.

forces acting on the malleable osseous pelvis and not direct sacroiliac ligament injury.[109] Horses with chronic sacroiliac problems and presumed sacroiliac joint subluxation have not had identifiable changes in the sacroiliac ligaments at necropsy.[31] In addition, Standardbred trotters with substantial tuber sacrale height asymmetries did not have significant increases in sacroiliac pain compared to horses with lesser degrees of asymmetry.[110] An ante-mortem diagnosis of sacroiliac joint luxation can only be supported if an acute change in tuber sacrale height asymmetry due to substantial trauma has been documented or if sacroiliac joint instability (i.e. crepitus or independent tuber sacrale movement) is evident during physical examination.

Pelvic stress fractures also need to be ruled out in horses with sacroiliac pain or dysfunction.[37] A high prevalence of occult pelvic stress fractures has been reported in Thoroughbred racehorses.[79,80,96,111] Pelvic stress fractures occur in consistent locations on the caudal border of the ilium adjacent to the sacroiliac joint.[78,83,96] The incomplete fracture lines extend into the caudomedial aspect of the sacroiliac joint, which could possibly produce concurrent sacroiliac joint inflammation and degradation. Complete ilial wing fractures (the most common type of pelvic fracture) typically produce a palpably depressed tuber sacrale on the affected side.[80]

Treatment and management

Medical management

The basic principles of medical management are to reduce pain and muscle spasms to permit better healing, followed by a program of rehabilitation and measures to prevent further injury or stress to the back. It is therefore necessary in many cases to use a combination of medications (e.g. NSAIDs, muscle relaxants, corticosteroids, local irritants or analgesics) in addition to physiotherapy or manipulative therapies (Table 21.5).

Non-steroidal anti-inflammatory drugs (NSAIDs)

For acute and severe pain from muscle strain, fractured withers and acute sacroiliac injury, intravenous NSAIDs followed by oral doses are beneficial. Phenylbutazone (1–2 g, p.o., b.i.d.) is still the drug of choice for many equine practitioners. Other NSAIDs include ketoprofen (2.2 mg/kg (1 mL/100 lb), i.v., s.i.d. for up to five days) or naproxen (5–10 mg/kg, p.o., b.i.d. for up to 14 days). If severe muscle spasms are present, then diazepam (0.08 mg/kg, i.v. or p.o.) may also be administered.[112] In mild or chronic cases, oral naproxen once or twice daily (5–10 mg/kg) is recommended. Phenylbutazone in low doses (1 g, p.o., s.i.d.) for mild aches and stiffness can be beneficial, but may mask signs of developing tendinitis or other musculoskeletal injuries with long-term use.[112] In chronic cases with low-grade bone pathology (e.g. over-riding dorsal spinous processes or osteoarthritis), a course of NSAIDs can be useful in conjunction with a progressive exercise program. Exercise should begin with a graduated program of lunging to build up and loosen the back and hindquarter muscles. Once the horse is fairly fit on the lunge line, riding work may begin. At this time oral phenylbutazone (i.e. 4 g/day for four days; 3 g/day for four days; 2 g/day for four days; 1 g/day for four days and 1 g every other day for eight days) can be given as the exercise is gradually increased.

Muscle relaxants

Muscle relaxants such as dantrolene sodium (2 mg/kg, p.o., s.i.d.) and methocarbamol (15–44 mg/kg, p.o., s.i.d.) have been

