

# A comparison of electrical stimulation and the conventional ankle foot orthosis in the correction of a dropped foot following stroke

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## Abstract

*Numerous studies have reported improvement in hemiplegic gait using an Ankle Foot Orthosis (AFO) or Functional Electrical Stimulation (FES) although no studies have been found that have compared the two. The conventional AFO is cheaper, easier to apply than FES and provides consistent and stable support. However, FES allows more passive and active movement of the ankle than the conventional AFO. 22 participants who had had a stroke within the last 6 months were randomly assigned to use either an Orthomerica Supra-Lite AFO or an Odstock Dropped Foot Stimulator (ODFS) to manage their dropped foot for 24 weeks.*

*Both groups demonstrated significant improvements in walking speed and physiological cost index (t-test,  $p < 0.05$ ). Both groups showed significantly increased endurance in their walking range (t-test,  $p < 0.05$ ). This general recovery was also demonstrated by significant improvements in the Rivermead Mobility Index (t-test,  $p < 0.05$ ). No significant changes in spasticity were observed as measured by the Ashworth scale. No significant differences between the groups were observed by ANCOVA on any of these measurements.*

## 1 Introduction

Numerous studies have reported improvement in hemiplegic gait using an ankle foot orthosis (AFO) [1][2][3] or functional electrical stimulation (FES) [4] [5] [6] [7]. No studies have been found that have compared the two, yet there are advantages and disadvantages for each method. The conventional AFO is cheaper, easier to apply than FES and provides consistent and stable support. Disadvantages

are that there is a loss of normal range of ankle movement, both passive and active, a delay in the recovery of active ankle dorsiflexion and, if the orthosis is not properly adjusted, an increase in knee instability. There is also some suggestion, though not proven, that AFOs increase spasticity in the calf muscles. In clinical practice it has been found that patients often discard AFOs because they find them uncomfortable or ineffective. The advantage that FES has, compared to conventional AFOs, is that it allows both passive and active movement of the ankle. There is also some evidence, although not conclusive, that it results in improved voluntary ankle movement [8][9] and in inhibition of calf spasticity [10]. The disadvantages of FES are that it is more expensive, takes more time and skill to apply, making it unsuitable for some patients, and does not provide such a fixed degree of ankle stability.

## 2 Methods

Over 40 potentially suitable participants were recruited by physiotherapy staff from 6 National Health Service Trusts. After formal screening 26 suitable participants were recruited who met the inclusion and exclusion criteria.

The participants were randomly assigned to use either an *Orthomerica Supra-Lite* AFO or an *Odstock Dropped Foot Stimulator (ODFS)* to manage their dropped foot. Wherever possible, the fitting and assessment of the devices were carried out by different people. Outcome measures were taken every six weeks.

## 2.1 Inclusion Criteria

1. Single stroke of vascular origin with hemiplegia (<6 months)
2. Assessed by a clinical specialist physiotherapist to confirm that both a stimulator and an AFO would be suitable for the patient
3. Affected by a drop-foot, identified by failure to achieve a heel strike, and corrected by FES
4. Inability to achieve an effective push-off at terminal stance, identified by clinical observation

## 2.2 Exclusion Criteria

1. Previous use of a dropped foot stimulator or AFO in four weeks prior to start of intervention
2. Required an AFO other than that selected for the trial

## 2.3 Outcome Measures

- Walking speed (measured over 10 metres and timed by a stopwatch).
- Physiological cost index (PCI), a measure of the effort in walking based on walking speed and increase in heart rate, was measured at the same time as walking speed. It has been shown to correlate well with other methods of determining energy expenditure (Butler et al. 1984).
- Endurance (the total distance the participant is able to walk without an AFO or FES in 3 minutes).
- Calf spasticity (measured using the modified Ashworth scale).
- Mobility (measured using the Rivermead mobility index).

