Efficacy of Manual Therapies in the Treatment of Thoracolumbar Dysfunction

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The realm of manual therapy includes diagnostic and treatment methods from a diverse array of healthcare professions, which include touch therapies, massage, physical therapy, osteopathy, and chiropractic methods. All of these techniques were originally developed for use in humans and subsequently, have been applied to horses. All forms of manual therapy have variable reported levels of effectiveness for treating musculoskeletal issues in humans. Currently, there is only limited evidence supporting the effectiveness of massage, spinal mobilization, and manipulation in reducing pain and muscle hypertonicity and increasing spinal mobility in horses. Author’s address: Gail Holmes Equine Orthopaedic Research Center, Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523; e-mail: Kevin.Haussler@ColoState.edu. © 2011 AAEP.

1. Introduction

The use of touch, massage, or manipulation of painful articulations or tense muscles is arguably one of the oldest and most universally accepted forms of therapy to relieve pain and suffering.1 Firmly grasping an acutely injured thumb after a misdirected hammer blow or rubbing a sore muscle or stiff joint after a long day’s work are simple and often effective methods of providing short-term pain relief in humans. Similarly, animals lick, scratch, or rub wounds or areas of irritation in an apparent attempt to reduce pain and suffering. Horses are known to respond favorably to grooming, stretch, roll on their backs, and rub up against objects, presumably because these activities provide some sense of comfort. Over time, both lay and licensed practitioners have developed a spectrum of manual methods, which involve the application of the hands to the body, with a therapeutic intent.2 Chiropracty, osteopathy, physical therapy, massage therapy, and touch therapy all use forms of manual therapy, which have been developed for the diagnosis and treatment of musculoskeletal disorders in humans and transferred for use in horses. Abdominal and rectal palpation, soft-tissue and bony palpation of musculoskeletal structures, or movement of an articulation through its expected range of motion are considered essential diagnostic manual techniques that are used routinely in veterinary medicine. The goal of manual therapy is to restore normal joint motion, stimulate neurological reflexes, and reduce pain and muscle hypertonicity. Comparisons of sensitivity to palpation, muscle tone, and joint motion are made before and after treatment to evaluate the response to and effectiveness of manual therapy. Therapeutic effects may be generalized to the entire body by inducing relaxation or altering behavior; regional effects may include alterations in pain perception or neuromuscular control, or effects may be localized to specific tissues and cellular responses.2
Challenge is in selecting the most appropriate and effective form of manual therapy to produce the desired physiological effect within an individual patient, such as increasing joint range of motion, reducing pain, or promoting general body relaxation. Anecdotally, all forms of manual therapy have reported levels of effectiveness in humans and horses. Unfortunately, most of these claims have not been supported by high levels of evidence such as randomized, controlled trials or systematic reviews of the literature. However, considerable advances have been made in conducting investigations into plausible mechanisms of action and assessing the clinical efficacy of manual therapies. The purpose of this article is to review the scientific literature for evidence of efficacy, safety, and common mechanisms of action of massage, soft-tissue and joint mobilization, and spinal manipulation, with specific focus on the thoracolumbar region and potential translational applications for treating equine back pain and dysfunction.

2. Diagnosis of Back Problems

Owners or trainers often complain that their horse has back problems. Veterinarians also frequently describe a horse as having poor performance, nonlocalized lameness, or altered gait of some sort, and therefore, they provide a diagnosis of possible back problems. Unfortunately, the use of the term back problems is very nonspecific and is comparable with terms like colic, lameness, skin problems, and “ain’t doing right”. However, with proper diagnostics (e.g., abdominocentesis, serum chemistries, exploratory surgery, nerve and joint blocks, or skin biopsies), a definitive diagnosis can often be provided for the ailment of interest. Regrettably, the diagnosis of a back problem in both humans and horses is neither straightforward nor definitive. Horses with back pain often present with vague signs of poor performance, lack of impulsion, stiffness, or avoidance of tack.3,4 Even with recent advances in high-tech diagnostic imaging, approximately 90% of human patients have no identifiable cause of their back pain and are subsequently categorized as having nonspecific back pain.5 The probability that a human back pain patient has a specifically related radiographic finding is less that 1%, which provides little guidance to the development of treatment options.6 The basic elements of joint or spinal dysfunction include altered articular neurophysiology, local biochemical alterations, pathological changes within the joint capsule, and articular degeneration, which are all difficult to diagnose or image within the axial skeleton.

Another factor contributing to the problem of definitive diagnosis is the poor correlation between structural changes identified on diagnostic imaging and actual functional capabilities. A common example is the radiographic diagnosis of impinged dorsal spinous processes in horses. Severe proliferative and sclerotic changes may be present at multiple vertebral levels; however, the affected horse is able to continually perform at a high level of athletic activity.7 Conversely, a horse may have mild signs of impinged spinous processes with small lytic areas confined to only one or two intervertebral sites, which seemingly cause severe functional limitations. Despite my hope for the future use of routine magnetic resonance imaging (MRI) and computed tomography (CT) imaging of the adult equine axial skeleton and pelvis, it may be unlikely that the prevalence of definitive diagnosis of back or sacroiliac joint pain in horses will be any higher than those diagnoses reported in humans with similar conditions. Anecdotally, some equine spinal imaging centers claim that they can identify significant spinal lesions in up to 75% of cases presented for back problems using radiographs, ultrasound, and nuclear imaging. However, a definitive diagnosis cannot be established by using diagnostic imaging alone without the use of small amounts of local anesthetic placed adjacent to sites of perceived clinically significant pathology and the immediate return to a prior level of functional athletic performance.

