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## EDITORIAL

### A new paradigm shift in musculoskeletal rehabilitation: why we should exercise the brain?



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Do you know that we should start looking at the brain when treating musculoskeletal disorders (MSKD) and that exercises can potentially train the brain? Given the high prevalence, impact, and burden of MSKD,<sup>1</sup> therapies need to focus on the origin of the problem to be more effective and reduce the economical expenses of these conditions. The latest evidence has highlighted that musculoskeletal rehabilitative therapy, including exercises, should not only look at local structural and functional abnormalities of the MSK system but also into alterations within the central nervous system. These central alterations have demonstrated to have a crucial role in the pathophysiology and clinical manifestations of MSKD.<sup>2</sup>

Therapeutic exercise has been considered a cornerstone for the rehabilitation of MSKD and is commonly used to treat MSKD due to its positive effects. Exercise treatment aims to restore normal function by altering sensory input, reduce inflammation, decreasing, coordinating and strengthening muscle activity, and promoting the repair and regeneration of tissues.<sup>3</sup> Evidence from systematic reviews support the use of therapeutic exercise to improve MSK pain in several conditions. In recent years, there has been abundant evidence through innovative research using functional magnetic resonance imaging (fMRI), transcranial magnetic stimulation (TMS) and positron emission tomography (PET) showing that subjects with chronic MSK conditions present abnormal activation of areas involved in the cognitive affective aspects of pain and injury, including the behavioural

response, the processing of fear, emotions, negative conditioning and attention.<sup>4</sup> The abnormal activation of these areas influence descending pain modulatory systems that perpetuate the ongoing abnormal augmented pain transmission originating from nociceptive and non-nociceptive peripheral receptors in the dorsal horn of the spinal cord. These findings are crucial for the area of exercise therapy since common rehabilitative treatments for pathological conditions do not target the underlying mechanisms of neuroplastic cortical changes that generate pain and dysfunction. This can result in unsuccessful restoration of the functionality of the subjects with these conditions. In the past, researchers have looked at structural and functional abnormalities within the MSK system; however, according to this new paradigm (i.e. cortical changes in chronic MSK conditions), rehabilitation efforts that attempt to target cortical neuroplastic changes provide the greatest potential for rehabilitation success.

Evidence shows that maladaptive changes in the motor cortex can be improved following specific exercise training through motor control exercises.<sup>5</sup> For example, Tsao et al.,<sup>5</sup> found that deep abdominal muscle training using real-time ultrasound feedback could reverse reorganisation of neuronal networks of the motor cortex in people with recurrent pain. This did not occur following general walking exercise, suggesting that repetitive exercise alone could not induce reorganisation of motor cortical networks and thus, skilled cognitive practice needed to be specific to induce cortical

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changes. Novel motor training has also been implicated in improving patient outcomes in conditions associated with neck pain such as tension type headache, cervicogenic headache, and craniomandibular disorders. However, evidence is still limited and more research investigating the effectiveness of novel motor training in these conditions is needed. A recent study performed by Pietrosimone et al.<sup>6</sup> highlighted the use of exercise plus feedback to induce cortical changes in healthy subjects. They found that exercises plus feedback using an external focus of attention increased corticomotor excitability. This recently study by Pietrosimone et al.,<sup>6</sup> was the first to demonstrate in healthy subjects that feedback increased descending corticomotor excitability from neurophysiological measures originating in the primary motor cortex of the brain and thus could be used as strategy for targeting cortical changes in subjects with clinical conditions. An external focus of attention has been shown to be more effective for improving motor performance than an internal focus of attention.<sup>7</sup> Thus exercises programmes using feedback should induce an external focus of attention to augment musculoskeletal rehabilitation, such as training neck muscles with the use of pressure biofeedback, or training coordination by controlling a metal ball on a flat surface mounted on top of the head.<sup>8</sup>

Exercise training performed prior to acute experimental pain can prevent pain associated neuroplastic changes in the spinal cord and thus can be used to prevent the development of chronic pain,<sup>9</sup> or can make the brain more adaptive to changes caused by injury.<sup>9</sup> However, a very recent systematic review<sup>10</sup> found only 2 studies that investigated the effectiveness of exercise therapy on brain alterations using functional imaging (fMRI) in fibromyalgia and chronic MSK pain. The results of this systematic review showed that 15 weeks of exercise therapy using a general resistance training in subjects with fibromyalgia partly normalised the aberrant intrinsic brain connectivity patterns in these patients. On the contrary, aerobic exercise did not significantly reduce perceptual rating to an innocuous stimulation in subjects with general chronic pain; although there was a trend to improve the BOLD signal in the caudate. Although these preliminary studies show some potential for the use of exercise therapy to target brain alterations, the designs of these studies are rather weak. Both of them are before-and after studies and also with very limited number of subjects (16 and 11 subjects respectively). Thus, it is important that research is expanded in this area and exercise therapy is tested in other populations using more rigorous research designs.

There is a paradigm shift in the way chronic MSKD should be treated and physical therapists should be at the forefront of these new developments. Research should support treatment strategies to manage chronic painful conditions

by looking at training the brain of individuals with MSK disorders. This knowledge will help clinicians, rehabilitation groups, and scientists interested in chronic pain and exercise therapy to understand the mechanisms of action of therapeutic exercise on the brain and develop more effective interventions to improve clinical outcomes for several MSK chronic conditions. This will hopefully reduce the burden of these conditions and help to improve quality of life of individuals with chronic MSK disorders.

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