

Lessons Learned from using Functional Electrical Stimulation Systems to Enhance Grasping and Reaching in Humans with Paralysis

Dejan Popovic¹ and Mirjana Popovic²

¹Faculty of Electrical Engineering, Belgrade, Yugoslavia

²Institute for Medical Research, Belgrade, Yugoslavia

Slide 1:

Material

CLINICAL EVALUATION OF THE FOLLOWING SYSTEMS:

1. THE FREEHAND SYSTEM (EARLY VERSION)

EDMONTON, ALBERTA (1988-1994)

3 subjects

(8 channels, percutaneous electrodes, proportional control)

2. THE BIONIC GLOVE

BELGRADE, YUGOSLAVIA (1995-1997)

12 subjects

(3 channels, surface electrodes, on-off control)

3. THE EMG CONTROLLED GRASPING DEVICE

MIAMI, FLORIDA; BELGRADE YUGOSLAVIA (1993-1997)

5 + 8 subjects

(2 channels, surface electrodes, on-off control)

4. THE BELGRADE GRASPING SYSTEM

BELGRADE, YUGOSLAVIA (1997-PRESENT)

12 subjects

(4 channels, surface electrodes, synergistic control)

Slide 2

Methods

The following parameters were evaluated:

1) **QIF** (Quadriplegia Index Function)

2) **FIM** (Functional Independence Measure)

3) **UEFT** (Upper Extremity Function Test)

The following tasks were tested: 1) combing hair; 2) using a fork; 3) picking up a VHS tape; 4) picking up a full juice can; 4) picking up a full pop/soda can; 6) writing with a pen; 7) answering the phone; 8) brushing teeth; 9) pouring from a one liter juice box; 10) drinking from a mug; and 11) handling finger food.

4) **The range of passive movements** of fingers

5) The weekly log reflects **the number of hours** that a subject **used the system**

Slide 3:

Conclusions

Some people with C6-C7 lesions may benefit from usage of the reaching systems. The benefits can be good enough to make the system a daily-used assistive device.

Technical improvements, specifically related to cosmesis, positioning of the electrodes and donning/doffing can possibly increase the number of regular users.

Power grasp and handling bigger objects was greatly improved (e.g., pouring from a container, using a telephone receiver, handling tapes).

Slipping of objects remained a problem in most subjects even after prolonged use. We have not noticed a change in skin texture after the study, and the friction coefficient remained very low (not measured).

Slide 4:

Conclusions

The functional status is the most important factor in deciding whether the glove should be used as a long term assistance.

The best candidate for a FES grasping system are among complete C6 - C7 tetraplegics with a FIM between 25 and 50, eventually up to 75 (out of 126), and a QIF between 0 and 13, eventually up to 27 (out of 56).

Grasping systems mostly contribute to improved grasping as a therapeutic aid. The functioning without an aid was more improved when compared to the improvements with it during the six months evaluation.

There are individuals in whom FES system is instrumental for grasping (orthosis), and works according to their expectations.

Slide 5:

References:

1. Saxena S, Nikolic S and Popovic D, An EMG controlled FES system for enhanced grasping in C5/C6 tetraplegics, *J Rehabil Res Develop*, Vol 32. pp. 17-24, 1995.
2. Popovic D, Stojanovic A, Pjanovic A, Radosavljevic S, Popovic M, Jovic S. and Vulovic D, Clinical Evaluation of the Bionic Glove, *J Phys Med and Rehabil*, 1998 (in press)
3. Popovic D, Popovic M, Stojanovic A, Pjanovic A, Radosavljevic S and Vulovic D, Clinical evaluation of the Belgrade grasping system, *Proc VI Vienna Workshop On FES, Vienna, Sep 22-26, 1998*