# FES Neuroprosthesis versus an Ankle Foot Orthosis: the effect on gait stability and symmetry

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**Purpose**
To compare the effects of an FES neuroprosthesis (NESS® L300™), versus an Ankle Foot Orthosis (AFO), on gait stability and symmetry in patients with foot drop.

**Relevance**
Gait rehabilitation is a cornerstone of physical therapy practice.

**Participants**
15 patients (mean age: 52.2±3.6 yrs) with chronic hemiparesis (5.9±1.5 yrs) whose walking was impaired by foot drop and regularly used an AFO. 12 patients were post stroke and 3 patients were post traumatic brain injury.

**Methods**
After providing written informed consent, approved by the Human Studies Committee, Lowenstein Rehabilitation Hospital, the FES neuroprosthesis was applied individually for each patient. There was a four week adaptation period during which participants increased their daily use of the neuroprosthesis; while using the AFO for the rest of the day. Gait was then assessed in a 6 minute walk while wearing force-sensitive insoles, alternately using the neuroprosthesis and the AFO in a randomized order. An additional gait assessment was conducted after using the neuroprosthesis for a further four weeks. Stride time (inverse of cadence) was determined, as were gait symmetry index and swing time variability, both markers of gait stability and fall risk.

**Analysis**
Paired t-tests were used for each parameter to compare the AFO and neuroprosthetic effects after four and eight weeks.

**Results**
After the four week adaptation period, the FES neuroprosthesis and the AFO affected gait similarly ($p>0.05$). After eight weeks of walking with the neuroprosthesis, gait was significantly improved relative to the AFO. Stride time, a measure of the walking pace, improved from 1.48±0.21 sec while walking with the AFO to 1.41±0.16 sec with the neuroprosthesis ($p<0.02$). The single limb support (SLS) of the paretic leg (swing time of the non paretic leg) became more consistent. The coefficient of variation (CV) of the SLS decreased from 5.3 ± 1.6% while walking with AFO to 4.3 ± 1.4% while walking with the neuroprosthesis ($p=0.01$). The gait symmetry index improved by 15%, from 0.20± 0.09 with the AFO to 0.17±0.08 with the neuroprosthesis ($p<0.05$). All of the participants preferred the neuroprosthesis to the AFO for daily ambulation.

**Conclusions**
After initial adaptation, the neuroprosthetic effect on gait was similar to an AFO, but was significantly better after eight weeks. The results thus indicate that the use of an FES neuroprosthesis (NESS L300) is likely to enhance gait performance in comparison to walking with an AFO. The neuroprosthesis improved walking pace, with gait becoming less variable and more consistent. These findings suggest enhanced "automaticity of gait", and a reduction in the risk of falls. The ongoing improvement at 8 weeks further suggests that continued use may lead to further normalization of gait.

**Implications**
These findings suggest that compared to an AFO, an appropriate dynamic FES neuroprosthesis may yield better balance control and symmetry during walking, and thus more effectively manage foot drop due to stroke or traumatic brain injury.

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Neuroprosthesis, AFO, Gait.

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