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Walking for six minutes increases both simple reaction time and stepping reaction time in moderately disabled people with Multiple Sclerosis

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Abstract

Background: Walking ability and fatigue are often reported as the most disabling symptoms in Multiple Sclerosis (MS). Motor fatigue may contribute to reduced mobility, and is likely caused by both central and peripheral deterioration in neuromuscular function. Simple and choice stepping reaction time (RT) measures have the potential to detect walking induced changes in motor impairment.

Objectives: The aim of this study was to assess the effect of six minutes of walking on simple and choice stepping RT in people with MS.

Methods: 31 people with moderate walking disability and a diagnosis of MS completed simple and choice stepping RT tasks, and rated their levels of fatigue on a 100 mm visual analogue scale before and after a modified six minute walk test.

Results: Subjects walked an average of 368($\pm$110)m in six minutes. Perceived fatigue increased following the six minute walk, as indicated by a 25($\pm$19.7)mm increase on the 100 mm visual analogue scale ($p<0.001$). There was a significant increase in both hand ($p=0.003$) and foot ($p=0.006$) simple RT following the six minute walk. For choice stepping RT, response time was significantly slower ($p=0.006$) following the six minute walk, while movement time was unchanged ($p=0.506$).

Conclusion: Simple and choice stepping reaction times are slower following six minutes of walking in people with MS. These findings suggest that walking-induced fatigue might lead to central slowing and slowed stepping performance. Further studies are needed to investigate the

Abbreviations: MS, Multiple Sclerosis; RT, Reaction Time; EDSS, Expanded Disability Status Scale; FSS, Fatigue Severity Scale

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clinical relevance of these RT measures in relation to fall risk and therapeutic interventions to improve mobility and manage fatigue in people with MS.

1. Introduction

Walking ability (Johansson et al., 2007) and fatigue (Bakshi, 2003; Schwid et al., 2002) are often reported as the most disabling impairments by people with Multiple Sclerosis (MS). A multidisciplinary consensus conference in 2007 by the Consortium of Multiple Sclerosis Centres recommended that a global outcome measure for fatigue be developed that would include an examination of fatigue throughout the MS disease course and be quick and easy to administer (Hutchinson et al., 2009). There is a known difficulty in measuring motor fatigue, and a physiological approach is needed to detect motor impairments. Activity dependent motor fatigue has been measured in previous studies using maximum voluntary contraction (Schwid et al., 1999). Neurophysiological studies suggest that motor fatigue is likely to be caused by both central and peripheral deterioration in neuromuscular function and is associated with reduced walking speed and cadence (Ng et al., 2004). Kinetic gait parameters have also shown some associations with perceived fatigue levels (Huisinga et al., 2011) however these laboratory measures are beyond the scope of normal clinical practice.

Reaction Time (RT) measures have the potential to detect important fatigue-related motor impairments in a clinical setting. RT is slower in people with MS compared with healthy controls (Bailey et al., 2007), and has previously been shown to further deteriorate with mental fatigue (Jennekens-Schinkel et al., 1988). Recently, Claros-Salinas et al. (2013) used a RT task as a measure of alertness in people with MS and healthy controls before and after both cognitive and physical exertion. They showed that hand RT was slower in people with MS compared with healthy controls, and worsened with cognitive fatigue and walking-induced fatigue. It is unclear how far or long participants walked to induce physical fatigue. Another study has shown that walking for an average duration of six minutes increases perceived fatigue in people with MS (Crenshaw et al., 2006), but does not elicit an increase in kinematic or kinetic variability in people with minimal disability. In people with MS, more cognitively challenging walking tasks result in larger variations in spatiotemporal parameters of gait (Hamilton et al., 2009). Even in people with MS with mild disability and no pyramidal signs, the double support phase of gait is prolonged compared with healthy controls (Martin et al., 2006), which may indicate a delayed stepping time when walking.

Impaired choice stepping RT has been shown to be a significant predictor of falls in people with MS (Hoang et al., in press) and older people (Lord and Fitzpatrick 2001). In a prospective study of falls in people with moderate MS (EDSS 3.5–6.0), Nilsagard et al. (2009) have also reported that an increased time taken to complete the Four Square Step Test was significantly associated with an increased risk of falls. Reicker et al. (2007) demonstrated that choice hand RT in people with MS is slower compared to both simple RT and choice RT in healthy controls, and suggest that a combination of motor dysfunction and changes in cognitive processing influences the performance of people with MS. The functional significance of these results and the influence of fatigue on RT in people with MS have not been reported.

Most existing literature has reported the effect of strenuous muscle activity on fatigability, as opposed to the fatigue that accompanies routine daily activities such as walking (Dobkin, 2008). Measures of simple and choice RT have the potential to assess important fatigue related motor impairments that are important for walking and fall prevention. The aim of this study was to investigate the effects of walking on simple RT and choice stepping RT in people with MS. We hypothesised that walking for six minutes would induce fatigue and have a detrimental effect on simple and choice RT.

2. Methods

2.1. Participants

Thirty-one people (23 women and 8 men) with a diagnosis of MS were recruited from the MS Society of South Australia, the MS Rehabilitation Clinic at the Repatriation General Hospital and from private physiotherapy clinics in South Australia. Inclusion criteria were an Expanded Disability Status Scale (EDSS) (Kurtzke, 1983) score of 3.0–6.0 and being able to walk for six minutes with or without the aid of a walking stick. Exclusion criteria included exacerbation or relapse of MS within the last 3 months, use of medication prescribed for fatigue or mobility, and having arthritis or other illness that severely limits walking. All participants provided written informed consent and ethical approval was granted by the Repatriation General Hospital Research and Ethics Committee (EC00191). This investigation was part of a larger study examining fatigue and walking ability in MS (McLoughlin et al., 2012).

2.2. Fatigue protocol

To induce fatigue, participants repeatedly walked back and forth along a marked 10 m section of a 20 m hall, following the instructions “walk as far as you can in six minutes, bearing in mind that you need to last for six minutes”. The six minute walk, aimed at maximising effort, has previously been used to assess motor fatigue in people with MS (Goldman et al., 2008).

2.3. Pre- and post-fatigue assessment

Participants rated their level of fatigue and underwent tests of simple and choice stepping RT before and after the six minute walk test. Participants rated their fatigue using a visual analogue scale – a 100 mm line with end descriptors of “not at all” and “very severe” (Lee et al., 1991).