Clinical Rehabilitation using Electrical Stimulation via Telematics (CREST)

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Abstract
There is a large and growing number of patients with incomplete spinal cord lesions (ISCL). These individuals will have some preserved motor and/or sensory functions below the level of their lesion which may augment the improvements they gain from using an FES system. As the gait deficit in this group is highly variable it is necessary to produce an individualised FES gait strategy for each patient.

A main obstacle to the employment of FES, for the rehabilitation of ISCL patients in spinal injuries units, is the lack of sufficient local expertise to tackle the complex problem of optimising the equipment for individual patients. This expertise is present in a small number of research centres but the target population is spread around a large number of clinical sites. There is therefore a need to bring the expert knowledge of the professional users (engineers and clinicians) to the end users (patients) at the clinical sites. CREST will do this by teleconsultation.

The aim of this project is to demonstrate that FES systems can be delivered by local non-expert professional users supported by interactive teleconsultation with a remote expert.

I. Background
Most research in FES restoration of gait in patients with spinal cord lesions has concentrated on those with complete lesions; but there is a large and growing number of patients with incomplete lesions. Many incomplete spinal cord lesioned (ISCL) patients will have preserved gait functions which can be substantially enhanced by the application of an FES system. However the gait deficit is this group is highly variable and it is necessary to produce an individualised FES gait strategy for each patient.

Previous FES gait programmes for ISCL individuals have included single channel stimulators on the peroneal nerve and two channel stimulators on the peroneal nerve and knee extensors. FES has been found to give improved walking performance when compared with conventional orthoses. In a previous study of six ISCL patients, five patients were likely to have benefited from an individualised FES system for home use [1]. These programmes for ISCL individuals have also shown a number of therapeutic benefits including an increase in voluntary control, an increase in muscle bulk and a reduction in spasticity [2].

Multichannel stimulators have been produced by various institutes and small companies. In general, these stimulators have a fixed stimulation programme, meaning that they can be used for standardised applications such as muscle training and simple walking programs. Due to the large inter-individual differences in ISCL patients these systems have limited applicability in this population. Recent advances in microelectronics have led to the development of portable stimulators that are multichannel, fully programmable and can use sensors and control algorithms to adapt the stimulation parameters.

A main obstacle to the employment of FES in ISCL patient rehabilitation at spinal injuries units is the lack of sufficient expertise to tackle the often complex problem of optimising the equipment for individual patients. This expertise is present in a small number of research groups scattered over Europe and the World and the target ISCL population is spread around a large number of clinical sites. There is therefore a need to bring the expert knowledge of the professional users (engineers and clinicians) and experience of the latest techniques in programmable stimulators and control software to the clinical sites where it is needed. CREST will do this by teleconsultation (the process of receiving clinical information and communicating clinical decisions via remote computer links).

The aim of this project is to demonstrate that FES systems can be delivered to the ISCL patient population by local non-expert professional users with the support of remote experts. This will be achieved by interactive teleconsultation with a remote expert providing ISCL individuals, throughout Europe, with increased mobility.

II. CREST programme
The project consists of the following phases:
1. Development of tools for clinical decision making which include: multimedia gait analysis tools, assessment of impairment/disability/handicap, visual programming tools for stimulator control, telematic links between the clinical and expert sites.
2. Verification of the system at expert clinical sites (Rehabilitation Centre Het Roessingh, Enschede;
Southern General Hospital, Glasgow and Northern General Hospital, Sheffield) local to the expert technical sites. The individualised FES systems will be applied, via telematic links, to 10 ISCL patients at each site and their performance will be evaluated in terms of established outcome measures.

3. Verification of the system will take place, with 10 patients, at each of two remote clinical non-expert sites (Righospitalet, Copenhagen and Hospital Juan Canalejo, La Coruna). The evaluation will be the same as in (2).

4. Evaluation of the CREST system will be performed at all sites. Patient’s gait will be assessed prior to starting the programme without FES and at the end of the programme both with and without FES.

III. Outcomes
The project will develop a 'package' for the delivery of FES gait to ISCL patients. This package will consist of: multimedia assessment tools, stimulation hardware and software and telematic consultation support. It is hoped that this will encourage the adoption of FES walking for incomplete ISCL patients throughout Europe.

IV. Progress
Assessment and evaluation protocols have been defined and developed. The telematic links, multimedia patient assessment system, control strategies and visual programming interface are now being developed.

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References