Does Functional Electrical Stimulation for Foot Drop Strengthen Corticospinal Connections?

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Abstract

Background. Long-term use of a foot-drop stimulator applying functional electrical stimulation (FES) to the common peroneal nerve improves walking performance even when the stimulator is off. This “therapeutic” effect might result from neuroplastic changes. Objective. To determine the effect of long-term use of a foot-drop stimulator on residual corticospinal connections in people with central nervous system disorders. Methods. Ten people with nonprogressive disorders (eg, stroke) and 26 with progressive disorders (eg, multiple sclerosis) used a foot-drop stimulator for 3 to 12 months while walking in the community. Walking performance and electrophysiological variables were measured before and after FES use. From the surface electromyogram of the tibialis anterior muscle, we measured the following: (1) motor-evoked potential (MEP) from transcranial magnetic stimulation over the motor cortex, (2) maximum voluntary contraction (MVC), and (3) maximum motor wave ($M_{\text{max}}$) from stimulating the common peroneal nerve. Results. After using FES, MEP and MVC increased significantly by comparable amounts, 50% and 48%, respectively, in the nonprogressive group and 27% and 17% in the progressive group; the changes were positively correlated ($R^2 = .35; P < .001$). Walking speed increased with the stimulator off (therapeutic effect) by 24% ($P = .008$) and 7% ($P = .014$) in the nonprogressive and progressive groups, respectively. The changes in $M_{\text{max}}$ were small and not correlated with changes in MEP. Conclusions. The large increases in MVC and MEP suggest that regular use of a foot-drop stimulator strengthens activation of motor cortical areas and their residual descending connections, which may explain the therapeutic effect on walking speed.