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Functional Electrical Stimulation to Assist Equinovarus Deformity during Gait for a Patient with a Foot Dystonia: A Case Report

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Abstract

Functional Electrical Stimulation (FES) to address a walking difficulty associated with equinovarus deformity and foot drop has been shown to improve gait pattern and quality of life in populations with central nervous system disorders. To our knowledge, no research has been performed on the use of FES to address foot drop for a patient with a foot dystonia. The purpose of this single case study was to assess the use of FES for an individual with a foot dystonia on gait speed and quality of life (QOL). After 20 months of daily use of the FES system, clinically significant improvements were noted in 10m Walk Self Selected pace (10SS) and 10m Walk Fast Pace (10FP) both with and without the FES device. 10SS with FES increased +0.17 m/s (+15%); 10FP with FES increased +0.27 m/s (+19%); 10SS without FES increased +0.22 m/s (+19%); and 10FP without FES increased +0.27 m/s (+22%). In addition, improvements were seen in patient subjective report of QOL, which increased by 20%. The results of this case study demonstrate improvement in the gait speed and subjective QOL measures for an individual with an equinovarus deformity secondary to a focal dystonia.

Introduction

Individuals with an equinovarus deformity and foot drop often present with walking difficulty, which has a direct connection with, decreased quality of life (QOL), decreased gait speed, increased fall risk, and increased mortalitly [1]. Functional Electrical Stimulation (FES) to address a walking difficulty associated with equinovarus deformity and foot drop has been shown to improve gait pattern and QOL in populations with central nervous system (CNS) disorders associated with spasticity (i.e. Stroke [2] and Multiple Sclerosis [3]). FES to address foot drop is a neuromuscular electrical stimulation system that provides electrical stimulation to the anterior tibialis and peroneal muscles through surface electrodes. Activation of these muscles is coordinated through input from a pressure sensor in the heel of the shoe that activates the stimulation when the pressure is sufficiently decreased from the sensor (pre-swing through mid-swing). During initial fitting the intensity (mA) was adjusted until an appropriate muscle contraction was obtain resulting in adequate dorsiflexion and eversion of the foot. Research on FES and foot drop has been generally limited to Central Nervous System (CNS) related lesions, such as stroke or spinal cord injury [2,3]. However, limited research has addressed the use of a FES on a foot or hand. Barrett et al. [4]; showed improvements in balance and gait endurance with the use of surface FES in an individual with an isolated focal dystonia not combined with an additional movement disorder [4]. Dystonia is a neurological movement disorder presenting with muscles that contract involuntarily, often presenting as a twisting movement of the affected body part making it difficult for voluntary muscle contraction to occur [5]. Since central nervous system pathologies have successfully used FES to address equinovarus deformity and foot drop, we surmised that in an individual with a focal foot dystonia associated with a primary central movement disorder would also increase gait speed and QOL. The purpose of this single case study was to assess the use of FES on an individual with an equinovarus deformity and foot drop from a dystonia manifesting after CNS compromise on gait speed, QOL, and fear of falling.

Case Presentation

The subject is a 32-year-old female diagnosed with West Nile virus meningoencephalitis confirmed by an elevated level of IgM and pleocytosis via cerebral spinal fluid after a mosquito bite. The subject was hospitalized for 8 days at onset of diagnosis and presented with progressive weakness of bilateral limbs and difficulty feeding requiring a feeding tube (Table 1). During this acute hospitalization she underwent Intravenous Immunoglobulin treatment, which retarded the

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Table 1: Timeline of events from initial mosquito bite through post-assessment with Functional Electrical Stimulation.

Subject Timeline	
Time 0	Mosquito bite.
Day 7 (0.25 months)	West Nile virus meningoencephalitis diagnosis, Admitted For Acute Hospitalization.
Day 15 (0.5 months)	Admitted to Inpatient Rehabilitation Hospital.
Day 29 (1 month)	Discharged to home.
7 Months	Diagnosis of Complex Regional Pain Syndrome (CRPS).
15 Months	Resolution of CRPS. Continued dystonia with no intervention for 46 months.
61 Months	Initial Assessment, Outpatient PT
81 Months	Post PT Assessment

Table 2: Initial and Post results of gait speed, via 10 meter self-selected pace (10SS) and fast pace (10FP) both with and without functional electrical stimulation (FES), subjective quality of life (QOL), and fear of falling. Raw score change in meters/second (m/s) and percentage change are presented. Minimally clinical importance difference (MCID) is reported based on individuals with stroke and is denoted as an asterisk.

	Initial Speed (m/s)	**Post Speed at 20 Months (m/s)**	**Raw Score Change (m/s)**	**Percent Change**
10 meter self-selected pace				
without FES	0.96	1.18	+0.22*	+19%
with FES	1.03	1.20	+0.17*	+15%
10 meter fast pace				
without FES	0.97	1.24	+0.27*	+22%
with FES	1.12	1.39	+0.27*	+19%
Change with FES 10FP	*0.15**			
Subjective measures				
Subjective QOL	65%	85%		+20%
Fear of Falling	30%	10%		-20%