Table 21.5 Techniques used in the treatment of back problems in horses

CATEGORY	SPECIFIC METHODS
Rest	Stall rest Paddock turnout Restricted or controlled exercise
Management	Replace or reflock saddle Therapeutic saddle pads Change stable and work routine Attempt reschooling or try another training approach Graduated exercise program Assess or modify rider's equitation
Pharmaceuticals	NSAIDs (oral, parenteral or local injection) Corticosteroids (oral or local injection) Muscle relaxants Sclerosing agents (local injection) Sweats or counterirritants Hormonal therapy RVI injections
Surgery	Compound or comminuted fracture of the withers Impinged dorsal spinous processes
Physiotherapy	Heat (hot packs, infrared heat lamp, poultice, short-wave diathermy)
Thermal	Therapeutic ultrasound
Mechanical	Hydrotherapy and swimming
Electrical	Electrical muscle stimulation Magnetic therapy (static and pulsed) Shock-wave therapy
Manual therapy	Osteopathic techniques
Articular techniques	Chiropractic techniques (high velocity, low amplitude)
Soft tissue techniques	Physical therapy techniques (mobilization, soft tissue techniques) Manipulation under general anesthesia (MUA) Massage therapy Stretching exercises
Acupuncture	Dry needle, aquapuncture, low-level laser puncture Moxibustion
Nutraceuticals	Chondroitin sulfate Glucosamine Glycosaminoglycans MSM
Botanicals	Western herbs Chinese herbs
Homeopathy	Arnica montana

advocated for many years, but their effectiveness does not seem to be uniform in all horses.[113] These drugs may not have any specific effects other than reducing muscle tension or spasm in order to allow natural healing to progress. Thiocolchicoside (2–4 mg/100 kg, i.m., twice weekly for four weeks) and repeated injections of methocarbamol (10 mg/kg, i.v.) have also been advocated in Europe.[114]

Corticosteroids

The systemic use of corticosteroids is rarely indicated for primary back problems because of the possible side effects of laminitis, arthropathy and alimentary problems. NSAIDs are usually more effective and are associated with fewer adverse effects. The use of local injections into the interspinous spaces for the diagnosis or treatment of impinged or overriding dorsal spinous processes has been successful.[112] The injection mixture includes methylprednisolone acetate, isoflupredone acetate and serapin with approximately 5 mL injected at each interspinous space of concern. Improvement usually takes 2–6 days and repeated treatment is sometimes necessary. Occasionally, a local infection at the injection site can be a complication, which needs to be treated immediately with antibiotics. Denoix & Dyson recommend local injections of corticosteroids (flumethasone, 0.5–1 mg per injection site with a maximum total dose of 4 mg; dexamethasone 1.5–2.5 mg per injection site, with a maximum total dose of 10 mg; methylprednisolone acetate, 40–60 mg per injection site, with a maximum total dose of 200 mg), sometimes in association with muscle relaxants or serapin.[114] Injections of corticosteroids around the sacroiliac joint region have been used quite extensively, but currently there are no well-designed or controlled trials reported in the literature. Larger doses of corticosteroids (20 mL) mixed with serapin have been advocated for sacroiliac joint injections.[112]

Additional medications

This is another controversial area and one where there is really only anecdotal information on efficacy of a range of different preparations. However, they have been widely used in practice, often in combination with acupuncture or physical therapy.

Serapin

Serapin is an aqueous solution derived from the pitcher plant *(Sarraseniaceae)*, which is said to block selectively the C fibers that carry pain sensation in peripheral nerves. Serapin is used alone or in combination with other drugs (i.e. corticosteroids) and may be used for both soft tissue (muscle and ligament injuries) and osseous problems (e.g. over-riding dorsal spinous processes). Small doses of 1–2 mL of serapin are given at multiple sites.

Sclerosing agents

Again a number of proprietary agents have been used particularly around the sacroiliac joint and in the region of the ventral sacroiliac ligament. Horses are reported to improve their performance, but no scientific reports of their use are available.

Iodine

For chronic muscle soreness, multiple injections of 2% iodine in oil (Hypodermin or McKay's solution, 3–4 mL, i.m., at multiple sites) within the sore muscle (e.g. longissimus and middle gluteal muscles) have been recommended.[112] The injection area is massaged and the horse walked out the next day. Light work can then be resumed. Scientific reports on the beneficial action of iodine on muscle soreness are not currently available.

Hormones

The estrus-suppressing drug altrenogest (0.044 mg/kg (1 mL/110 lb), p.o., s.i.d.) has been useful in some mares that exhibit apparent back pain when they are in estrus. Also in young Thoroughbreds that show signs of 'cold back' the use of estrone sulfate (0.1–0.15 mg/kg, i.m., every two weeks) may be beneficial.

