Retrospective study of patients using Functional Electrical Stimulation for drop foot correction and increased hip stability

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Abstract

This is an audit of patients attending the Salisbury Functional Electrical Stimulation Clinic for surface stimulation of common peroneal nerve and gluteal muscles. Results show this combination of stimulation is possible for patients with neurological deficit due to CVA and MS to set up and manage as part of their daily routine. From objective data significant improvements in speed and effort were found with stimulation. Significant improvements were found in non stimulated walking over six months of use in CVA group, which could indicate a training effect.

For patients capable of managing the more complex equipment, stimulation of common peroneal nerve and gluteal muscles is an acceptable treatment to improve gait pattern and hip stability in stance, reduce effort and increase speed and distance patients can walk.

1 Introduction

The concept of Functional Electrical Stimulation (FES) was put forward by Liberson, 1961 when electrical stimulation was applied to the common peroneal nerve to correct foot drop with hemiplegic patients [1]. Useful orthotic effects and some training or carryover was noted. Several groups have continued this work including Salisbury District Hospital, UK where 1144 patients, with a mixture of upper motor neurone problems, have been seen for walking stimulation. Most use a single channel drop foot stimulator (ODFS). Results of previous trials and audits have shown improvements in walking speed and reduced effort as measured by the Physiological Cost Index (PCI), and subjective improvement noted by patients [2][3]. Recognising drop foot is frequently not an isolated problem, the Salisbury Team developed the Odstock 2 Channel Stimulator (O2CHS). It has been applied to a diverse range of problems with the first channel often correcting foot drop and the second commonly stimulating hamstrings for increased knee flexion in swing or gluteal muscles to increase hip stability in stance phase of the gait cycle. Hip instability often has a classic Trendelenberg presentation or appears as a reluctance to transfer weight to the affected side. A lack of hip extension in stance is associated with a tendency to hyper extend the knee because the ground reaction vector passes in front of the knee at heel strike. Sixty patients have used the O2CHS for correcting drop foot and improving hip stability. From experience many patients continue to use the O2CHS for more than three months and report benefits including better walking pattern and decreased fatigue.

Large self-adhesive electrodes (usually round 7cm diameter PALS) are used over the gluteal muscles in order to maximise the contraction. Positions can be chosen to favour gluteus maximus for hip extension or gluteus medius for hip abduction/lateral stability. In a questionnaire ODFS users highlighted problems siting and keeping in place electrodes, but the frequency of problems occurring in this O2CHS population has not been studied [3].

The purpose of this audit is

- to evaluate stimulated and unstimulated gait by comparing walking speeds and Physiological Cost Index (PCI) values recorded in clinic
- to explore subjective changes reported by patients
- to examine reasons for stopping use of the 2 channel stimulator

2 Methods

Patients attend the FES clinic for an initial assessment to ensure suitability and for a set up appointment (over two days), then at six week and three month intervals. After this patients usually attend every six months with telephone advice and technical back up readily available. As use of the more complex O2CHS takes commitment and skill on the part of the patient

they start with single channel drop foot stimulation. The O2CHS is triggered from a pressure sensitive foot switch worn in the shoe (affected side). Heel rise triggers stimulation of the common peroneal nerve (CPN) correcting foot drop in swing phase. CPN stimulation is turned off by loading of switch at heel strike and this event starts the second gluteal channel, which ceases at heel rise.

From computer records 60 patients were found to have used gluteal stimulation. Clinical records and correspondence were hand searched to gain subjective information. Therefore patients whose notes were unavailable at the time of the hand search were excluded. Patients excluded for this reason had a mixture of pathology multiple sclerosis (MS) n=1, spinal cord injury (SCI) n=1, stroke (CVA) n=5, other n=2. A total of 51 patient records were available to audit, 25 had CVA, 16 had MS, 3 had SCI, 2 had a traumatic brain injury (TBI), 2 had drop foot following radiotherapy, 1 had encephalitis resulting in hemiparesis, 1 had myopathy and 1 had MS and multiple CVA's. In order to examine trends it was decided to concentrate on the two largest groups, CVA and MS patients. The data from the two groups was analysed separately. The aim of FES treatment in the CVA group is often provision of an orthotic improvement with training effect, while the aim of FES treatment in the MS group is predominantly an orthotic improvement.

3 Results

3.1 CVA Group (n=25)

Full objective data for the first appointment at which O2CHS was set up, was available for 14 of these 25 patients. Lengthy set up of the more complex 2 channel system often means patients are too tired to do the walking tests or there is not enough time during the clinic appointment. Also some patients are unable to walk 10 metres with no stimulation (NS), with one channel of stimulation (S1) and two channels (S2) a total of 30m. Mean results for the 10m walking tests are shown below (Table 1).

Patients in this group had a mean time post CVA of 4 years (range 1-10 years) at the time of starting FES treatment at Salisbury. ODFS was used for 21 months prior to set up with an O2CHS (mean, range 2-70 months). Nine patients had full data sets for the appointment following their O2CHS set up, mean time between appointments 5 months. From this data it was calculated that over this time NS walking speed increased by a mean of 8.5% (p=0.03) and no significant changes occurred in PCI.