*MCID data for the 10-meter walk is not available for dystonia. MCID for Stroke = 0.14 m/s [9] and 0.16 m/s [10]

progression of symptoms. Following the acute hospitalization she presented to Inpatient Rehabilitation (IR) for Physical Therapy (PT) for limb muscle weakness and Speech Language Pathology to address bulbar muscle weakness. After two weeks of IR she was discharged home with almost full resolution of bulbar and muscle weakness. Six months later, she returned to neurology due to left foot weakness, pain, dysesthesias, hyperesthesia, swelling, skin changes and a dystonia. The subject was diagnosed at that time with Complex Regional Pain Syndrome (CRPS). Eight months later, without treatment for the CRPS, the pain resolved but the patient still presented with a dystonia of the left foot. To address the dystonia, she tried gabapentin and a series of onabotulinumtoxinA (Botox) injections with limited effect. Forty-six months later she presented to outpatient PT with difficulty walking longer distances, decreased QOL, and increased fear of falling because of the foot dystonia. The patient was assessed on gait speed via 10 meter walk self-selected and fast pace (10SS, 10FP respectively; with and without an FES system), QOL (subjective percentage), and fear of falling (subjective percentage). She was provided an FES system to address the equinovarus deformity and foot drop and a trial of a FES system was used (Bioness®, Inc) in the clinic. A successful muscle contraction was achieved to warrant further training with the device. Settings for the program included a symmetrical sinusoidal waveform were used at phase duration of 200 μS and a pulse rate of 30 Hz. Patient was interested in using this technology full time for community ambulation. She purchased an FES system for community use (WalkAide®, Reno, NV). She was educated on progressive use of the FES system to be worn daily during ambulation. Twenty months later, she returned for a follow up visit to assess gait speed, QOL and fear of falling.

Outcomes

At the twenty month follow up visit (post-intervention), the subject reported daily use of the FES system and clinically significant improvements were observed in 10SS and 10FP both with and without the FES system (Table 2); supplemental video of walking with and without FES both Initial and Post).

Initial/Post change with FES

Clinically significant improvements in 10SS (change, +0.17 m/s) and 10FP (change, +0.27 m/s) were noted with use of an FES system.

Initial/Post change without FES

Additionally, clinically significant improvements in 10SS (change, +0.22 m/s) and 10FP (change, +0.27 m/s) were noted without use of an FES system.

Immediate Initial change with FES

There was also an immediate clinically significant improvement observed in her gait speed on Initial 10FP (change, +0.15 m/s) with use of the FES system compared to without the FES system. No change in 10SS was noted during initial evaluation when using the FES system.

Additionally, improvements were noted in subjective report of QOL comparing Initial to Post (improved, +20%), and Fear of Falling (reduced, -20%).

Conclusion

The purpose of this single case study was to assess the use of FES on an individual with a foot dystonia on gait speed and QOL. The

results suggest a positive improvement in gait speed, QOL, and fear of falling with the use of FES for equinovarus deformity secondary to a focal dystonia. Improvements were observed both with immediate and long-term use with the FES system, which is consistent with other studies on other neurological conditions [6] Improvements were also observed long-term without an FES system, which may suggest an improvement in voluntary muscle control, which is consistent with other studies [7]. Other options exist for treatment of a foot dystonia, e.g. orthotics, deep brain stimulation, and orthopedic surgical interventions [8]; however, these results suggest that FES may be a feasible and less invasive option to address this impairment.

1. Limitations include the following: This is a single case study and future research is needed to determine the effectiveness of FES on a foot dystonia over a greater number of subjects

2. No measure of dystonia severity was used. Future research is warranted to understand the neurophysiologic response to FES with a foot dystonia. Additionally, future research is warranted to understand the long-term response and benefit of different treatment options compared with FES.

References

1. White DK, Neogi T, Nevitt MC, Peloquin CE, Zhu Y, Boudreau RM, et al. Trajectories of gait speed predict mortality in well-functioning older adults: The Health, Aging and Body Composition study. J Gerontol A Biol Sci Med Sci. 2013; 68: 456-64.
2. Sabut SK, Sikdar C, Kumar R, Mahadevappa M. Functional electrical stimulation of dorsiflexor muscle: effects on dorsiflexor strength, plantarflexor spasticity, and motor recovery in stroke patients. NeuroRehabilitation. 2011; 29: 393-400.
3. Miller L, Rafferty D, Paul L, Mattison P. The impact of walking speed on the effects of functional electrical stimulation for foot drop in people with multiple sclerosis. Disabil Rehabil Assist Technol. 2015; 11: 478-483.
4. Barrett MJ, Bressman SB, Levy OA, Fahn S, O'dell MW. Functional electrical stimulation for the treatment of lower extremity dystonia. Parkinsonism Relat Disord. 2012; 18: 660-661.
5. Dystonia Fact Sheet. Office of Communications and Public Liaison. National Institute of Neurological Disorders and Stroke. Dystonia Fact Sheet. 2015.
6. Kralj A, Acimovic R, Stanic U. Enhancement of hemiplegic patient rehabilitation by means of functional electrical stimulation. Prosthet Orthot Int. 1993; 17: 107-114.
7. Pilkar R, Yarossi M, Nolan KJ. EMG of the tibialis anterior demonstrates a training effect after utilization of a foot drop stimulator. NeuroRehabilitation. 2014; 35: 299-305.
8. Schjerling L, Hjermind LE, Jespersen B, Madsen FF, Brennum J, Jensen SR, et al. A randomized double-blind crossover trial comparing subthalamic and pallidal deep brain stimulation for dystonia. J Neurosurg. 2013; 119: 1537-1545.
9. Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. J Am Geriatr Soc. 2006; 54: 743-749.
10. Tilson JK, Sullivan KJ, Cen SY, Rose DK, Koradia CH, Azen SP, et al. Meaningful gait speed improvement during the first 60 days poststroke: Minimal clinically important difference. Phys Ther. 2010; 90: 196-208.