Rubeola virus immunomodulator (RVI)

Some practitioners have promoted RVI injections to assist in the reduction of chronic muscle soreness in some horses. RVI (2 mL, SQ, s.i.d. for six or more days) is an inactivated rubeola virus that is reported to have immunomodulatory effects that reduce chronic myofascial inflammation. However, the exact mechanism of action and extensive clinical reports are not currently available.

Mesotherapy

Mesotherapy is a technique that has been used for more than 30 years in France.[115] It consists of multiple intradermal injections with fine 5 mm needles into the dermatomes corresponding to the site of the lesion. The mechanism of action apparently involves type I and II nerve fibers coming from the skin which have collateral fibers that can inhibit pain transmission in the spinothalamic fasciculus, from deep structures of the same spinal segment to the thalamus and cerebrum.[114]

Mesotherapeutic injections are made using a mixture of local anesthetic solution (7 mL of lidocaine, 140 mg), short-acting corticosteroid (7 ml of dexamethasone, 15 mg), and muscle relaxant (8 ml of thiocolchicoside, 20 mg). The injections are made at the level of the lesion and caudal to it, taking into account the caudal orientation of the segmental nerves. For example, if treating overriding dorsal spines between T10 and T15, the treated region extends from T10 to L1. Two to three rows of injections are made on each side of the median plane. The horse is restricted to light work on the lunge for three days. Normal training is progressively resumed over five days. A substantial improvement is anticipated within 7–14 days. The expected duration of action varies between three and 12 months.

Surgical management

There are few surgical indications for treatment of back problems except for impinged or over-riding dorsal spinous processes. In young horses that fracture the dorsal spines in the withers (T3–T10) surgery is not necessary unless the fractures are highly comminuted, when it may be necessary to debride the site to prevent infection or osteomyelitis.

Resection of dorsal spinous processes

Surgery for over-riding spinous processes was first reported by Roberts[116] and since then there have been a number of modifications to the technique.[32,117,118] However, the principle is the same, which is to remove the parts of the spinous processes that impinge. We believe that it is absolutely essential to confirm the correct diagnosis and select the most appropriate spines to alleviate the condition. There are many horses that show radiographic findings of over-riding spinous processes that do not exhibit clinical signs of a back problem.[70] Furthermore, many milder cases of over-riding spinous processes will respond to medical and conservative therapy.[53]

A recent paper reported by far the largest series to date and recorded a good response to surgery in those horses that failed to respond to conservative management.[32] The surgical technique involved placing the horse in lateral recumbency. A midline incision is made through the skin, subcutis and supraspinous ligament. The incision extends from one spinous process cranial to those identified for resection to one process caudal to them. The dorsal 4–5 cm of the dorsal spinous processes are dissected free of the supraspinous ligament, the interspinous ligaments and adjacent muscle tissue. Partial resection of the processes is performed with an oscillating saw to a depth that ensures that there is a minimum gap of 5 mm between the remaining bodies of each process resected. The minimum number of processes are resected in each case (e.g. if two processes are affected then one is removed, and if three are affected only the middle one is removed). One centimeter of the dorsal apex of the adjacent spinous process is also removed so that the change from resected to unresected processes is less abrupt. The supraspinous ligament and muscles are sutured and a simple interrupted suture placed between these sutures. The subcutis is sutured using three metric polyglycolic acid sutures and the skin is closed. The wound is protected by a stent bandage sutured over it. In the series, 72% of horses returned to full work and a further 9% improved sufficiently to be used for some athletic work.[32]

Chiropractic

Mechanism of action

Chiropractic evaluation focuses on evaluating and localizing segmental vertebral dysfunction (i.e. chiropractically defined 'subluxation') which is characterized by localized pain, muscle hypertonicity and reduced joint motion.[119] A thorough knowledge of vertebral anatomy, joint physiology and biomechanics is required for proper chiropractic evaluation and treatment. Alterations in articular neurophysiology from mechanical or chemical injuries can affect both Mechano-receptor and nociceptor function via increased joint capsule tension and nerve ending hypersensitivity.[120] Mechanoreceptor stimulation induces reflex paraspinal musculature hypertonicity and altered local and systemic neurologic reflexes. Nociceptor stimulation results in a lowered pain threshold, sustained afferent stimulation (i.e. facilitation), reflex paraspinal musculature hypertonicity and abnormal neurologic reflexes.