Given the above situation, the equine profession is not in a position of being able to make substantial advances in the diagnosis of structural or functional causes of back problems. However, if we begin to consider back problems as a syndrome characterized by pain, muscle hypertonicity, and stiffness (all of which can be somewhat objectively measured), then we can make substantial diagnostic and therapeutic advances in the profession. A syndrome refers to the association of several clinically recognizable features that often occur together, and the presence of one of these features should alert the examiner to the possibility of the development or finding of other clinical signs. Some of these clinical signs are considered major signs, which are essential to the diagnosis; others are considered minor signs, which may or may not be present. A syndrome can also refer to a set of detectable characteristics where the reason for their common occurrence has not yet been discovery (i.e., pathophysiology). In equine practice, there are many identifiable syndromes, some of which include head shaking, wobbler’s disease, stringhalt, shivers, tying up, and cauda equina syndrome. As medical progress continues, the etiology of many syndromes can be identified as a single causative agent (e.g., glycogen synthase mutation contributing to polysaccharide storage myopathy).8 After a distinct etiology has been identified, then specific treatment or management protocols can be developed for that syndrome or seemingly unrelated collection of signs.

The formal description of a syndrome typically specifies the minimum number of major and minor findings that are required for a diagnosis. The cardinal signs of acute inflammation include swelling, heat, altered function, redness, and pain. In chronic spinal dysfunction, the most common clinical signs include chronic pain (e.g., hyperalgesia or
alldynia because of peripheral or central sensitization) and altered function, which are characterized by thoracolumbar stiffness and muscle hypertonicity. Therefore, major findings characteristic of the back problem syndrome in horses are localized thoracolumbar pain, epaxial muscle hypertonicity, and intervertebral stiffness combined with a general history of poor performance. Pain can often be localized with detailed palpation of specific soft-tissue or bony landmarks within the axial skeleton. Muscle hypertonicity is often palpable within regions of the longissimus or middle gluteal muscles. Stiffness may be caused by fibrosis, muscle guarding, or osteoarthritis, and it can often be localized to certain spinal regions or vertebral segments during combinations of flexion and extension, lateral bending, and axial rotation. Minor or inconsistent clinical signs of back pain may include altered spinal conformation (e.g., lordosis or kyphosis), asymmetric sweat patterns under the saddle, resentment to grooming, tail swishing with girth tightening, reluctance to backing, or abnormal temperament (e.g., biting or bucking). For us to advance as a profession, we need to begin to characterize back problems in terms of the presence, location, gradation, and specific tissues showing signs of pain, muscle hypertonicity, and stiffness. This characterization will allow the development of focused treatment and rehabilitation programs for horses with varying degrees of spinal dysfunction.

3. Spinal Examination

The principle goals of the manual therapy evaluation are to identify if a musculoskeletal problem exists and localize the injury to either soft-tissue, articular, or neurologic structures. Orthopedic and neurologic evaluations are important adjunctive assessments used to identify common causes of limb lameness, spinal injuries, and neurological disorders that are more appropriately and effectively treated with traditional medical or surgical approaches. Manual therapy evaluation and treatment is not a substitute for a thorough lameness examination and diagnostic imaging. However, horses with conditions not readily diagnosed using traditional modalities or concurrent lameness and spinal dysfunction may benefit from a thorough manual therapy evaluation. Some horses present with vague or overlapping signs of neurologic disease and musculoskeletal pain, which may be differentiated with a detailed axial skeleton evaluation. The spinal examination also helps to identify and differentiate signs of acute and chronic spinal dysfunction and localize pain, stiffness, or muscle hypertonicity to a few vertebral segments or an entire vertebral region.

The challenge, as with any musculoskeletal injury, is to identify the specific musculoskeletal structures affected and quantify the associated disability or altered function present. Palpation is used to localize and identify soft-tissue and osseous structures for changes in texture, tissue mobility, or resistance to pressure. Pain’s response to being approached and its anticipation of palpation is often used as a behavioral indication of potential back pain or hypersensitivity. Soft-tissue layers are evaluated from superficial to deep by increasing digital pressure and focusing attention to specific tissues or structures with discrete palpatory movements. The shapes of superficial landmarks, transitions between structures, and attachment sites are also palpated. Soft-tissue texture and mobility can be compared between the skin, subcutaneous tissue, thoracolumbar fascia, and epaxial musculature.

