Clinical Biomechanics 37 (2016) 22–26

Contents lists available at ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

An investigation of commonly prescribed stretches of the ankle plantarflexors in people with Multiple Sclerosis

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ARTICLE INFO

Article history:
Received 31 July 2015
Received in revised form 4 April 2016
Accepted 18 May 2016

Keywords:
Stretching
Multiple Sclerosis
Stiffness
Spasticity

ABSTRACT

Background: Stretches are often prescribed to manage increased limb stiffness in people with Multiple Sclerosis. This study determined the ankle plantarflexor torque magnitude that people with Multiple Sclerosis can apply during four commonly prescribed stretches and determined the relationship between the applied torque and functional ability.

Methods: People with Multiple Sclerosis (N = 27) were compared to healthy control participants (n = 15). Four stretches were investigated; stretching in step standing; using a step; pulling the ankle into dorsiflexion and standing in a frame. Joint position and forces were measured using 3D motion analysis and torque transducers. Baseline ankle strength and stiffness was measured using motor driven ankle perturbations.

Findings: People with Multiple Sclerosis (N = 27) had higher stretch reflex amplitudes and lower strength compared to the control group (n = 15). People with Multiple Sclerosis achieved less lengthening of the plantarflexor muscle-tendon complex when stretching but similar ankle torques compared to controls. While stretching people with Multiple Sclerosis showed greater muscle activation in the ankle plantarflexors. Stretches in weight bearing positions produced higher plantarflexor torques. People with Multiple Sclerosis with lower functional ability preferred the more supported stretches (ankle pull and standing frame).

Interpretation: Stretches in weight bearing positions achieve higher ankle torques but this is in part due to increased postural activity in people with Multiple Sclerosis. Functional ability may limit stretch effectiveness

1. Introduction

Increased limb stiffness is seen in up to 80% of people with multiple sclerosis (MS) (Barnes et al., 2003; Rizzo et al., 2004) with the ankle plantarflexors being the most commonly affected muscle group (Hoang et al., 2014). Increased limb stiffness is associated with reduced functional ability, quality of life and increased health and social care costs (Hoang et al., 2009; Arroyo et al., 2013; Svensson et al., 2014; Sosnoff et al., 2011). It is caused by changes in passive stiffness and/or stretch reflex activation resulting in spasticity (Sinkjaer et al., 1993; Zhang et al., 2014). Stretching is commonly used as a treatment for symptomatic, increased limb stiffness (Bhimani and Anderson, 2014; Satkunam, 2003), based on the rationale that stretching promotes musculoskeletal adaptations that can prevent or correct increased passive stiffness and contracture (Gorter et al., 2007) and reduces hypertonia by inhibiting the stretch reflex activity (Maynard et al., 2005). However, a systematic review of stretch techniques aimed at reducing contracture in people with neurological conditions, highlighted the lack of evidence supporting stretching for the treatment of passive and stretch-reflex mediated stiffness (Katalinic et al., 2011). To date studies investigating stretching have varied widely in terms of the stretch parameters used such as the applied torque (the turning moment at a joint that results in a muscle stretch), the duration of stretch; the mode of delivery (e.g. via a motor, therapist or self-administered); the follow-up period (single session Vs longer term) and the muscle(s) targeted (Katalinic et al., 2011). These factors may influence the effectiveness of a stretch. Constant torque stretches, for example, are more effective in the short term reduction of limb stiffness than stretching in a constant position or cyclic stretching post stroke (Bowen et al., 2001; Yeo et al., 1995). This study characterised the torques produced at the ankle during commonly applied manual stretches in people with MS and healthy participants. It further measured muscle activity during the stretch to assess whether the stretch is passive in nature.

Some commonly prescribed manual stretches require the person to be standing. In people with a neurological deficit achieving and maintaining these positions may be difficult because of underlying neurological deficit such as muscle weakness and spasticity. We therefore also

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http://dx.doi.org/10.1016/j.clinbiomech.2016.05.013
0268-0033/

assessed the relationship between people's functional ability and how this impacted on the torques they could generate during a stretch, their preferred type of stretch and the duration they could maintain the stretch position. Understanding the torques generated during commonly prescribed stretches for the ankle plantarflexor, the degree of background muscle activity and the duration a stretch can be maintained could be important factors in determining the effectiveness of a stretch.

2. Methods

Participants with MS (N = 27) were recruited through local MS neurology consultants. Participants were included if they scored between 4.5–7.0 on the Expanded Disability Status Scale (EDSS); were able to take a minimum of 10 steps with or without the use of a walking aid; transfer independently and passively achieve a neutral alignment of the foot between inversion and eversion with the foot in 10° plantarflexion to allow reproducible positioning and stretching during motor-driven perturbations. People were excluded if they had additional neurological conditions not associated with MS, severe cognitive impairment such that they were unable to provide informed consent, or upper limb deficits that prevented them from consistently using the manual motor safety cut off switch used to measure baseline stiffness. People with MS were compared to 15 age, height and weight matched healthy controls that were recruited from local staff and acquaintances of people with MS. Written informed consent was obtained from all participants and the study was conducted with approval from the NHS Torbay and Devon Research Ethics Committee, UK.

