**Introduction to Equine Physical Therapy and Rehabilitation**

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**Key Words:**

**Physiotherapy; neuromotor control; sensorimotor; spine; pelvis; joints; horse-rider interaction; veterinarian-physiotherapist team**

**Abstract**

Physical therapy (physiotherapy, or PT) is an important allied health profession that was largely established following the wars and polio outbreaks that occurred at the beginning of the 20th century. PT can be broadly defined as the restoration of movement and function and includes assessment, treatment and rehabilitation. This review outlines the history, definition and regulation of PT, followed by the core scientific principles of PT. Since musculoskeletal physiotherapy is the predominant subdiscipline in equine PT, encompassing poor performance, back pain syndromes, other musculoskeletal disorders and some neuromuscular disorders, the sciences of functional biomechanics, neuromotor control and the sensorimotor system in the spine, pelvis and peripheral joints are reviewed. Equine PT also may involve PT assessment and treatment of riders. Incorporating a veterinarian-PT team in the investigation, management and rehabilitation of equine athletes and their riders adds a vital new dimension to equine sports medicine.

**Key Points**

* Physical therapy (physiotherapy, or PT) is an important allied health profession and can be broadly defined as the restoration of movement and function.
* Musculoskeletal physiotherapy is the predominant subdiscipline in equine PT, encompassing poor performance, back pain syndromes, other musculoskeletal disorders and some neuromuscular disorders.
* Underpinning musculoskeletal physiotherapy are the sciences of functional biomechanics, neuromotor control and the sensorimotor system in the spine, pelvis and peripheral joints.
* Equine PT also, importantly, must involve the assessment of the rider and horse-rider interaction, as well as the tack and training aides used.
* Incorporating a veterinarian-PT team in the investigation, management and rehabilitation of equine athletes add a vital new dimension to equine sports medicine.

**Introduction**

Physiotherapy (called physical therapy in some countries) or PT is an important allied health profession where physiotherapists contribute an essential part to the care of individuals. The profession addresses a broad range of conditions in the young to the aged and from the severely debilitated to the elite athlete. Depending on the country, the legally protected title varies and includes physiotherapist, physical therapist and chartered physiotherapist.

PT is an established, independent profession with an excellent reputation for evidence-based practice. Veterinarians have embraced PT and rehabilitation across the world and the last decade has witnessed the development of a close working relationship between veterinarians and physiotherapists. The American College of Veterinary Sports Medicine and Rehabilitation is a specialist college where veterinarian diplomates have an excellent working knowledge of the benefits of working with PTs in a multidisciplinary team to care for the sports horse during competition and rehabilitation following injury or disease. Since most PTs in most countries need to work via veterinary referral and veterinarians and their clients understand and are demanding the unique skills base of a professional animal PT, the veterinarian-PT multidisciplinary team has become the gold standard in equine sports medicine and rehabilitation.

This review will discuss the history and definition of PT (including animal PT) and the core principles of equine PT and its role in rehabilitation of horses.

**History of Physiotherapy**

PT is believed to have been practiced by physicians like Hippocrates and Galen from around the 5th century BC who advocated massage, manual therapy and hydrotherapy to treat people [1,2]. In the subsequent centuries, the benefits of remedial exercise, hydrotherapy and massage were known and practised by relatively few. The earliest documented origins of PT as scientifically based profession date back to Per Henrik Ling, ‘Father of Swedish Gymnastics’ who founded the Royal Central Institute of Gymnastics (RCIG) in 1813 for massage, manipulation, and exercise [2]. In 1887, PTs were given official registration by Sweden’s National Board of Health and Welfare[[1]](#footnote-1). Other countries soon followed including Great Britain which founded its first professional PT society in 1894, and was awarded its Royal Charter in 1920[[2]](#footnote-2) (the Chartered Society of Physiotherapy), Australia in 1906, with the formation of The Australian Physiotherapy Association[[3]](#footnote-3) and the United States in 1917 following both an outbreak of poliomyelitis and the first world war and the subsequent need for rehabilitation [3]. The profession was established as The American Physical Therapy Association (APTA) in 1921.

As PT has progressed so has the database of information and journals specific to the area. The profession has its own PT evidence database (PEDro[[4]](#footnote-4)) of over 31,000 randomised trials, systematic reviews and clinical practice guidelines in physiotherapy. Of relevance to animal PT is that much of the human research has been developed based on animal models, especially the cat (for example, spinal cord injury and rehabilitation models, [4]), dog (for example, electrotherapies, [5]) and pig (for example, back pain models, [6]).