The goal of chiropractic treatment is to restore normal joint motion, stimulate neurologic reflexes and to reduce pain and muscle hypertonicity. Multiple theories have been proposed and tested over the years to explain the pathophysiology of vertebral segment dysfunction and its interactions and influences on the neuromusculoskeletal system.[119,121] Chiropractic treatment is thought to affect mechanoreceptors (i.e. Golgi tendon organ and muscle spindles) to induce reflex inhibition of pain and reflex muscle relaxation and to correct abnormal movement patterns.[47,122] Anecdotal evidence and clinical experience suggest that chiropractic is an effective adjunctive modality for the diagnosis and conservative treatment of select musculoskeletal-related disorders in horses.[123,124] However, therapeutic trials of chiropractic manipulations are often used since we currently have limited formal research available about the effectiveness of chiropractic procedures in equine practice.

During treatment, a 'release' or movement of the restricted articulation is often palpable. An audible 'cracking' or 'popping' sound may also be heard during chiropractic treatment as the applied force overcomes the elastic barrier of joint resistance.[125,126] The rapid articular separation produces a cavitation of the synovial fluid.[127] In humans, radiographic studies of synovial articulations after manipulation have shown a radiolucent cavity within the joint space (i.e. vacuum phenomenon) that contains 80% carbon dioxide and lasts for 15–20 minutes. A second attempt to recavitate the joint will be unsuccessful and potentially painful until the Intra-articular gas has been reabsorbed (i.e. refractory period). The static position of the vertebral or sacroiliac joints in humans has been studied before and after manipulation by roentgen stereophotogrammetric analysis, which allows precise measurements of three-dimensional articular movement.[128] Static palpation changes were noted before and after manipulation, but no changes were seen with the roentgen stereophotogrammetric analysis. Therefore, soft tissue responses such as joint capsules, muscles, ligaments, tendons and postural neuromuscular reflex patterns should be the focus of future spinal manipulative studies and not articular malpositioning (i.e. bone out of place).[128]

Indications

The principal indications for equine chiropractic evaluation are back or neck pain, localized or regional joint stiffness, poor performance and an altered gait that is not associated with overt lameness. A thorough diagnostic work-up is required to identify soft tissue and osseous pathology, neurologic disorders or other lameness conditions that may not be responsive to chiropractic care. The primary clinical signs that equine chiropractors look for are localized musculoskeletal pain, muscle hypertonicity and restricted joint motion. This triad of clinical signs can be found in a variety of lower limb disorders, but is most evident in neck or back problems. Chiropractic care can help manage the muscular, articular and neurologic components of select musculoskeletal injuries in performance horses. Musculoskeletal conditions that are chronic or recurring, not readily diagnosed or are not responding to conventional veterinary care may be indicators that chiropractic consultation is needed. Chiropractic care is usually contraindicated in the acute stages of soft tissue injury. However, as the soft tissue injury heals, chiropractic has the potential to help restore normal joint motion, thus limiting the risk for future reinjury.[43] Chiropractic care may provide symptomatic relief in early degenerative joint disease if related to joint hypomobility and subsequent joint degeneration. Chiropractic is usually much more effective in the early clinical stages of disease versus end-stage disease where reparative processes have been exhausted.