The evaluation of muscle begins with observation and palpation of the neck, trunk, and proximal limb musculature for development and symmetry. Epaxial muscle development within the neck, trunk, and pelvis is assessed by laying a hand transversely across the spinal or gluteal musculature. Horses with exceptional spinal muscle development have a palpable uniform convexity or outward curvature of the muscles along the entire length of the vertebra column from the poll to the scapula, along the trunk, over the croup, and down the caudal aspect of the thigh. Deconditioning or poor flexibility may contribute to epaxial muscles with the thoracolumbar that are palpably flat between the dorsal spinous processes medially and the ribs laterally. Horses with chronic back pain or poor-fitting saddles will have a palpable concavity or inward curvature of the epaxial muscles at the withers or along the trunk and pelvis. Asymmetries in epaxial muscle development may be palpable cranial to caudal, medial to lateral, or left to right within the axial skeleton. The epaxial and pelvic musculature is further evaluated from superficial to deep with detailed palpation to identify areas of abnormal muscle tonicity, pain, or fasciculations. Muscle hypertonicity is the most commonly palpable abnormality in horses with acute or chronic back problems and can have either neural or myopathic origins. Muscle hypertonicity may affect a small portion of a muscle (i.e., trigger point), an entire muscle belly, or a regional group of muscles. In general, localized muscle hypertonicity is considered indicative of a primary back problem, whereas regional or generalized longissimus muscle hypertonicity is often associated with chronic pelvic limb lameness or systemic disease.

Osseous palpation involves evaluating bony structures for pain, morphology, asymmetries, and alignment. Individual thoracolumbar and sacral spinous processes are palpated for a painful response to firm digital pressure. Typical signs of discomfort include avoidance reactions such as rapid elevation of the head, extension of the back or withers away from the applied pressure, or localized secondary muscle spasms, which are indicative of local injury or impinging spinous processes. Pressure algometry of osseous landmarks provides an
objective measure of mechanical nociceptive thresholds and allows for monitoring of the efficacy of treatment protocols. During induced kyphosis, the abaxial borders of each individual thoracolumbar spinous process and the overlying supraspinous ligament are palpated for pain, thickening, or deviation from midline. Palpable deviations of individual spinous processes are common but are typically not associated with spinous process fracture or vertebral malposition (i.e., bone out of place), which is commonly thought.

A complete spinal examination includes assessment of active and passive joint ranges of motion. Abnormal active joint motion is characterized by weakness, incoordination, asymmetry, and restricted or excessive joint movements. The willingness, coordination, and amount of vertebral or limb segment motion is compared bilaterally, and left to right range of motion asymmetries are documented. Active joint range of motion of the axial skeleton is evaluated during normal daily activities (e.g., lying to standing movements or locomotion) or during induced vertebral movements while using a carrot or other treat to produce active movements of the head, neck, or trunk. Similar procedures can be used therapeutically as active stretching exercises to increase neck or trunk range of motion or develop coordination and strength of the muscles responsible for trunk stabilization. Normal vertebral movements consist of varying amounts and combinations of flexion, extension, left and right lateral bending, and left and right axial rotation. In comparison, active joint motion within most equine limb articulations consists almost exclusively of flexion and extension, with occasional joints capable of undergoing small amounts of internal or external rotation.

Passive joint range of motion is evaluated by measuring the amount and characteristics of joint motion beyond the active range of joint motion. Assessing passive range of joint motion requires patient cooperation and muscular relaxation as each articulation is moved passively throughout its unique ranges and directions of motion. The goal of palpating joint movement is to evaluate qualitative characteristics of overall joint motion, initiation of resistance to induced motion and end range of motion (i.e., joint end feel), and quantity or amplitude of joint motion present. Similar palpatory findings can be identified in soft tissues, such as skin, connective tissue, muscles, or ligaments. Passive joint range of motion is evaluated to characterize whether a particular movement is normal, restricted, or hypermobile. Evaluation of passive joint range of motion within the axial skeleton begins at the head and continues to the tip of the tail. In the thoracolumbar region, individual spinous processes are manually deviated from midline and monitored for signs of reduced vertebral motion, localized or generalized pain response, and induced muscle hypertonicity. Segmental and regional spinal motion is also evaluated in lateral bending and flexion and extension for similar signs of spinal dysfunction. Normal lateral bending range of motion is maximal at the midthoracic region and gradually diminishes to the lumbosacral junction. Conversely, induced flexion and extension are minimal within the thoracic region, and amplitudes gradually increase to the lumbosacral junction, which is the site of maximal flexion and extension range of motion.

4. Normal Joint Mechanics

The use of palpation techniques to quantitatively and qualitatively assess joint motion requires an understanding of joint mechanics. Joint motion can be categorized into three zones of movement: physiologic, parapathologic, and pathologic. The physiological zone of movement includes both active and passive joint motion within all possible directions of movement (e.g., flexion, extension, lateral bending, and axial rotation). Active range of motion is characterized by the amplitude and quality of voluntary joint movements (e.g., flexion and extension) produced by active muscle contractions. Vertebral range of motion in left and right lateral bending or axial rotation is typically distributed symmetrically about a neutral joint position; however, joint ranges of motion in flexion versus extension at certain vertebral levels or limb articulations may be quite asymmetrical. Passive joint range of motion can be assessed only with the application of external articular forces. The transition between the limit of active range of motion and the beginning of induced passive joint motion is termed the physiologic limit of joint motion. Passive joint motion can occur beyond the range of voluntary joint movements and is often the site where joint mobilization and stretching exercises are applied.