NS = non stimulated walking S1 = with 1 channel of stimulation S2 = with 2 channels of stimulation	Mean % change * Wilcoxon Test
Speed (m/s) NS v S1	15.0 p=0.01*
Speed (m/s) NS v S2	17.7 p=0.01*
Speed (m/s) S1 v S2	1.6 P=0.39*
PCI (heartbeats/min) NS v S1	-12.0 p=0.03*
PCI (heartbeats/min) NS v S2	-8.1 p=0.09*
PCI (heartbeats/min) S1 v S2	-4.6 P=0.16*

Table 1: *Mean walking test results*

From the entire group of CVA patients 14 continue to use the O2CHS and 11 have stopped and reverted to use of the ODFS for CPN stimulation only (mean time O2CHS used 16 months). Recorded reasons for stopping were, preferred ODFS n=3, skin irritation n=1, sensitivity to sensation of gluteal stimulation n= 1, 'bother' of donning not worth benefit n= 1 and inconvenience of 2 channel n= 1. It should be remembered that subjective information gained from patient records is a mixture of patients' and clinicians' opinions recorded by the clinician.

The O2CHS was used for a variety of reasons

- improve gait pattern n= 10
- increase stability n=1 0
- corrected hip retraction n=7
- increase distance walked n=6
- increased confidence n=3
- better weight transfer to affected side n=2

and improved balance, speed, lower limb spasticity, quality of life and decreased knee hyperextension and reduced reliance on carers all noted at n=1 frequency.

Problems using gluteal stimulation were reported, mainly keeping the electrodes in place n=5, actually placing the electrode for a good contraction n=4, stimulation sensation n=2, 'bother' of using not worth benefit n=2, skin irritation n=2 and equipment reliabilty n= 1.

3.2 MS Group (n=16)

Full data sets were available for 10 of the 16 patients at their O2CHS set up appointment and mean results are shown below (Table 2). Reasons for incomplete data are the same as the

CVA group. Within this group 9 continue to use O2CHS and 7 have stopped, including one who died, of unrelated cause. The other 6 reverted to ODFS use. Mean time O2CHS used was 9 months. Reasons for stopping were, not coping with using the O2CHS n=5, 'bother' not worth benefit n= 1, electrode placement n= 1 and no longer walking much n=1. Problems keeping the electrodes in place n=3, placing the electrodes for a good contraction n=2 and skin irritation n=2 were reported with gluteal stimulation.

NS = non stimulated walking S1 = with 1 channel of stimulation S2 = with 2 channels of stimulation	Mean% change * Wilcoxon Test
Speed (m/s) NS v S1	13.8 p=0.01 *
Speed (m/s) NS v S2	17.4 p=0.01 *
Speed (m/s) S1 v S2	3.0 P=0.12*
PCI (heartbeats/min) NS v S1	-18.8 p=0.01*
PCI (heartbeats/min) NS v S2	-20.8 p=0.02*
PCI (heartbeats/min) S1 v S2	-2.8 P=0.36*

Table 2: *Mean walking test results*

The O2CHS was used for a variety of reasons - increase stability n=7
- corrected hip retraction n=5
- improve gait pattern n=4
- increase distance walked n=4
- decrease fatigue n=2
- rely on 2 channel stimulator to walk n=2

Also improved safety and confidence and reduced effort all reported at n= 1 frequency. One person also reported that it helped on rough ground and another that they used it as a gait training tool.

4 Discussion and Conclusions

Clinicians record the O2CHS improves gait pattern and hip stability in stance and assists patients in walking further. It is impossible to separate patient and clinician comments therefore subjective data regarding reasons to use/stop O2CHS cannot be attributed. Problems managing the O2CHS, including electrode positioning warrants further investigation and should assist in refining the technology and patient selection criteria. The availability of patient notes and the incomplete nature of the patient records also limit the conclusions of this audit.

Use of the O2CHS for gait re-education (CVA patients) is supported by an average increase in non stimulated walking speed of 8.5% (p=0.03) over 5 months. This follows trends seen with ODFS [4] but could be explained by improvements/life style changes unrelated to electrical stimulation. These patients are mean 4 years post CVA and therefore an investigation of the optimum point in recovery for this kind of intervention is indicated.

Significant improvements in speed and PCI between one channel (CPN) of stimulation and non stimulated gait were recorded for both the CVA and MS groups. Addition of the 2nd channel in MS patients further increased speed and reduced effort but the change did not reach significance. In the CVA group the 2nd channel increased speed but took more effort, neither change significant. Walking speed and PCI may not be the most appropriate outcome measures to demonstrate the use of O2CHS for assisting weight transfer and gait retraining.

The results of this audit demonstrate subjective and objective benefits can be gained from use of O2CHS for CPN and gluteal stimulation. In conclusion there is a need for further controlled trials, with appropriate outcome measures, to evaluate the orthotic and training effects of O2CHS use and define the populations for whom most benefit can be gained.

References

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