Contraindications

Chiropractic is not a 'cure all' for all back problems and is not suggested for treatment of fractures, infections, neoplasia, metabolic disorders or non-mechanically related joint disorders. Acute episodes of sprains or strains, degenerative joint disease or impinged spinous processes are also relative contraindications for chiropractic treatment. All neurologic diseases should be fully worked up to assess the potential risks or benefits of chiropractic treatment. Serious diseases requiring immediate medical or surgical care need to be ruled out and treated by conventional veterinary medicine before routine chiropractic treatment is begun. However, chiropractic care may contribute to the rehabilitation of most postsurgical cases or severe medical conditions by helping in the restoration of normal musculoskeletal function. Chiropractic care cannot reverse severe degenerative processes or overt pathology.

Acupuncture

Mechanism of action

Acupuncture involves the insertion of fine needles into specific predetermined locations (i.e. acupuncture points) to produce therapeutic effects.[129] Acupuncture points are often chosen within the same dermatome as the lesion or condition being treated, as well as local tender or painful sites, points cranial or caudal, proximal or distal to the localized lesion.[130] Additional methods of stimulation include acupressure, aquapuncture, electrostimulation and low-level laser therapy. Theoretically, each acupuncture point, or combination of points, has specific therapeutic actions when stimulated.

The primary benefit of acupuncture for back problems is pain management via opioid (i.e. enkephalin and β-endorphin) and non-opioid (e.g. serotonin) pathways.[130] Pain relief is often immediate, but may have variable durations of effectiveness, depending on the type and severity of musculoskeletal dysfunction. Acute injuries often respond rapidly and require fewer treatment sessions, whereas chronic musculoskeletal conditions may require periodic or long-term treatment. Acupuncture is often the treatment of choice for trigger points, which are localized tight, painful bands of muscle at characteristic locations within large muscle groups, particularly the middle gluteal muscle.

Indications

Clinical studies and experimental reports indicate that acupuncture is a safe and effective modality for specific musculoskeletal conditions if used properly.[129] Disease conditions managed by acupuncture include trauma, osteoarthritis and muscle hypertonicity.[131] Pain is the primary indication for acupuncture in horses with back problems.[132] Acupuncture does not have any known direct effects on reducing joint stiffness, as do manual therapies. Therefore, synergistic effects are often obtained with combined chiropractic and acupuncture treatment that cannot be obtained consistently with either modality by itself. The immediate pre-race use of acupuncture is banned by many racing jurisdictions and athletic organization regulations due to its potential misuse of analgesic properties.

Contraindications

There are few specific contraindications for acupuncture since the majority of medical and surgical conditions have associated indications for acupuncture. Fractures, active infections and bleeding tendencies are relative contraindications. Risks and complications associated with needle placement include infection, puncture of organs or pneumothorax. Solid needles or aquapuncture are often recommended over the thoracolumbar region due to the risk of breaking off a portion of the needle within the epaxial muscles from the action of the thoracolumbar fascia on the needle.

Physical therapy

Mechanism of action

Physical therapy modalities that may have direct application to back problems in horses include devices that apply electrical currents for pain control or neuromuscular rehabilitation; thermal modalities (i.e. superficial and deep heat or cold applications) for influencing inflammatory mediators, collagen extensibility and altering nerve conduction; and mechanical approaches (e.g. massage, vibration, stretching and training exercises) for maximizing musculoskeletal rehabilitation.

Indications

In the absence of trauma or documented pathologic findings, the primary goal of treatment should address restoration of function and prevention of future disability.[43] Management should be systematically and methodically directed toward developing co-ordination and proprioception, flexibility, strength and endurance. The negative effects of immobilization and deconditioning should be minimized with early mobilization and controlled activity. Increased mobility is addressed with joint mobilization and muscle stretching.[133] Altered movement patterns are addressed with co-ordination via proprioceptive retraining, postural re-education, muscle strengthening and endurance training.[43]