Demographics and self-report measures of spasticity and function:

Participants completed self report questionnaires of symptom severity (EDSS, Expanded Disability status scale Bowen et al. (2001)), function (Barthel Index Yeo et al. (1995)), walking ability (12-item Multiple Sclerosis Walking Scale, MSWS-12 Hobart et al. (2003)), spasticity (Multiple Sclerosis Spasticity Scale, MSSS-88 Hobart et al. (2006)) and ankle plantarflexor hypertonia using the Ashworth scale (Ashworth, 1964). Demographic information (age, weight, gender) was also collected. Baseline ankle plantarflexor stiffness, stretch induced EMG activation and isometric strength were measured using a dynamometer as outlined in the Supplementary material.

Manually applied stretches:

Four stretches of the right plantarflexor muscles were assessed (Fig. 1); stretching in step standing (WALL); stretching off a step (STEP); pulling the ankle into dorsiflexion (PULL) and standing in an Oswestry Standing (FRAME). All stretches were first demonstrated

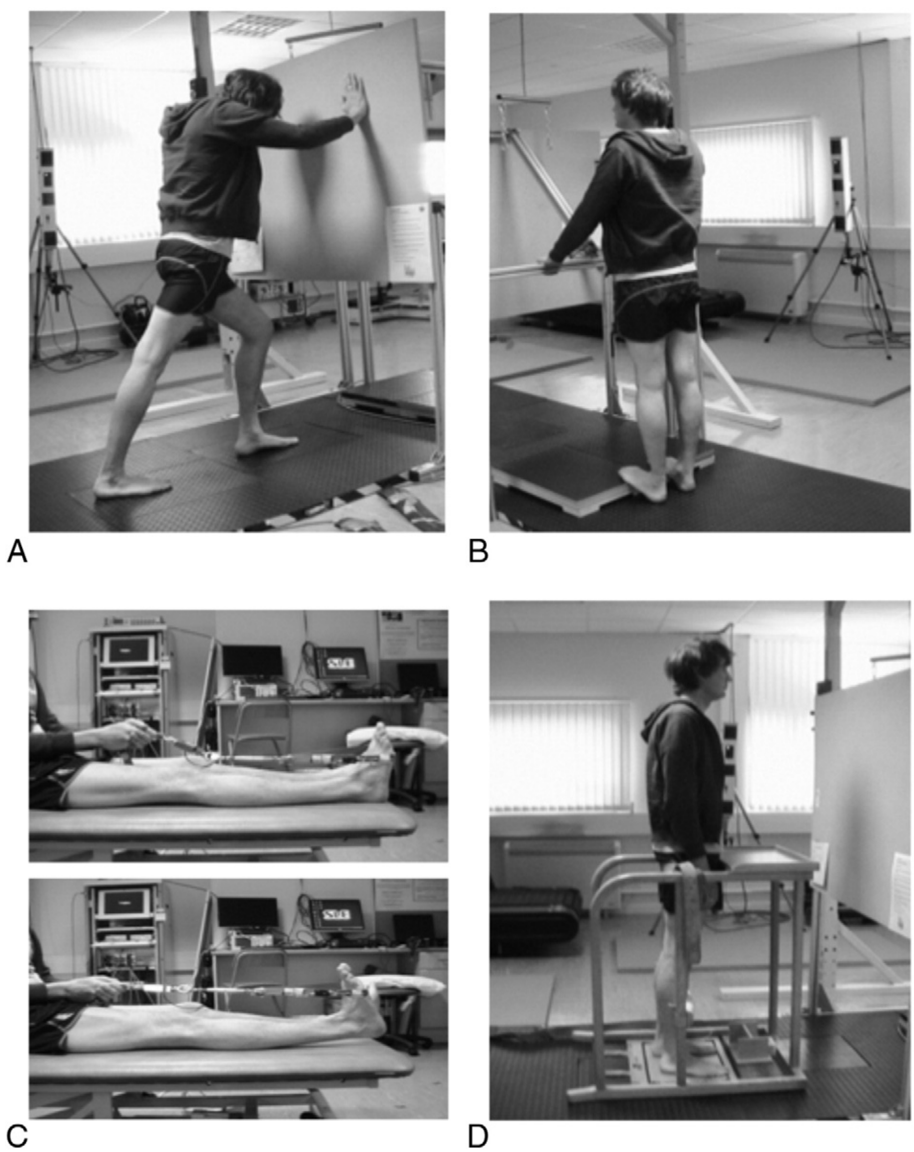

Fig. 1. Stretch conditions A Wall stretch; B Step stretch C Pull stretch (showing the ankle move into dorsiflexion from top to bottom) D Frame stretch.