The profession is now represented internationally by the World Confederation for Physical Therapy (WCPT) that ‘believes every individual is entitled to the highest possible standard of care…underpinned by sound clinical reasoning and scientific evidence[[5]](#footnote-5)‘ The WCPT currently has twelve internationally recognised subgroups, the: Acupuncture Association of Physical Therapists; Association of Physical Therapists in Animal Practice (IAPTAP); Confederation of Cardiorespiratory Physical Therapists; Society for Electrophysical Agents in Physical Therapy; Federation of Orthopaedic Manipulative Physical Therapists; Organization of Physical Therapists in Mental Health; Neurological Physical Therapy Association; Association of Physical Therapists working with Older People; Organisation of Physical Therapists in Paediatrics; Private Physical Therapy Association; Federation of Sports Physical Therapy; and Organization of Physical Therapists in Women's Health.

World IAPTAP members include the following members:

• Animal Physiotherapy Group (Australia)

• Animal Rehabilitation Division (Canada)

• Finnish Association of Animal Physiotherapists (Finland)

• Fachkommission Tierphysiotherapie (Germany)

• Chartered Physiotherapists in Veterinary Practice (Ireland)

• South African Association of Physiotherapists in Animal Therapy SAAPAT (South Africa)

• Legitimerade Sjukgymnaster inom Veterinärmedicin LSVET (Sweden)

• Schweizerischer Verband für Tierphysiotherapie SVTPT (Switzerland)

• Association of Chartered Physiotherapists in Animal Therapy ACPAT (United Kingdom)

• Animal Rehabilitation Special Interest Group AR SIG (United States of America)

**Definition of Physiotherapy**

Encompassing the range of disciplines within the profession, PT can be broadly defined as the restoration of movement and function. PT involves using a professional assessment and reasoning process to select appropriate interventions or treatments for individual patients looking at physical, psychological, emotional and social wellbeing [7]. The profession of PT uses an evidence-based, clinical reasoning process to underpin its management approaches [8].

The clinical reasoning processes for PT are the same as those practised by veterinarians, although the overall aim is different. The physiotherapist’s aim is to reach a *functional* diagnosis. That is, identification of existing or potential impairments, activity limitations, participation restrictions, environmental influences or abilities/disabilities [7]. In contrast, the veterinary approach is usually to reach a *pathoanatomical* diagnosis (what pathological processes are occurring and where they are located) [9].

Animal PT is an extension of evidence-based practice in the human field and is not merely the technical application of one or more treatment modalities (e.g. massage, heat, cold, electrotherapy) [9]. The difference in aims for PT is important as it dictates the treatment and rehabilitation options used. PT treatments are selected to manage sensory and motor disturbances and provocative factors in work or sport for functional improvement and activity-specific performance rehabilitation. Animal PTs use physical interventions, such as manual therapies, specific motor retraining, exercise prescription and electrophysical agents, in conjunction with education and advice to restore function and quality of life [9]. Selection of the appropriate combination of techniques is based on clinical reasoning, assessment and reassessment of the patient, with reassessment of improvement following treatment dictated by objective outcome measures [9, 10].

**Regulations and the Team Approach**

The titles ‘physiotherapist’ and ‘physical therapist’ are protected by law in most countries and regulated by its respective Act or equivalent and as such may only be used by individuals who are registered with the respective government body.

In some countries PT or single modalities (e.g. massage, hydrotherapy, Bowen therapy) are also practised at a technical level by technicians. However, it is important that veterinarians understand the difference between technical and professional training. This is particularly the case in the those countries where referral to a physiotherapist by a veterinarian is required before PT is undertaken on animals, meaning the veterinarian is still professionally responsible for the animal throughout its treatment.

There are many advantages to utilising a professionally medically trained physiotherapist. The medical training allows PTs to have highly developed manual skills, based on their training with verbal feedback from their human patients. For many equine musculoskeletal disorders, there will also be an impact of the rider [11] and the ability of the PT to professionally assess the rider as well as the horse cannot be underestimated. With the skills of clinical reasoning, evidence-based practice and the ability to translate knowledge between species, the PT is an ideal partner in the veterinarian-PT relationship. Finally, the medically experienced PT is trained to work with and very often is the key facilitator of a multidisciplinary team which ensures the horse receives the most appropriate treatment. Within the equine environment the multidisciplinary team predominantly consists of veterinarian, farrier, saddler, trainer, PT and rider. The wider team can also include nutritionist, veterinary nurse, handler, owner, osteopath, and chiropractor. The professional PT is trained in being part of this team approach and understands the dynamics of these resources and how to make best use of them in relation to their own clinical practice.

