Neurocognitive and sensorimotor deficits represent an important sub-classification for musculoskeletal disorders – Central Nervous System Coordination

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Introduction

Chronic low back pain presents with a large variety of motor function and central disturbances (Gibbons 2008, 2010a, 2011a). This heterogenous nature of chronic low back pain (LBP) has lead to various sub-classification strategies to aid in rehabilitation. Common sub-classifications in current clinical practice include: patho-anatomical, movement patterns, pain mechanisms, and psychosocial factors. Current strategies for chronic low back pain fail to address the complexities that clients present with. One type of central disturbance that has received little attention are neurocognitive deficits (e.g. concentration, memory, attention), despite being common in whiplash (Kessels et al 2000), fibromyalgia (Sephton et al 2003, Glass 2008, Verdejo-Garcia et al 2009, Park et al 2001, Dick et al 2008), and chronic pain (Sjøgren et al 2005, Dick and Rashiq 2007, Kreitler and Niv 2007).

Neurocognitive deficits should be of interest to Physiotherapists because they are related to sensory motor deficits, coordination deficits, neurological soft signs, and psychological co-morbidities in children with learning disabilities (Barnhart et al 2003, McPhillips and Sheehy 2004, Semiz et al 2008,Mugnaini et al 2009). They have the potential to influence rehabilitation in adults (Gibbons 2009c, 2009d). Further, many interventions require neurocognitive function. Skills such as reading, concentration, memory, attention, visualization and problem solving should not be taken for granted. The purpose of this paper is to describe a sub-classification strategy for neurocognitive deficits and sensory motor deficits relevant to Physiotherapists.

Sub-classification – Central Nervous System Coordination

There is an overlap in the central nervous system where the processing of neurocognitive function, sensory motor function, movement and psychological function occur. This creates the potential for competition for resources. In a normal brain, resources are allocated effectively. There is only competition when the system is significantly challenged. When there is a deficit in one of these areas, competition may occur for the limited resources and a deficit occurs in one or more areas depending on the prioritization, need for function and initial ability to deal with multiple demands. In the end, function within the central nervous system suffers. This may manifest as reduced motor control, impaired neurocognitive function or a psychological reaction (Gibbons 2011b).

Although, there is a greater prevalence of neurocognitive deficits in populations with pain as noted above, neurocognitive deficits may be present prior to the development of pain. This is evident from two key areas. Approximately 10% of children have a fundamental learning difficulty (Lagae 2008). Another 25% - 45% have a mild learning difficulty. Most children keep their learning difficulty into adulthood (Cousins and Smyth 2003, Shaywitz et al 2008). Mild cognitive impairment (MCI) is a syndrome with neurocognitive deficits greater than that expected for an individual's age and education level but that does not interfere notably with activities of daily life. Prevalence in population-based epidemiological studies ranges from 3% to 19% in adults older than 65 years (Gauthier et al 2006). This shows that in the general population there are a range of neurological, sensory motor and neurocognitive problems.

It is proposed that another sub-classification, Central Nervous System (CNS) Coordination, be considered to identify the spectrum of sensory motor and neurocognitive deficits in the population. CNS Coordination is the ability of the CNS to receive and process sensory motor information, and process cognitive information. The CNS intimately requires constant feedback from the sensory motor system for postural stability and control of movement. It is critical to appreciate that CNS Coordination deficits do not include just learning difficulties and MCI in the general population that present with musculoskeletal pain. The brain competition model should be further considered here. Sensory motor deficits such as proprioceptive deficits (Heikkila and Wenngren 1998, Treleaven et al 2003, 2005, Brumagne et al 2000, O'Sullivan et al 2003), and tactility (Peters and Schmidt 1991, Wand et al 2010) are common in chronic pain conditions. Motor deficits occur shortly after the onset of pain and continue (Hodges 2003, MacDonald et al 2006). Further, it is difficult to exclude psychological reactions from pain and the injury process. These presentations will add strain to an already challenged CNS (e.g. learning difficulty or mild cognitive decline), however they have the potential to compromise a normal CNS if the deficits are significant enough.

A CNS Coordination deficit is not meant to be a medical condition, but rather used for sub-classification purposes in rehabilitation. The existing diagnoses of learning difficulties and mild cognitive impairment can fall under this heading for sub-classification purposes in rehabilitation. The neurocognitive deficits that occur with pain still require a medical or neuropsychological diagnosis. The concept of brain competition leading to neurocognitive deficits with sensory, motor and psychological competition is a hypothesis at this stage and requires further investigation.

The Motor Control Abilities Questionnaire (MCAQ) is an instrument that was developed to identify neurocognitive and sensory motor deficits along with related symptoms in adults (Gibbons 2009a). The MCAQ has identified three sub-groups of CNS Coordination: significant deficits, mild to moderate deficits; and minimal deficits (Gibbons 2009b). The physical assessment of neurological soft signs and sensory motor function can also identify these subgroups (Gibbons 2009c). The MCAQ's ability to predict if an adult can learn specific motor control exercise for chronic low back pain is very good with a specificity and sensitivity of 0.98 and 0.88, respectively (Gibbons 2009a). The MCAQ along with ruling out high psychosocial and psychological issues make up a clinical prediction rule for who will respond to specific motor control exercise for low back pain (Gibbons 2010b, 2010c).

Relevance

The group with significant CNS Coordination deficits are uniquely different from others in numerous ways. They present with inherently different beliefs related to their presentation and possess numerous risk factors for poor outcome. These include: higher self rated pain, disability, fear avoidance, and psychosocial factors; lower self rated function, and sleep quality. They also have a poor ability to learn specific motor control exercise. Although the presentation is amenable to change, the timeframe is longer than normal and can take three to six months for significant change to take place (Gibbons 2009d).

Rehabilitation

The principles of neuroplasticity must be applied in rehabilitation. Rehabilitation strategies for neurocognitive function come from children with learning difficulties, adults with MCI and stroke sufferers. Our preliminary results show that primitive reflex inhibition, focused attention to sensory motor function and active exercise programs can provide a rehabilitation option for those with significant CNS Coordination deficits (Gibbons 2009d).

Conclusion

Neurocognitive and sensory motor deficits make up an important sub-group of musculoskeletal conditions which we have termed CNS Coordination. A better understanding of the inter-relationships between sensory, motor, neurocognitive and psychological function will increase our knowledge of appropriate intervention strategies.

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