Passive movement of an articulation from a neutral joint position first involves evaluating the range of joint motion that has minimal, uniform resistance. As an articulation is moved to the end range of passive joint motion, there is a gradual increase in the resistance to movement that terminates at an elastic barrier (i.e., joint end feel). Normal joint end feel is initially soft and resilient, and it gradually becomes more restrictive as the limits of joint range of motion are reached. A pathologic or restrictive end range of motion is palpable earlier in passive joint movement and often has an abrupt or painful end feel when compared with normal joint end feel. Joint end feel is often evaluated by bringing an individual articulation to tension and applying rhythmic oscillations to qualify the resistance to movement. Each articulation within the body has unique palpatory end feels for each of the directions of joint motion (e.g., flexion, extension, lateral bending, etc.). The goal of palpating passive joint movement is to evaluate each articulation of interest for the quality of joint motion, the initiation of resistance to motion and type of end feel, and the
Joint mobilization and manipulation are two types of induced articular movements used in musculoskeletal rehabilitation to restore joint mobility and reduce pain. Mobilization is characterized as repetitive joint movements induced within the normal physiological range of joint motion. Joint manipulation involves the application of force to bring an articulation to end range of motion and then, the application of a thrust or impulse to move the articulation of interest beyond the elastic barrier and into the paraphysiological zone with the intent of stimulating both mechanical and neurophysiologic mechanisms. The paraphysiological zone is contained within the elastic and anatomical limits of an individual joint. Joint motion into the paraphysiological space occurs only with the application of high-velocity forces associated with joint manipulation or unguarded joint movements. The anatomical barrier of the joint marks the junction between the paraphysiological and pathologic zones of movement. The pathologic zone of joint motion is characterized by the application of excessive forces or joint trauma, which causes an articulation to move beyond its anatomical limits and results in mechanical disruption of intra- and periarticular structures and subsequent joint instability or luxation.

5. Mechanism of Action

Manual therapy is considered to produce physiologic effects within local tissues, on sensory and motor components of the nervous system, and at a psychological or behavioral level. Each manual therapy approach has a unique origin and different proposed biomechanical or physiological effect; however, all forms of manual therapy are characterized by applying variable gradations of manual force and degrees of soft-tissue or articular displacement. It is likely that specific manual therapy techniques are inherently more effective than others in addressing local, regional, or systemic components of spinal dysfunction. The challenge is in choosing the most appropriate form of manual therapy or combination of techniques that will be efficacious for an individual patient with a specific set of musculoskeletal disabilities. If soft-tissue restriction and pain are identified as the primary components of a musculoskeletal injury, then massage, stretching, and soft-tissue mobilization techniques may be indicated for increasing tissue extensibility. However, if the musculoskeletal dysfunction is localized to articular structures, then stretching, joint mobilization, and manipulation are the most likely indicated manual therapy techniques needed for restoring joint range of motion and reducing pain.

Local tissue effects produced by manual therapy techniques relate to direct mechanical stimulation of skin, fascia, muscles, tendons, ligaments, and joint capsules. Mechanical effects can also influence the vasculature, lymphatics, and synovial fluid. Direct mechanical loading of tissues can alter tissue healing, physical properties of tissues (e.g., elongation), and local tissue fluid dynamics associated with extravascular or intravascular fluids. Normal tissue repair and remodeling relies on mechanical stimulation of cells and tissues to restore optimal structural and functional properties, such as tensile strength and flexibility. Nonspecific back pain is most likely related to a functional impairment and not a structural disorder; therefore, many back problems may be related to muscle or joint dysfunction with secondary soft-tissue irritation and pain generation. Soft-tissue contractures and adhesions are unwanted effects associated with musculoskeletal injuries and post-surgical immobilization. Stretching exercises or direct mechanical mobilization of the affected tissue can be used to elongate contracted or fibrotic connective tissues to improve soft-tissue extensibility and increase joint range of motion. Tissue viability is highly dependent on its vascular and lymphatic supply, which is often compromised because of mechanical disruption or ischemia. Soft-tissue or joint mobilization may facilitate flow to and from the affected tissues, help to reduce pain and edema, and decrease joint effusion. Joint manipulation can improve restricted joint mobility and may reduce the harmful effects associated with joint immobilization and joint capsule contractures. Limb and joint mobilization can also have direct mechanical effects on nerve roots and the dura mater, which may have clinical application in the treatment of perineural adhesions and edema.

Tissue manipulation has the additional effect of stimulating regional or systemic changes in neurologic signaling related to pain processing and motor control. Manual therapy can provide effective management of pain and neuromuscular deficits associated with musculoskeletal injuries, alterations in postural control, and locomotor issues related to antalgic or compensatory gait. In response to chronic pain or stiffness, new movement patterns are developed by the nervous system and adopted in an attempt to reduce pain or discomfort. Long after the initial injury has healed, adaptive or secondary movement patterns may continue to persist, which predispose adjacent articulations or muscles to injury. Activation of proprioceptors, nociceptors, and components of the muscle spindles provide afferent stimuli that have direct and widespread influences on components of the peripheral and central nervous systems, which directly regulate muscle tone and movement patterns. The various forms of manual therapy are thought to affect dif-
different aspects of joint function through diverse mechanical and neurologic mechanisms. Alterations in articular neurophysiology from mechanical or chemical injuries can affect both mechanoreceptor and nociceptor function through increased joint capsule tension and nerve-ending hypersensitivity. 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. Touch and light massage preferentially stimulate superficial proprioceptors, whereas any technique that involves deep-tissue massage, stretching, muscle contraction, or joint movement has the potential to stimulate deep proprioceptors. Massage, stretching, and joint mobilization are also considered to affect more superficial epaxial muscles, such as the longissimus muscle, and have a multisegmental effect. In contrast, manipulation preferentially stimulates mechanoreceptors within deep multifidi muscles and has a more segmental focus. Joint manipulation can affect mechanoreceptors (i.e., Golgi tendon organ and muscle spindles) to induce reflex inhibition of pain and muscle relaxation and correct abnormal movement patterns. Because of somatovisceral innervations, mobilization and manipulation within the trunk have possible influences on the autonomic system and visceral functions; however, the clinical significance and repeatability of these effects are largely unknown.

