Functional Electrical Stimulation (FES) and Spinal Cord Injury – a review of the literature

Many articles document the effects of FES on gait impairment post Spinal Cord Injury (SCI). However, variation in the nature of SCI produces complicated and unique clinical presentations with a great deal of variability in the muscle groups affected. Consequently, most FES studies with this population seek to address deficits in multiple muscle groups and investigate the effects of multi-channel FES systems. Nonetheless, there are 9 more recent studies in the literature that specifically investigate the use of Peroneal Nerve FES (PN FES) systems to alleviate drop foot after SCI.[1-9]

Many of the studies within the population of SCI investigate PN FES as part of a therapeutic program including other treatment modalities such as body weight support treadmill training (BWSTT). Only 3 of the 9 studies look at PN FES as a long-term, neuroprosthetic solution for drop foot.7-9 One study investigates short-term neuroprosthetic effects of PN FES, using single session measurements to compare gait performance with PN FES to that of an AFO.5 Five of the 9 studies involve the therapeutic use of PN FES and BWSTT combined.1-4,6 Gait speed and symmetry are the outcomes most often measured in studies utilizing PN FES.

Outcomes:

Gait Speed: The results of all the PN FES studies for this population demonstrate increased gait speed regardless of whether the gait was tested over-ground with PN FES or with PN FES and BWSTT. The study comparing the short-term efficacy of PN FES to AFOs measured over-ground gait speed under three conditions: AFO alone, PN FES alone and with both devices combined, reporting a 10% increase in gait speed with PN FES alone and an 18% increase when PN FES was combined with an AFO.[5] The 3 studies that looked at long-term PN FES showed increases ranging from a 13%[7] to a 55%[9] change at 12 months. One of these studies also looked at possible therapeutic effects, or the continued improvement noted when device is turned off, and found that at 12 months the subjects with SCI showed a 28% increase in gait speed *without* PN FES.[8]

Four of the therapeutic studies measured changes in gait speed with PN FES both over-ground and with BWSTT and showed very significant increases.[1-4] The duration of PN FES in these studies varied from sessions lasting 60 minutes 3 days/week for 12 weeks[2] to sessions lasting 60 minutes 5 times/day for 12 weeks.[1] The results of these studies showed large increases in gait speed ranging from a 55%[1] to an 84% increase.[3] Two of the studies reported remarkable increases of 106% and 158% respectively when the subjects walked with PN FES and BWSTT.[2,3] Additionally, one study reported that of all the training methods, the most significant gait speed gains occurred in the over-ground with PN FES group.[4] This study showed that the PN FES over-ground group had the most significant gains in distance walked during the 2 minute walk test as well.[4]

Gait Symmetry: Two of the studies that compared PN FES over-ground and with BWSTT reported increases in step and stride length,[1,6] with one also reporting an increase in the symmetry of swing and stance phase.[1]

Other outcomes: In the study comparing PN FES and AFOs under three conditions: AFO, PN FES and a combination of both devices, results showed that the distance between the subject's foot and the floor during swing was significantly greater with PN FES than with an AFO.[5] The combination of AFO and PN FES was even more effective for foot clearance.[5] Considering that the AFO is currently the standard of care for reducing foot drop; it is significant that this study shows PN FES to be superior to bracing in that regard.

Key Points: The SCI literature is varied and few studies specifically investigate PN FES as a neuroprosthesis; however, the results that are reported provide significant support for PN FES. A SCI typically results in weakness involving many more muscle groups than just the anterior tibialis muscle. The fact that single channel PN FES produces such positive

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outcomes is a testament to the incredible effectiveness of FES in restoring motor function. Patients with SCI are excellent candidates for PN FES and the results in the literature support significant functional gains, even with patients who are many years post injury.[9]

Reimbursement is also a consideration. Both multi-channel FES and PN FES systems are reimbursed by Medicare for people with SCI. SCI is the only diagnosis with that distinction. The multi-channel system Parastep has been reimbursed since 1982 for SCI and the WalkAide PN FES system was approved for reimbursement in January of 2009. The support of a third party payer makes the prescription of a PN FES system to alleviate drop foot an even more realistic option for those with SCI.

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