

Functional Electrical Stimulation in Hereditary Spastic Paraparesis

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1. Introduction

Hereditary spastic paraparesis (SP) is caused by a dying back axonal degeneration affecting the corticospinal tracts and dorsal columns. It leads to weakness, spasticity and stiffness that is greater in the lower limbs. People with SP have difficulties with balance and walking especially over uneven territory and often trip due in part to poor clearance of the foot in swing phase. In recent years functional electrical stimulation (FES), usually of the common peroneal nerve, has been used clinically to mainly improve foot clearance and aid walking ability.

2. Aims

This study measured the change in ankle stiffness and strength and their effects on foot clearance in people with SP. The effect of FES on walking speed; efficiency and kinematics and its' perceived effectiveness was explored

3. Methods

A convenience sample of long term users of FES (>0.5 yrs) was sampled. Isometric ankle dorsiflexion strength and stiffness was measured using a dynamometer (Biodex, USA). Ankle stiffness was measured following slow (5°/s) and fast (60°/s) 5° dorsiflexion ramp and hold stretches when the participant was at rest. Stiffness was defined as:

A Torque / A Position

Ankle kinematics while walking was measured using a 3D motion analysis system (CODAmotion); three walking trials were recorded per subject. Results were compared to age, gender and weight matched controls walking at a matched walking speed.

Participants with SP were tested either without any FES (NONE), with bilateral FES to the common peroneal nerve (BIDF) or with their prescribed pattern of stimulation (PRES). The order of testing was randomised between participants. In each condition the walking speed, kinematics and physiological cost index was assessed over 10m (x3 per condition).

Additionally, participants were asked to rate the perceived effectiveness of the usual stimulation and degree of discomfort on a visual analogue scale (VAS).

4. Results

Eleven people with SP were assessed (57 ±14.2 yrs mean ±SD; 9 male) and compared to 11 matched controls (56.4 ±8.0 yrs).

Comparison with controls

People with SP had an increase in ankle stiffness when measured at both slow (SP=74.3 ± 8.9 Control 57.4 ± 13.9 Nm/rad) and fast speeds (SP= 120.4 ±16.0 Control= 67.5 ± 19.6Nm/rad). There was a significant reduction in isometric dorsiflexion strength (SP= 0.13 ±0.02 control= 0.58 ±0.5Nm/Kg).

In people with SP the range of ankle dorsiflexion in midswing was more reduced in people with higher passive stiffness in the ankle plantarflexors (R²=0.19) as measured during a slow stretch.

Effect of FES

People with SP had used FES for 2.6 yrs (±1.6). On a 10 point visual analogue scale they rated its' effectiveness as 7.5 (±3 median ± interquartile range) and discomfort as 0 (±1). This indicated a high perception of effectiveness (10 = most effective) and low degree of discomfort (0= no discomfort).

Eight people used BIDF routinely; other stimulation configurations targeted the hip abductor and lumbar extensors and the flexor withdrawal reflex. As a group BIDF resulted in a 7.0 ° ± 2.1 increase in the range of dorsiflexion in midswing (P<0.01). Walking speed increased compared to NONE (23.7 m/min) (ANOVA P<0.05) and this was slightly larger with PRES (25.8 m/min) compared to BIDF (25.3 m/min). There was no significant change in the PCI.

5. Discussion and Conclusions

FES may be a useful intervention for people with SP, it is generally well tolerated, can improve foot



clearance and lead to a change in walking speed. Future work should explore the effects on community ambulation and utilise a control group of people with SP.

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