The effects of touch or massage on psychological issues, such as behavior or emotion, are often dismissed as an insignificant component of the overall healing process in patients. Promoting general body relaxation and reducing anxiety may be significant components of some treatment protocols. Behaviors related to pain, depression, or fear are associated with patterned somatic responses, which may be manifest as generalized changes in muscle tone, autonomic activity, or pain tolerance. Other psychological factors associated with manual therapies include placebo effects and patient satisfaction. Unfortunately, the role of placebo effects in horses and their owners is currently unknown.

6. Massage Therapy

Massage therapy is defined as the movement or manipulation of the skin and underlying soft tissues either manually (e.g., rubbing, kneading, or tapping) or with an instrument or machine (e.g., mechanical vibration) for therapeutic purposes. Massage techniques do not typically cause movement or changes in articular positioning and include many named methods such as Swedish massage, Rolfing, myofascial release, trigger point therapy, lymphatic drainage, and acupressure. The manual techniques employed in massage include effleurage, pétrissage, friction, kneading, and hacking, which often vary in the depth or speed of the applied pressure and the specific tissues or regions of interest. Massage is indicated for a wide variety of conditions in which pain relief, reduction of swelling, or mobilization of adhesive tissues are desired. Systematic reviews suggest that massage may be beneficial for subacute and chronic nonspecific low-back pain in humans, especially combined with exercises and education programs. There is moderate evidence that acupressure may be more effective than Swedish massage for chronic low-back pain. Unfortunately, the methodological quality of most massage studies is poor, which prevents definitive conclusions and recommendations. Additional research is needed to determine the individual massage techniques that are most indicated for specific musculoskeletal complaints, such as pain, localized muscle spasms, or stress and anxiety. Massage is generally recognized as a safe intervention with minimal adverse effects. However, deep friction, compression, or ischemic compression have been reported to produce temporary post-massage soreness or ecchymosis in humans. Massage is contraindicated for acute injuries, open wounds, and skin infections.

In horses, a single session of massage therapy has been shown to be effective for reducing heart rate and stress-related behavior and lowering mechanical nociceptive thresholds within the thoracolumbar region in actively ridden horses. Massage applied to preferred areas of allogrooming (i.e., mid-neck and withers) is reported to have the largest physiologic and behavioral effects. Massage has also been shown to be more effective than oral phenylbutazone (1 g, q 12 h for 7 days) in increasing thoracolumbar pain thresholds in non-back pain horses. A noncontrolled, clinical trial using eight horses measuring increased stride lengths at the walk and trot compared pre- and post-massage, but changes were not significant because of the small sample size. Manual and mechanical lymph drainage has been described for use in the management of chronic lymphedema in horses; however, no controlled studies exist that evaluate effectiveness. More high-quality, objective outcome-based evidence is needed to support the use of massage therapy in horses.

7. Soft-Tissue and Joint Mobilization

Mobilization is defined as manually or mechanically induced movement of articulations and associated soft tissues for both diagnostic and therapeutic purposes. Soft-tissue and joint mobilization is used diagnostically to subjectively assess the quality and quantity of the ease of joint motion, joint stability, range of motion, and joint end feel, which can provide insights into the biomechanical and neurologic features of an articulation. Goniometry is often used to objectively quantify and document the amount of flexion or extension present at an articulation. Soft-tissue and joint mobilization can also be used as a primary means of treating musculosk-
Clinical medicine has focused on restoring movement to the skin, connective tissue, ligaments, tendons, and muscles, with the goal of modulating pain, reducing inflammation, improving tissue repair, increasing extensibility, and improving function. Neural mobilization techniques have also been developed to induce movement within specific spinal or peripheral nerves and the dura mater in the postoperative rehabilitation of low-back pain, with the intent of reducing neural adhesions and edema. Joint mobilization is indicated in chronic stiffness or fibrosis and the restoration of normal joint range of motion.

Joint mobilization usually applied in a graded manner, with each grade increasing the range of joint movement. Grades 1 and 2 mobilizations are characterized by slow oscillations within the first 25–50% of the available joint motion, with the goal of reducing pain. Grades 3 and 4 mobilizations involve slow oscillations at or near the end of available joint motion, which are used to increase joint range of motion. Some soft-tissue and joint mobilization techniques may include a hold and stretch at the end range of motion. Gentle, low amplitudes of joint mobilization are recommended in acute pain or post-surgical conditions. Higher-amplitude joint mobilization is indicated in chronic stiffness or fibrosis and the restoration of normal joint range of motion.

