

Functional Electrical Stimulation (FES) and Multiple Sclerosis – a review of the literature

In the past few years, there has been a substantial increase in the evidence supporting the use of Peroneal Nerve FES to alleviate drop foot in people with Multiple Sclerosis (MS). The evidence supporting the use of FES now includes: three randomized trials,^{1,2,3} one controlled trial (healthy controls),⁴ two treatment device comparison trials (FES vs. AFO vs. no Device⁵ and two different FES devices vs. each other and no device⁶) and nine single intervention (FES on versus off), subjects as own controls studies.⁷⁻¹⁵ The results of these studies have added tremendously to the base of knowledge for intervention with FES.

Outcomes:

Gait Speed: Significant improvements in gait speed with the utilization of FES for people with MS have been demonstrated in the majority of studies in the literature.^{1,3-8,10-15} The significant increases in gait speed with FES range from a low of a 6% change from baseline¹¹ to a high of 49%.¹⁵ These gains in gait speed are appreciated quickly and proved stable over time.^{11,15} The greatest percent change in gait speed (49%) was calculated from a decreased time to complete a Timed 25 Foot Walk Test and was seen in a study of 19 subjects with MS who used FES as a neuroprosthesis during a 2 week home assessment.¹⁵ The largest longitudinal study of the effects of FES on gait speed for people with MS followed 32 subjects across 11 months.¹¹ The results of this study showed that the greatest increase occurred within 3 months but noted that the improvement was significant in as little as 1 month and remained stable over the entire 11 month study.¹¹

Energy cost with gait: FES has also been shown to decrease the energy cost of gait. Study results have demonstrated decreases in O₂ consumption,^{4,8} increased endurance with gait^{1,14} and a decrease in Physiologic Cost Index (PCI).^{7,10-12} Two studies investigated the effect of FES wear on oxygen cost. One showed a decrease in O₂ consumption after only 5 minutes of walking at a self-selected walking speed.⁸ The other study included subjects with MS who had worn FES more than 6 months and demonstrated that utilization of FES resulted in significant decreases in O₂ consumed per unit distance.⁴ The decrease in the energy cost of gait can also be measured by demonstrating an increase in distance walked over a period of time. The evidence now demonstrates that utilization of FES can result in a significant increase in distance walked during both a timed 2 minute¹⁴ and a timed 3 minute walk.¹ PCI is a measure that combines changes in heart rate and respiratory rate; a decrease in PCI indicates a lower energy cost. The decreases in PCI noted in people with MS who utilize FES range from a low of a 3% change from baseline⁷ to a high of 24%.¹² The largest decrease in PCI noted in the literature, 24%, was measured after only 4.5 months of daily FES wear.¹²

Functional Mobility: Two studies investigated changes in functional mobility with the utilization of FES.^{2,9} One study looked at 11 people with MS (previous AFO users) and measured outcomes using the functional activity section of the Modified Emory Functional Ambulation Profile (mEFAP).⁹ This performance measure includes ambulation on tile, carpet, through obstacles, upstairs and during a Timed up and Go test. Results demonstrated a significant improvement on the stair component of the mEFAP with FES. There was also a trend toward improved navigation of the obstacle course but this was not significant.⁹ An earlier study by the same author looked at the effectiveness of an AFO alone in improving gait for persons with MS.¹⁵ That study showed no significant improvements in these same measures illustrating that FES may be an improvement over the current standard of care. The impact of MS on functional mobility was also studied in a randomized controlled trial that used the self-report Canadian Occupational Performance Measure (COPM) to compare a score of performance with ADLs and perceived satisfaction with functional ability.² This study randomized 64 people with MS to an FES group and compared their outcomes to a group of subjects receiving Physical Therapy alone. The FES group showed significant increases on both the performance and

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satisfaction scores of the COPM. The FES group also had a significantly decreased incidence of falling. With regards to the falls that did occur, 70% occurred when the FES device was not on.² Another study investigating the effects of using PN FES as a neuroprosthesis showed a similar correlation of changes in function and patient satisfaction. This study found that after completion of a 2 week home assessment program, subjects demonstrated significantly increased scores on both the MS Walking Scale and the MS Impact scale, two measures of perceived improvement in gait function and Quality of Life (QOL).¹⁵

Neuroplasticity: Therapeutic effects of FES, meaning that improved function is retained even after the FES device has been turned off, have been demonstrated in the both CVA and MS populations even given the progressive nature of MS.^{7,10,16} Some of these effects have been shown to be cumulative over the course of 3-4 months. Two studies have shown that these cumulative effects were greatest at 3-4 months and tended to plateau thereafter.^{7,10} Values never returned to baseline however, suggesting that some long term improvement was made even taking into account progression of the disease. One of the studies showed continued neuroplastic changes in persons with MS over the course of 4.5 months.⁷ These studies measured maximum voluntary muscle contractions (MVC) and changes in the cortical activity in the brain and the resulting muscle function (Motor Evoked Potentials or MEP) using Transcranial Magnetic Stimulation. The significant improvements in both MEP and MVC measures were highly correlated and unrelated to muscle hypertrophy or learning.⁷ Both of these studies also showed therapeutic effects for gait speed (improvements noted even with the FES device turned off), with increases in speed of 7%⁷ in one study and 10%¹⁰ in the other.

Gait Quality: Recent studies have also investigated the effect of the use of FES on the quality of gait for people with MS. One looked at FES wear with Physical Therapy vs. a control group receiving Physical Therapy alone.³ The FES group showed improved gait as measured by the Rivermead Observational Gait Analysis as well as improved speed and a reduced incidence of falls. Other studies looked at changes in gait kinematics during the use of FES.^{5,13-14} The parameters noted to have significantly improved were peak dorsiflexion during swing,¹³⁻¹⁴ peak knee flexion during swing,¹³ improved ankle dorsiflexion at initial contact⁵ and increased stride length.¹⁴ All of these demonstrated results point to improvements in gait symmetry and quality when FES is utilized to alleviate drop foot during gait.

Key Points: Though the Ankle Foot Orthosis continues to be the standard of care for drop foot post MS, there is evidence that the AFO is not always effective for this population.¹⁶ MS is a condition that responds favorably to FES and the literature supports that people with MS are excellent candidates for FES. FES has proven to be an effective means of eliminating drop foot, increasing gait speed and improving functional mobility with some studies supporting positive neuroplastic effects post FES wear. FES has also been shown to be an effective long-term solution with a beneficial impact on not only the perception of disability and QOL but also on cost of care.^{15,18} These studies report important findings and speak directly to the ability of persons with MS to stay mobile, independent and active well after the functional decline imposed by their disease. Changes noted with the utilization of FES have direct implications for healthcare costs, workplace productivity and quality of life for persons living with Multiple Sclerosis. FES should be considered as a viable alternative to the current standard of care, an AFO.

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