

Neuromotor control in the horse – where neuromuscular function and orthopaedics meet

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1. Overview

The veterinary approach to pathology in the axial skeleton and peripheral joints has focused primarily on identifying underlying skeletal, tendon and or ligamentous pathology and its treatment.

The physiotherapy approach is to focus on the assessment and management of a patient's function¹. For physiotherapists, this includes assessment of the musculature of the region, especially the core stabilising musculature and its function. Rehabilitation protocols focus on restoration of function, including recognition and assessment of the effects joint pathology has (via impaired neural signalling) on the surrounding musculature (arthrogenic muscle inhibition²). This includes muscle weakness, activation failure and atrophy. Careful attention to restoring muscle function is important for rehabilitation and prevention of reinjury².

Physiotherapy research in the neuromotor control model has been used to successfully guide treatment and rehabilitation of people with back pain^{2,3} as well as injury to peripheral joints⁴. This presentation will introduce the physiotherapy concepts of neuromotor control and apply them to the horse, with a focus on equine back pain.

2. Neuromotor control and joint neutral zone

Neuromotor control refers to the complex relationship between neural and muscular (motor) control of locomotion. Although rhythmic gait in both the pelvic and thoracic limbs is initiated via central pattern generators located within the spinal cord, the locomotion produced must be modulated by the central nervous system⁵. The central nervous system receives and processes sensory information (such as proprioceptive, cutaneous, visual and vestibular input), and uses this sensorimotor system information to control movement in an effective, coordinated, energy conserving fashion⁵.

A model of neuromotor control described by Panjabi⁶ involving 3 components:

- a. passive (tissues such as bone, ligaments)
- b. active (muscles)
- c. controller (CNS modulation)

Central nervous system modulation occurs as a result of both feedback and feed forward. Neural feedback from the sensorimotor system occurs from passive tissues and muscles e.g. nerves, golgi tendon organs and motor end plates providing information such as changes in length and the rate of change in tissues. Importantly, the central nervous system is able to control movement by feedforward mechanisms as well. This is where perturbations are predicted or anticipated and can be learned⁷.

Neuromotor control provides a stabilising core for appropriate resistance to movement for any given joint, which maintains the joint in a 'neutral zone' during locomotion⁶. Keeping a joint in its neutral zone throughout its range of motion is vital to prevent excessive joint movement and tissue overload which can result in injury to structures within and around the joint.

3. Application to back pain

Neuromotor control was first described in reference to the spine where muscular support and protection to the lumbo-pelvic region during movement became important areas of research. Spinal stability and control of movement is highly dependent on the contribution of the muscular system, and not just the strength of the musculature, but the central nervous system's timing and control of muscle recruitment^{2,3}. In the presence of injury such as low back pain, the strategies used by the central nervous system to control trunk muscles may be altered resulting in less efficient muscle recruitment strategies^{2,7}. Back pain patients, for example, display delayed activation of the musculature, depriving the painful and injured spinal segments of timely support. Knowledge gained from this research related to the changes in neuromotor control that occur with back pain have translated to the development of new rehabilitation strategies for the lumbo-pelvic muscles in back pain patients⁸.

The most important muscle group for neuromotor control in the thoracolumbar region are the deep epaxial multifidus muscles with both in vivo and in vitro evidence demonstrating the ability of the multifidus muscle to control intervertebral motion. Morphological changes, especially reduced cross-sectional area, have been shown in the multifidus muscle in association with low back pain in people^{2,9}. What is notable is that there is not an automatic reverse of these changes following the resolution of pain. Despite apparent recovery or resolution of pain following an episode of acute back pain, the dysfunction of multifidus persists⁹.

Despite the differences between the quadruped and biped and the increased passive stability of the equine lumbar spine, research in equine back and pelvic anatomy and biomechanics have shown that the anatomy and function of the equine epaxial muscles are comparable to that of humans¹⁰. The multifidus in the horse was shown to be similarly morphologically orientated and thus functions in a comparable way to that in man with the sacrocaudalis dorsalis lateralis muscle continuing the function of the multifidus in the caudal

spine. Core stabilising muscles have a predominance of Type I muscle fibres which are highly oxidative and fatigue resistant and research has shown the equine multifidus (as well as some of the hypaxial muscles) to have over 50% Type I muscle fibres, as opposed to locomotory muscles which are 80-90% Type II¹¹.

The ability to assess the size and function of the lumbar multifidus has been a valuable guide to assessment, management and prevention of recurrence of back pain in man.

Ultrasonography has also been found to be a repeatable and reliable tool for measurement of the equine epaxial muscles and when examined in clinical cases of equine back pathology, there was a clear reduction of the epaxial muscle size at the level of and side of significant injury or pathology¹².

4. Physiotherapy rehabilitation using principles of neuromotor control

In addition to the general principles of training muscles for strength and stamina, physiotherapy rehabilitation strategies, include attention to specific motor learning principles to the affected muscles to restore function and optimal control of joint movement. Ultimately the outcome is the development of motor skill or the effortless automaticity in (correct) movement¹³.

Physiotherapy exercises targeted at the core stabilising muscles of the back, the epaxial muscles, have been prescribed to human back pain sufferers with dramatic reductions in the incidence of recurrence of back pain^{2,8}. Specific physiotherapy exercises targeting core stabilising muscle have also been devised and used in horses and have been shown to improve multifidus size and symmetry in horses^{14,15}.

Dr Lesley Goff will go into more detail about physiotherapy treatment in the next presentation.

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