Few formal studies exist to support the use of active soft-tissue or joint mobilization techniques in horses. Most mobilization studies in horses involve a period of inducing joint immobilization by a fixture or cast and then allowing the horse to spontaneously and the restoration of normal joint end feel. Joint mobilization is usually applied in a graded manner, with each grade increasing the range of joint movement. Grades 1 and 2 mobilizations are characterized by slow oscillations within the first 25–50% of the available joint motion, with the goal of reducing pain. Grades 3 and 4 mobilizations involve slow oscillations at or near the end of available joint motion, which are used to increase joint range of motion. Some soft-tissue and joint mobilization techniques may include a hold and stretch at the end range of motion. Gentle, low amplitudes of joint mobilization are recommended in acute pain or post-surgical conditions. Higher-amplitude joint mobilization is indicated in chronic stiffness or fibrosis and the restoration of normal joint range of motion.

Several studies have shown that manually applied forces and decreasing stiffness in actively ridden horses without clinical signs of back pain. These changes in spinal biomechanics are indicative of producing the beneficial effects of increased passive spinal mobility or flexibility and increased tolerance to pressure in the thoracolumbar region, which can be interpreted as a beneficial effect in any ridden horse with saddle- and ridden-induced pressures along the dorsal trunk.

8. Spinal Manipulation
Joint manipulation is characterized by the application of a high-velocity, low-amplitude (HVLA) thrust or impulse, which moves a joint beyond its physiological range of motion without exceeding the anatomical limit of the articulation. Spinal manipulation involves applying a controlled thrust or impulse to articular structures within the axial skeleton. The chiropractic and osteopathic professions both use HVLA thrusts to induce therapeutic effects in articular structures, muscle function, and neurological reflexes, with the goal of increasing joint range of motion and reducing pain and muscle hypertonicity. The therapeutic dosage of joint manipulation is varied by the number of vertebrae or articulations treated, amount of force applied, and frequency and duration of treatment. Unfortunately, there is no good scientific evidence on which to base optimal dosage recommendations for continued care; therefore, therapeutic trials are often used on an individual basis. In humans, high-dose manipulation is superior to low-dose manipulation for chronic low-back pain in the short term. Few studies have assessed the efficacy of preventative spinal manipulation for managing chronic low-back pain.

In horses, anecdotal evidence and clinical experience suggest that manipulation is an effective adjunctive modality for the conservative treatment of select musculoskeletal-related disorders. However, therapeutic trials of spinal manipulation are often used, because there is limited formal research available about the effectiveness of osteopathic or chiropractic techniques in equine practice. Equine osteopathic evaluation and treatment procedures have been described in textbooks and case reports, but no formal hypothesis-driven research exists. Human osteopathic techniques also include highly controversial methods associated with mobilizing cranial bones and abdominal viscera, which have questionable applications to horses. The focus of recent equine chiropractic research has been on assessing the clinical effects of spinal manipulation on pain relief, flexibility, muscle hypertonicity, and spinal motion symmetry. Obvious criticism has been directed at the physical ability to produce substantial segmental spinal motion that is comparable with findings reported in humans.

Two randomized, controlled clinical trials using pressure algometry to assess mechanical nociceptive thresholds (MNTs) in the thoracolumbar region of horses have shown that both manual and instrument-assisted spinal manipulation can reduce back pain (or increase MNTs). The effect of spinal manipulation on asymmetrical spinal movement patterns in horses with documented back pain suggests that chiropractic treatment elicits slight but significant changes in thoracolumbar and pelvic kinematics and that some of these changes are likely to be beneficial. Additional studies have assessed the effects of equine chiropractic techniques on increasing passive spinal mobility (i.e., flexibility) and reducing longissimus muscle tone. A single session of spinal manipulation in 10 horses with back pain produced increased ranges of spinal motion immediately after treatment, but spinal mobility was decreased 3 wk later compared with before treatment status.
propose that the decrease was caused by the recurrence of spinal dysfunction or temporary palliative effects of treatment, suggesting that some horses may require several treatments at intervals to achieve longer-term effects. A study comparing spinal mobilization with manipulation in horses reported that a single session of manipulation induced a 15% increase in displacement and a 20% increase in tolerance to manually applied force compared with mobilization, whereas spinal manipulation applied one time per week for 3 wk caused an increase of 40% in displacement, a 20% increase in applied force, and a 7% increase in stiffness. These findings support the theory that a series of spinal manipulation may be more effective than a single treatment session. Spinal manipulation is able to produce immediate and larger increases in displacement compared with spinal mobilization, which has a delayed effect of increasing spinal flexibility. These differences suggest two possibly different mechanisms of action for spinal mobilization and manipulation.

9. Biomechanical Considerations

The biomechanical characteristics of joint mobilization and manipulation include factors related to specificity, leverage, velocity, amplitude, direction, and tension applied to the articulation before treatment. Levers are used to increase mechanical advantage and assist in applying force to an articulation or body segment to induce joint motion. Long levers include using the limbs or head and neck as levers to induce spinal motion instead of the inducing motion at one or two individual vertebrae by using transverse or spinous processes as short-lever contacts. Velocity relates to the speed of the impulse applied to move a vertebra or body segment, and displacement is the distance over which the applied thrust is applied. Amplitude refers to the amount of force applied. With long-lever techniques, lower amplitudes of force are required to induce similar joint motion as short-lever contacts. However, the rationale for using short-lever techniques is to increase the specificity of the applied thrust, because a single vertebral process is contacted on the vertebra of interest with short-lever techniques. With long levers, it is likely that multiple articulations are included between the doctor’s contact and the body segment of interest, which produces a more generalized treatment effect. Using a specific contact is theorized to address a single articulation; however, studies on treatment effects indicate that specific contact techniques produce local as well as regional and systemic effects. The therapeutic dosage of joint mobilization or manipulation is also determined by the number of vertebrae or body segments treated and the frequency of the applied treatments.