**Core Principles of Equine Physiotherapy**

As for the definition of PT, the core principles of equine PT revolve around clinical reasoning and evidence-based practice to inform assessment, treatment and rehabilitation. During the course of rehabilitation, assessment and reassessment using objective outcomes measures are essential to direct progress and allow for modification of treatments [10]. PT assessment is covered in detail in the review by Dr Lesley Goff in this issue [12].

Musculoskeletal physiotherapy is the predominant subdiscipline in equine PT, encompassing poor performance, back pain syndromes, other musculoskeletal disorders and some neuromuscular disorders. Underpinning musculoskeletal physiotherapy are the sciences of functional biomechanics, neuromotor control, and the sensorimotor system in joint function. Equine PT also, importantly, must involve the interaction of the rider and horse, as well as the tack and training aides used. Functional biomechanics is reviewed in a subsequent chapter of this issue [13], so the focus in this section is on the principles of neuromotor control and the sensorimotor system in the spine, pelvis and peripheral joints, and the horse – rider interaction.

**1. Neuromotor control and the sensorimotor system**

When training the equine athlete, the aims are to increase stamina, speed and muscular strength as well as increase aerobic capacity, reduce the risk of musculoskeletal breakdown and improve the biomechanical skill and neuromuscular co-ordination [14]. In order to do this successfully, the body co-ordinates a number of different systems. For the musculoskeletal system, these include soft tissue (muscle, tendon, ligaments, nerves, fascia), bone and articular structures.

The basic functions of limb coordination, rhythm and speed through all gaits is generated and controlled in part by central pattern generators (CPG). These specialised interneuron circuits located within the spinal cord have an ability to produce rhythmic patterned locomotion independent of supraspinal (brain) input [15]. There are separate control centres for the thoracic and pelvic limbs though they are inter-connected by long neurones to allow phasic coordination between the front and rear of the horse. Normal locomotion also depends on the ability of the central nervous system (CNS) to receive and process afferent sensory information (such as proprioceptive, visual and vestibular input) from the sensorimotor system and to initiate and control movement in an effective, coordinated, energy efficient fashion [16, 17]. The relationship between neural and muscular (motor) control of movement is complex with reflexes (involuntary nervous system) as important as the voluntary activation patterns in control of spinal stability [18]. The final motor output during locomotion is a result of the CPG’s and their modulation by an intact CNS. The complex relationship between neural and muscular (motor) control of locomotion is referred to as neuromotor control [19].

**2. Neuromotor control in the spine and pelvis (axial skeleton)**

As well as modulating the dynamic limb patterns of locomotion, neuromotor control is highly important in providing a stabilising ‘core’ of muscles their associated soft tissues to provide appropriate resistance to movement for a given joint. In the spine and pelvis, stability in man has been clearly shown to be dependent on the contribution of three elements: 1. the passive structures (including the intervertebral disks, ligaments, joint capsules and intervertebral joints), 2. the active structures (muscles) and 3. the control system (CNS) which exerts its effects on the muscles [20]. Spine equilibrium and stability, and resultant spinal function, are reliant on the coordination and control of muscle recruitment via neural input from the sensorimotor system [17]. A coordinated pattern of when and how the muscles activate including neural feedback, compensatory mechanisms and motor adaption to changing environments are required. This includes neural feedback of changes in length and the rate of these changes in passive tissues and muscles which trigger reflex muscle activity to counter the change and feed-forward control by motor cortex whereby perturbations are predicted or anticipated and can be learned [17,21].

The importance of these mechanisms in the muscular control of the lumbar spine and pelvis have been shown in a series of experiments in people whereby the transverse abdominus [22], lumbar multifidus [23], diaphragm [24] and pelvic floor muscles [25] are all activated prior to and during perturbations created by rapid arm raises. This work demonstrated the predictable coordination of an array of muscles to provide a stabilising core of muscles in the spine and pelvis in a manner primarily linked to the direction reactive moments [26]. Such neuromotor control modulates muscular recruitment to fine tune the demands of internal and external forces, so ensuring appropriate motor responses to unexpected disturbances of movement and function.

Effective neuromotor control provides maintenance of functional stability which is important in preventing excessive loading or movement that may lead to injury, degenerative changes or predispose to pain and dysfunction [26]. This stabilisation is required to support the skeleton during locomotion and to ensure joints are maintained in their ‘neutral zone’ [20]. The neutral zone has been defined as the area of intervertebral motion where little resistance is offered by passive structures. It is a clinically important measure of joint stability in humans and has been shown to increase with degeneration or injury [20]. Unwarranted and unnecessary joint motion places the musculoskeletal system at risk of injury and is often termed ‘functional instability’ [27].

