Clinical results of a preliminary investigation into the use of two channel stimulation to improve the quality of walking of patients with established hemiplegia.

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Single channel stimulation of the common peroneal nerve has been shown to improve walking in a sample of patients with established hemiplegia [1]. For most patients with upper motor neurone lesions gait problems are compounded by weakness and inappropriate activation of muscle groups other than the peronei and anterior tibial group.

This pilot study investigated the usefulness of stimulating a second muscle group during a defined period of the gait cycle. The investigation set out to establish the following:

- Which muscle groups could effectively be stimulated
- At what period of the gait cycle
- How could this be defined by two foot-switches
- With what effect on gait parameters

The sequence of stimulation is determined by either one or two FSR foot switches placed on an innersole within the users shoe. By placing switches under the heel and first metatarsal head it is possible to determine the heel strike, flat foot, terminal stance and swing phases of gait in a simple and convenient manor. Stimulation and timing parameters are set up in LabVIEW and down loaded from the PC via a serial link. When a foot switch or logical combination of switches changes state, an initiation condition is met triggering a stimulation sequence. The therapist can program the pre stimulation delay, rising and falling edge ramps, on times and foot switch termination conditions for each channel in addition to the normal stimulation parameters. Each channel can produce two bursts (wavelets) of stimulation per sequence. The second burst has commonly been used as an extension period after heel strike to prevent "foot flap" when stimulating the common peroneal. Where possible it is desirable to initiate and terminate stimulation times directly from foot switch states as adding fixed times and delays means the sequence will adapt poorly to changes in walking speed. However in practise, this is often not a significant problem allowing the simplicity and reliability of a single switch.

Eight patients were studied using the Compustim 10B programmable two channel stimulator. With the exception of one patient, who had bilateral foot-drop, each patient used a single channel stimulator for a period prior to the addition of a second channel.

In all cases one channel continued to be used to stimulate the common peroneal nerve during swing phase and the second channel was added to stimulate an additional muscle group. In three cases the hamstring muscles were stimulated during terminal stance and part of swing phase. In three cases the calf muscle group was stimulated during push-off and in one case the triceps bracchii and posterior deltoid muscles were stimulated to enhance arm swing and inhibit the associated reaction of arm flexion.

Gait was assessed by walking speed and physiological cost index over a series of 10 metre walks. The results are summarised in the table below.

Conclusions:
The sample size is not large enough for results to reach statistical significance but suggest that some carry-over is experienced which was not achieved with single channel stimulation and considerable improvement is seen in both walking speed and PCI. (Mean increase in walking speed = 39.6%, mean decrease in PCI -0.4%) Greatest improvement in PCI was seen in the subjects using hamstring stimulation (Mean -51%). From these results stimulation of triceps and posterior deltoid seemed not to be effective but the authors feel that this needs to be tested with more patients. Bilateral common peroneal stimulation was an effective orthosis for the patient studied but did not elicit any carry-over.

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SUMMARY OF THE ABSOLUTE AND PERCENTAGE CHANGES IN GAIT PARAMETERS DURING THE TRIAL PERIOD

	SPEED m/s			**PHYSIOLOGICAL COST INDEX (PCI)**		
	CARRY-OVER	SINGLE CHANNEL	2 CHANNEL	CARRY-OVER	SINGLE CHANNEL	2 CHANNEL
SUBJECT	NS4 - NS1	S4 - NS1	S4 - NS1	NS4 - NS1	S4 - NS1	S4 - NS1
1. CP and Calf	0.27 (129%)	0.39 (186%)	0.41 (195%)	-0.8 (-62%)	-0.9 (-69%)	-0.90 (-69.2%)
2. CP and Hams	0.31 (54%)	-0.48 (35%)	0.51 (106%)	-0.3 (-14%)	-0.7 (14.3%)	0 (0%)
3. CP and Hams	0.26 (100%)	0.35 (135%)	0.57 (219%)	-0.6 (55%)	-0.6 (-54.5%)	-0.8 (-73%)
4. CP and Triceps	-0.27 (-19%)	-0.37 (-26%)	-0.25 (-18%)	0.23 (177%)	0.16 (123%)	0.16 (123%)
5. CP and Calf	0.13 (15%)	0.19 (22%)	0.23 (26%)	-0.16 (-43%)	-0.17 (-46%)	-0.19 (-51.4%)
6. CP and Calf	0.03 (24%)	0.23 (24%)	0.51 (53%)	0.2 (50%)	0.10 (50%)	0 (0%)
7. Bilateral CP	0.02 (0.0%)		0.26 (217%)	-0.6 (-27%)		-3.8 (-86%)
8. CP and Hams	0.08 (14%)	0.15 (27%)	0.12 (21%)	-0.68 (84%)	-0.66 (-82%)	-0.7 (-86%)
Mean (all subjects)	0.10 (39.6%)	0.07 (57%)	0.30 (102%)	-0.26 (-0.4%)	-0.40 (-9%)	-0.78 (-31%)
SD	0.19	0.35	0.27	0.46	0.42	1.29
Mean (CP and Calf)	0.14 (55.69%)	0.27 (77%)	0.38 (91%)	-0.25 (-18%)	-0.32 (-22%)	-0.36 (-41%)
SD	0.12	0.11	0.14	0.51	0.52	0.47
Mean (CP and Hamstrings)	0.22 (56.15%)	0.01 (65.61%)	0.40 (116%)	-0.33 (-51%)	-0.65 (-41%)	0.50 (-53%)
SD	0.12	0.43	0.24	0.54	0.05	0.44

Key: CP = common peroneal nerve Calf = calf muscle group Hams = hamstring muscle group
NS1 = no stimulation at 1st assessment S1 = with stimulation at 4th assessment
NS4 = no stimulation at 4th assessment


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