The literature suggests that any stimulus that activates high-threshold receptors within the periarticular tissues has the potential to initiate unique neurologic reflexes associated with joint manipulation. It has been theorized that spinal manipulation preferentially influences a sensory bed, which in terms of anatomical location and function, is different from the sensory bed influenced by spinal mobilization techniques. Manipulation may particularly stimulate receptors within deep intervertebral muscles, whereas mobilization techniques most likely affect more superficial axial muscles. It has been reported that approximately 40 N force is required to activate mechanical and neurologic responses associated with spinal manipulation. In horses, peak forces measured during spinal mobilization vary from 200 to 400 N, whereas spinal manipulation varies from 400 N to 700 N (range, 100–350 N) recorded during mobilization of the human lumbar spine. Manually applied impulses applied to the human cervical and lumbar spine during manipulation range from 40 to 400 N and occur over 30–150 ms. In horses, peak forces measured during spinal manipulation can approach 700–800 N and produce similar force time profiles as found in humans. Because of body mass differences, the force required to mobilize the equine trunk would be expected to be higher than that of humans. However, the differences may be more related to applying vertical forces in a standing quadruped versus a prone human lying on a semi-rigid table.

Differences in the magnitude and rate of loading associated with mobilization versus manipulation are also likely to produce variable therapeutic effects because of the viscoelastic nature of the soft tissues surrounding the vertebral column. Joint mobilization typically induces low-force, low-velocity movements and large displacements. Mobilization of the human thoracic spine can produce 2–3 cm amplitude displacements, whereas manipulation typically induces 6–12 mm displacements. In horses, both mobilization and manipulation of the thoracolumbar spine can produce up to 2–3 cm amplitude displacements. It is hypothesized that the velocity of the applied force may actually be more important than the amplitude of the applied force.

10. Indications for Spinal Mobilization and Manipulation

Back pain is a common cause of poor performance in equine athletes. Unfortunately, medical and surgical treatment options are often limited for affected horses. Manual therapy has the potential to provide important diagnostic and therapeutic approaches for addressing equine axial skeleton problems that are not currently available in veterinary medicine. Most of the current knowledge about equine manual therapies has been borrowed from human techniques, theories, and research and applied to horses. Spinal mobilization is generally considered a more conservative or low-force technique applied in acute pain conditions, whereas ma-
Manipulation is theoretically considered a more specific and forceful type of manual therapy that has shown more beneficial effects for chronic neck or back pain in humans. Additional selection factors for considering mobilization versus manipulation include the technical training and skill of the practitioner, perceived risks versus benefits, presence of acute pain and inflammation, and pathoanatomic considerations. Joint mobilization is easier to apply, requires less psychomotor skills, has minimal risks, and can be used in the presence of acute pain and inflammation compared with manipulation. Manual therapy procedures are also dependent on the ability of the patient to relax and the patient's response to the applied force. Mobilization is performed within the patient's ability to resist the applied motion and therefore requires the full cooperation and relaxation of the patient. Spinal manipulation is characterized by forces applied outside of the physiological zone of joint motion; therefore, it is often difficult for patients to resist or guard against the applied impulse at end range of joint motion.

The indications for joint mobilization and manipulation are similar and include restricted joint range of motion, muscle spasms, pain, fibrosis, or contracted soft tissues. The principal indications for spinal manipulation are neck or back pain, localized or regional joint stiffness, poor performance, and altered gait that is not associated with overt lameness. A thorough diagnostic workup is required to identify soft-tissue and osseous pathology, neurologic disorders, or other lameness conditions that may not be responsive to manual therapy. Clinical signs indicative of a primary spinal disorder include localized musculoskeletal pain, muscle hypertonicity, and restricted joint motion. This triad of clinical signs can also be found in a variety of lower limb disorders; however, they are most evident in horses with neck or back problems. Clinical signs indicative of chronic or secondary spinal disorders include regional or diffuse pain, generalized stiffness, and widespread muscle hypertonicity. In these cases, additional diagnostic evaluation or imaging should be done to identify the primary cause of lameness or poor performance. Manual therapy may help in the management of muscular, articular, and neurologic components of select musculoskeletal injuries in performance horses. Musculoskeletal conditions that are chronic or recurring, not readily diagnosed, or not responding to conventional veterinary care may be indicators that manual therapy evaluation and treatment is needed. Manual therapy is usually more effective in the early clinical stages of disease processes versus end stage disease, where reparative processes have been exhausted. Joint manipulation is usually contraindicated in the acute stages of soft-tissue injury; however, mobilization is safer than manipulation and has been shown to have short-term benefits for acute neck or back pain in humans. Manipulation is probably more effective than mobilization for chronic neck or back pain and has the potential to help restore normal joint motion, thus limiting the risk of reinjury. Therapeutic trials are often used because of limited knowledge about the effectiveness for specific disease conditions or the duration of action of select manual therapies in horses. Additional studies need to assess the optimal dosage and frequency of treatments in horses with documented signs of back pain, epaxial muscle hypertonicity, and stiffness in an effort to develop standards of care in the use of equine manual therapies.