*Neuromotor control principles in PT (spine and pelvis)*

The principles of neuromotor control have been successfully applied to humans with back pain. Research has shown that there is a reduced and delayed muscular recruitment and stabilisation in patients with back pain, especially of the deep, core muscles of the spine and trunk [22, 28, 29]. Delayed muscle response times were also correlated with poorer postural control in patients with lower back pain [30]. This delayed onset of deep muscle activity does not reflect compromise of CNS performance caused by pain interference but has been suggested to be a result of adoption of an alternate postural strategy by the CNS, consistent with chronic adaptation to pain, and may serve to limit the amplitude and velocity of trunk excursions caused by limb movements [31]. However, pain adaptation may not be protective and patients with back pain are at risk of re-injury due to a failure of protection of structures from overload and unwanted movement [29]. Similarly, in the low motion joints such as the sacroiliac joint in the pelvis (SIJ), mild articular instability or ‘microinstability’ may result in gradual remodelling of a joint [32, 27].

Knowledge gained from this research related to the changes in neuromotor control that occur with back pain have translated to the development of rehabilitation strategies based on motor control training approaches [26]. It is now universally accepted that clinical benefit can be gained if motor control can be changed to optimise the load and minimise unwanted joint motion on structures of the spine and pelvis [26]. Motor relearning strategies may focus on deep core muscles such as the transverse abdominus and multifidus [33, 34] and may also involve targeting specific patterns of activation of muscle groups in combined functional movements such as bracing the trunk [35] to optimise motor control for spinal dynamic stability. There is evidence that this motor control approach can reduce low back pain intensity and functional disability which is maintained following treatment [33]. Importantly, specific physiotherapeutic intervention in people with multifidus dysfunction following an episode of acute back pain reduced the rate of recurrence of injury to 30% in the physiotherapy intervention group compared with the controls who had a recurrence rate of 84% [34].

Similarly, knowledge of neuromotor control of the sacroiliac joint has contributed to the ability of clinicians to diagnose sacroiliac dysfunction in humans. Non-invasive, manual tests have a high predictive odds ratio for sacroiliac dysfunction and are currently recommended over diagnostic joint analgesia [36]. These manual tests are described as pain provocation tests for the sacroiliac joint, and are designed to compress the sacroiliac joint articular surfaces and/or stress the extra-articular structures of the joint. Manual tests are also utilised to assess the degree of movement and the quality of motion of the sacroiliac joint during application of manual force based on the amount of hypo/hypermobility. This includes analysing movement of the sacrum relative to the pelvis in weight bearing through the pelvis [37].

*Neuromotor control principles in equine PT (spine and pelvis)*

Despite obvious limitations with respect to communication of specific exercises, the principles of neuromotor control have also been successfully applied in equine PT for the spine [38,39,40] and pelvis [41]. Stubbs and colleagues applied the human model of researching the equine multifidus muscle to the horse and found striking similarities in structure and function [38]. This research was used to develop and validate ultrasonography as a tool to detect reduced multifidus cross sectional area associated with severe osseous pathology in horses [39]. The use of this technique also enabled the identification of multifidus asymmetry in asymptomatic riding horses which was improved by specific physiotherapy exercises over a three month period aimed at improvement of core muscle function [40].

Diagnosis of equine sacroiliac disease using manual tests similar to that used in the human literature has been described [42] and is based on biomechanical and neuromotor control principles including motion between the sacrum and ilium during the application of manual forces by a PT in vivo and in vitro [41,43].

**3. Neuromotor control in the appendicular skeleton**

As well as controlling muscular activity in the axial skeleton, neuromotor control and the sensorimotor system are important in controlling joint position and loading of the associated soft tissues in the appendicular skeleton. Fatigue [44] as well as injury [45,46] can alter the function of active elements (muscles) as well as sensorimotor inputs and neuromotor control, principally reflected in reduced joint position sense and proprioception. Furthermore, appropriate warm-up can improve joint position sense [47].