## 3 Results

Both groups demonstrated significant improvements in walking speed and physiological cost index when comparing measurements in week 24 to week 0 (t-test,  $p < 0.05$ ) (figures 1 & 2). Both groups showed significantly increased endurance in their walking range (t-test,  $p < 0.05$ ). This general recovery was also demonstrated by significant improvements in the Rivermead Mobility Index (t-test,  $p < 0.05$ ). No significant changes in

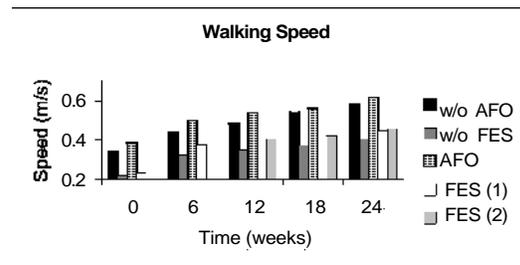
spasticity were observed as measured by the Ashworth scale.

The changes in walking speed, physiological cost index, Rivermead, endurance, and spasticity that both groups exhibited were compared by an ANCOVA but there were no significant differences between the groups on any of these measurements.

When the second channel of stimulation was added at week 12 to the FES group a non-significant trend of increased speed and reduced PCI was observed in measurements of two-channel walking versus single-channel walking.

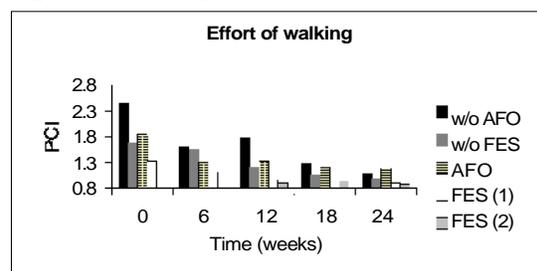
It was also observed that the greatest group improvements in walking speed, physiological cost index, endurance and Rivermead Mobility Index occurred during the first six weeks of the trial.

**Figure 1:** Average walking speed against time for



both groups. W/o AFO is walking speed when AFO group is not wearing AFO, w/o FES is similar, FES(1) and FES(2) are single and two channel FES respectively.

**Figure 2:** Physiological Cost Index against time for



both groups. Similar nomenclature is used as in figure 1.

## 4 Discussion and Conclusions

Both groups demonstrated significant improvements in walking speed, physiological cost index, Rivermead Mobility Index and endurance consistent with recovery from a stroke within the last 6 months. The study showed that FES can be used very early post

stroke to aid walking e.g. one subject used started FES only seven weeks after a severe stroke. It is always a problem discriminating between natural recovery and the effect of intervention in acute and sub-acute patients. The trend observed for the greatest improvements occurring within the first 6 weeks of intervention clearly indicates that this improvement was unlikely to be solely accounted for by 'natural recovery' but rather was increased by the intervention of FES or an AFO. A further result of these improvements in both groups was that it was not possible to detect any significant change in any of the outcome measures between the groups.

It was noted that a number of participants were excluded from the trial as there were overriding clinical reasons why only an AFO or only an ODFS was preferable for that individual. There will clearly be some people for whom only an AFO or an ODFS will be appropriate. For the remainder, however, the study presented no evidence to support either FES or AFOs being preferable in the sub-acute stage of recovery.

An additional finding of the study was that the use of second channel of calf stimulation for every patient with single channel common peroneal stimulation only yielded a modest non-significant improvement in the walking speed and physiological cost index of the group indicating that calf stimulation is not clinically appropriate for all single channel users. Some trial subjects found the extra pair of electrodes counterproductive, however others benefited. Those subjects with marked lack of push-off, good motivation, and low spasticity benefited most from two channel common peroneal and calf stimulation.

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## Acknowledgements

The authors are grateful to the trial volunteers. They also acknowledge the statistical advice from Mr. Paul Strike, Research and Development Unit, Salisbury District Hospital. This research was funded by Action Research.