11. Contraindications

The contraindications for spinal mobilization and manipulation are often based on clinical judgment and are related to the technique applied and skill or experience of the practitioner. Few absolute contraindications exist for joint mobilization if the techniques are applied appropriately with specific attention to the patient’s response to the applied treatment. Manual therapy is not a cure all for all joint or back problems and is generally contraindicated in the presence of fractures, acute inflammatory or infectious joint disease, osteomyelitis, joint ankylosis, bleeding disorders, progressive neurologic signs, and primary or metastatic tumors. Joint mobilization and manipulation cannot reverse severe degenerative processes or overt pathology. Acute episodes of osteoarthritis, impinged dorsal spinous processes, and severe articular instability, such as joint subluxation or luxation, are often contraindications for manipulation. Inadequate physical or spinal examination and poorly developed manipulative skills are also contraindications for applying manual therapy. All horses with neurologic diseases should be evaluated fully to assess the potential risks or benefits of joint mobilization or manipulation. Cervical vertebral myelopathy occurs because of both structural and functional disorders. Static compression caused by vertebral malformation and dynamic lesions caused by vertebral segment hypermobility are contraindications for cervical manipulation; however, adjacent regions of hypomobile vertebrae may benefit from mobilization or manipulation to help restore joint motion and reduce biomechanical stresses in the affected vertebral segments. Life-threatening injuries or diseases requiring immediate medical or surgical care need to be ruled out and treated by conventional veterinary medicine before any routine manual therapy is initiated. However, manual techniques may contribute to the rehabilitation of most post-surgical cases or severe musculoskeletal injuries by helping to restore normal joint motion and function. Horses that have concurrent hock pain (e.g., osteoarthritis) and a stiff, painful thoracolumbar or lumbosacral vertebral region are best managed by addressing all areas of musculoskeletal dysfunction. A multidisciplinary approach entails combined medical treatment of the hock osteoarthritis and manual...
therapy evaluation and treatment of the back problem.

12. Adverse Effects

In humans, adverse effects or risks of complications associated with joint mobilization are minimal. Mobilization is considered safer than manipulation.90 One work suggests, given the higher risk of adverse reactions and lack of proven effectiveness of manipulation over mobilization, that manual therapists should consider conservative mobilization, especially in human patients with severe neck pain.85 In humans, most adverse events associated with spinal manipulation are benign and self-limiting.86 Potential mild adverse effects from properly applied manipulations include transient stiffness or worsening of the condition after treatment. Data from prospective studies suggest that minor, transient adverse events occur in approximately one-half of all patients during a course of spinal manipulative therapy.97,86 However, these mild adverse effects do not cause patients to stop seeking manipulative care. Mild adverse effects usually last less than 1–2 days and resolve without concurrent medical intervention. Severe complications after spinal manipulation are typically uncommon, and estimates of incidence range from 1 per 200,000 to 1 per 100 million manipulations in humans.82,89,90 The most common serious adverse events in humans are verteobasilar accidents, disk herniation, and cauda equina syndrome.97 However, there is no evidence of increased risk of verteobasilar artery stroke associated with chiropractic care compared with primary medical care.91 Although the complication rate of spinal manipulation is small, the potential for adverse outcomes must be considered because of the possibility of permanent impairment or death.92 The benefits of chiropractic care in humans seem to outweigh the potential risks.92 The risk of adverse effects associated with joint mobilization or spinal manipulation in horses is unknown but would likely follow similar rates of adverse effects if applied appropriately by licensed professionals. The apparent safety of spinal manipulation, especially compared with other medically accepted treatments for neck or low-back pain in humans, should stimulate its use in the conservative treatment of spinal-related problems.90,93 If an exacerbation of musculoskeletal dysfunction or lameness is noted after spinal manipulation, then a thorough reexamination and appropriate medical treatment should be pursued. If the condition does not improve with conservative care, referral for more extensive diagnostic evaluation or more aggressive medical treatment is recommended.

13. Future Studies

Additional research is needed to assess the effectiveness of specific manual therapy recommendations or combined treatments for management of back pain, muscle hypertonicity, stiffness, and select lameness issues. Additional studies are needed to objectively measure both the short- and long-term clinical effects of manual therapies and assess if and how these modalities can enhance athletic performance. More understanding of the local and systemic effects of mobilization and manipulation on pain reduction and tissue healing is also needed. New methods of objectively measuring musculoskeletal dysfunction and additional studies into the pathophysiolog of chronic pain syndromes are needed to help assess the effectiveness of manual therapies on reducing morbidity and improving overall performance in equine athletes.

14. Conclusion

A thorough knowledge of equine anatomy, soft-tissue, and joint biomechanics, musculoskeletal pathology, tissue-healing processes, and pain mechanisms is required to understand the basic principles and clinical application of the various forms of manual therapies. There is a notable lack of evidence for using touch, massage, and stretching exercises in horses. However, spinal mobilization and manipulation have been shown in several studies to be effective for reducing pain, improving flexibility, reducing muscle tone, and improving symmetry of spinal kinematics in horses. Because of potential misuse and safety issues, mobilization and manipulative therapies should be provided only by specially trained veterinarians or licensed human manual therapists.

References