*Application in PT*

Understanding neuromotor control and the sensorimotor system has informed treatment and rehabilitation of peripheral joint and soft tissue injuries including the ankle [48], knee [49] and shoulder [50]. Proprioceptive retraining is an important part of rehabilitation, one example of which is taping. The aim of taping techniques is to stimulate mechanoreceptive and proprioceptive activity in the skin and superficial soft tissues (fascia, ligaments and joints). Taping affects the sensory afferent activity from that region via stimulation of mechanoreceptors responding to skin stretch and compression during joint motion, improving sensorimotor afferent input and ultimately joint position sense [51]. Patellar taping was shown to improve control of the knee joint in both pain free people with poor joint proprioception [52] and in people with femoropatellar pain [53]. Similarly the combined mechanical and proprioceptive benefits of taping for improving dynamic balance for preventing ankle sprains [54] as well as recurrence of sprains is well documented [55]. Taping, bracing and manual therapy are used prior to exercise based PT for an immediate effect on proprioception, while exercise based therapies are used to maintain the improvements [51].

*Applications in equine PT*

Taping has also been used clinically in horses for similar purposes. One study investigated the biomechanical effects of taping the fetlock in the forelimbs of horses which showed an effect on fetlock flexion during swing and reduced peak vertical force during stance [56]. Although in this model, mechanical rather than sensorimotor effects were being investigated, the results suggested that changes seen may have reflected proprioceptive adaptations. More recent PT led research has shown clear effects of tactile stimulation of the distal hindlimb in horses, causing increased hoof flight arc, increased peak flexion angles in the hindlimb, and increased concentric activity of the tarsal musculature and will be discussed in more detail in the review in this issue on functional biomechanics [13, 57].

**4. Horse rider/horse-tack interaction**

In the past decade there has been an emergence of research and growing awareness of the interaction between the horse, its tack and the rider [11]. Riders have a large influence of horse’s gait, and can increase or decrease the expression of lameness detected by asymmetry [58]. Furthermore, this effect varies depending on the experience of the rider with more the experienced rider more likely to increase hind limb lameness, presumably due to increasing collection and hind limb usage [58]. Professional riders have been shown to be more stable than novice riders, with reduced motion detected by reduced vector angles between the rider's head and the rider's back and between the rider’s back to the horse's head [59]. Experienced riders have also shown improved stability at the trot corresponding to more synchronous activation of the erector spinae and rectus abdominus muscles [60].

Research into the effect of the saddle, in particular in the role of increased forces and ‘bridging’ (where the weight of the rider is distributed on the caudal and cranial parts of the saddle but not throughout its lengths) have improved understanding of saddle induced pain [61,62]. Saddle slip has also been investigated. Despite previous assumptions about slip being due to a poorly fitting saddle or rider asymmetry, it has been shown that the saddle slip is most associated with hind limb lameness or gait abnormalities [63]. Almost 53% of saddle slip was attributed to this and only 6% to rider asymmetry [63].

However, in this study rider asymmetry was present in 103 of 276 (37%) riders and even though the majority (78%) of crooked riders did not induce saddle slip [63], crooked riders may place additional stress in the horses’ back, or indeed their own. It is already well known that elite athletes in many disciplines frequently show asymmetries, and the same is true of equestrian riders [64]. Less elite athletes or paralympic athletes may show more marked asymmetries that require extensive PT intervention [65]. Asymmetry can negatively affect performance in horses in various ways from the inappropriate delivery of aides to altered biomechanics of locomotion [11,58]. The important contact points of the rider and the horse are the lower limbs, pelvis and, indirectly, the hands. Rider asymmetry, injury or dysfunction can impact optimal delivery of aides and their interpretation by the horse. The relevance of the multidisciplinary team becomes significant here; the PT is well placed to identify rider asymmetry as well as assess and treat the rider as well as to ensure any suspected lameness is referred to a veterinarian and saddle problems referred to a master saddler. Professional PTs are already highly trained in managing musculoskeletal disorders in the human athlete so the ability to assess the rider provides an important extension of the diagnostic workup. Furthermore, PT intervention can be an important part of the treatment and rehabilitation plan. Experienced riders post PT intervention to the pelvic region showed a marked improvement in symmetry compared to untreated controls [66].

**Summary**

In conclusion, PT is an important allied health profession that has been largely established following the wars and polio outbreaks that occurred at the beginning of the 20th century. PT can be broadly defined as the restoration of movement and function. There are many subdisciplines of PT, but musculoskeletal physiotherapy is the predominant subdiscipline in equine PT, encompassing poor performance, back pain syndromes, other musculoskeletal disorders and some neuromuscular disorders. Underpinning musculoskeletal physiotherapy are the sciences of functional biomechanics, neuromotor control and the sensorimotor system in the spine, pelvis and peripheral joints. Equine PT also, importantly, must involve the rider and horse-rider interaction, as well as the tack and training aides used. Incorporating a veterinarian-physiotherapist team in the investigation, management and rehabilitation of equine athletes adds a vital new dimension to equine sports medicine.

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