The primary indications of physical therapy for back or pelvic problems include localized or generalized pain, joint motion restrictions and altered back muscle tonicity.[134] Pain modulation can be provided by influencing inflammatory mediators, altering pain perception and transmission, and increasing β-endorphin levels. Physical therapy modalities involved in pain control include electrical stimulation (i.e. muscle stimulation, transcutaneous electrical nerve stimulation (TENS)), the application of hot or cold, mechanical vibration and electromagnetic modalities. Soft tissue and articular motion restrictions (i.e. stiffness) can be directly addressed with specific stretching exercises to induce creep and stress relaxation within fibrotic or shortened periarticular soft tissues.[135] With minimal training, horses and their owners can be taught how to do simple but effective passive joint mobilization and active stretching exercises (i.e. carrot stretches) to improve both axial skeleton and limb flexibility.[136] Cryotherapy (i.e. ice packs or ice massage) is indicated in the first 24–48 hours post injury to reduce pain, induce muscle relaxation and reduce inflammation. The application of heat or electrical stimulation can provide increased soft tissue extensibility, reduced inflammation and adhesion formation, and pain control to help facilitate the restoration of normal joint motion.[120]

Abnormal muscle tone can be addressed with modalities that increase or decrease muscle contractility or coactivation and nerve conduction or inhibition. Some of these modalities include hydrotherapy, electrical stimulation and rehabilitative exercises that specifically address issues of reduced flexibility, coordination, strength and endurance. In humans, anti-inflammatories and other drugs can be delivered into superficial soft tissues via electrical currents (i.e. iontophoresis) or via mechanical sound waves (i.e. phonophoresis). However, preliminary equine research indicates that a heavy hair coat, thick skin and deep articular structures may limit the overall effectiveness of these novel drug delivery systems for back problems.

Contraindications

Contraindications for massage include active skin lesions, open wounds, acute inflammation or persistent muscle hypertonicity (i.e. exertional rhabdomyolysis).[137] Contraindications for electrical modalities include active skin lesions, open wounds, pain of unknown origin or pain conditions where masking the pain may be detrimental (e.g. pre-race).[138] Contraindications for superficial or deep heating modalities include acute injury or inflammation, open wounds, recent or potential hemorrhage, neoplasms or impaired sensation.[120] Precautions or contraindications for cryotherapy include open wounds, vascular compromise or peripheral vascular disease due to the induced vasoconstriction produced by the ice.[120]

Future areas of research

In horses with back pain, specific functional pathologies that need to be addressed in addition to initial pain relief include trigger points, hypertonic muscles, weak muscles, abnormal movement patterns and joint dysfunction. Compared to their human counterparts, veterinarians and equine athletes often have a very limited selection of options for the treatment of musculoskeletal disorders. Currently, we do not have objective measurement or rehabilitation tools to specifically assess soft tissue or articular pain, reduced flexibility and joint stiffness, muscle hypertonicity, trigger points or alterations in proprioception or co-ordination associated with musculoskeletal or nerve dysfunction. Normal kinematics of the thoracolumbar spine have been investigated[8,9,11,139,140] but continued work needs to be done to assess segmental vertebral motion and its response to specific and defined articular and soft tissue injuries. Objective measures of spinal stiffness have been investigated[141] but the effects of pain, muscle hypertonicity, articular process osteoarthritis and concurrent lameness have not been explored.

Functional outcome measures assess how well a horse is able to do the job asked of it (e.g. speed, flexibility, coordination, strength and endurance). Quantitative assessments of pain include the use of a 0–10 pain scale, algometry or pain pressure threshold measurements, and mapping areas of pain. A 0–10 visual analog scale or pain scale is easy to use and provides a semi-objective means of following pain, dysfunction, performance or any other musculoskeletal parameter either immediately before and after treatment or over several days or weeks of treatment. Measurements can be compiled independently by both the owner and the veterinarian, with similarities or differences evaluated.

Other areas of musculoskeletal treatment that need further scientific investigation include well-defined, scientifically validated strength and endurance training programs tailored for the unique athletic demands of the various equestrian events. It is hoped that new insights into measuring musculoskeletal dysfunction and the pathophysiology of chronic pain syndromes will assist in assessing the effectiveness of many of the traditional and complementary modalities currently applied to horses with the rationale of reducing morbidity and improving overall performance in our elite equine athletes.

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