Chapter 37

The Use of Mesh Glove Neurostimulation for Motor Recovery in Chronic Stroke

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ABSTRACT

In 1994, the whole-hand electrical neural stimulation technique was reported by Dimitijevic to be useful in facilitating the recovery of hand-motor control after spinal cord injury and stroke. The authors of this chapter replicated this work and determined the effectiveness of the technique in restoring fine hand movement in 7 chronic stroke cases.

Prior to treatment with electrical stimulation, all patients received rehabilitation, either for three months (acute cases) or for at least one month (chronic cases), after which no remarkable improvements in hand control were seen. The patient group consisted of 5 females and 2 males. The stroke damage included brain hemorrhage in 5 cases, brain infarct in 1 case, and bled AVM in 1 case. Post-onset duration was between 3 and 44 months, and the ages of patients ranged from 11 to 65 years. The electrical stimulation was carried out according to the protocol previously reported by (Dimitrijevic, 1994).

DOI: 10.4018/978-1-60960-559-9.ch037
The results showed that the range of motion (ROM) was improved in 6 out of 7 cases, while fine movement of the hand was also improved in 4 cases. These improvements were observed a few days after the initiation of whole-hand electrical neural stimulation. In one chronic stroke case, the treatment resulted in an almost full recovery of hand control during the first 30 minutes of sub-threshold sensory stimulation, including pinching and grasping. This dramatic recovery led the authors to hypothesize that the responder would show no lesioning of the motor cortex on CT or MRI images. While more cases are needed to test the limitations of this modality and to determine the relationship between the level of recovery and the topology of CNS lesioning, this work illustrates the utility of this approach for improving motor control of the hand in chronic stroke patients.

I. INTRODUCTION

Restorative neurology is used to improve functional recovery by enhancing neuroplasticity or functional compensation beyond the results obtainable by routine rehabilitation programs (Feeney and Sutton, 1983; Dimitrijevic et al, 1991; Dimitrijevic, 1992; Sunderland et al, 1992). However, motor recovery in patients with upper extremity dysfunction is less likely than recovery from impairments of the lower extremities with orthodox rehabilitation programs. Whole-hand electrical stimulation (Dimitrijevic, 1994) uniquely targets the motor recovery of hand control after stroke. Since our first clinical application in Japan (1995), we have continued to use whole-hand electrical stimulation as a treatment option for cases of stroke and other pathological conditions that are associated with poor recovery of hand control after 3 months of a routine rehabilitation program. Here we describe the clinical results and address factors that could contribute to the level of success attained with this treatment.

II. MATERIALS AND METHODS

Seven patients with no severe muscle atrophy were given whole-hand electrical stimulation. Patient ages ranged from 11 to 65 years old. Post-onset duration was between 3 and 44 months. All cases suffered from spastic hemiparesis or poor hand control that did not show marked improvement with a routine rehabilitation program. Patients with cardiac pacing or epilepsy were not included (Table 1).

After a brief period of neural stimulation with mesh glove electrodes, 4 of the 7 patients showed improved movement, such as grasping and pinching.

A. Stimulating Conditions

A mesh glove electrode (Prizm Med Inc, Norcos, Georgia, USA) was placed on the affected hand after it was moistened with electromist (Pharma-ceutical Innovations Inc, Newark, NJ, USA) (Figure 1). Transcutaneous electrical nerve stimulation was conducted below the sensory threshold level for 30 min twice daily for 2 weeks, followed by stimulation at the sensory level for 30 min twice

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Diag</th>
<th>Post-onset</th>
<th>Results</th>
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<tbody>
<tr>
<td>1</td>
<td>54</td>
<td>m</td>
<td>BI</td>
<td>3y3m</td>
<td>E(R,G,P)</td>
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<tr>
<td>2</td>
<td>61</td>
<td>m</td>
<td>BH</td>
<td>1y4m</td>
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<td>3</td>
<td>11</td>
<td>f</td>
<td>AVM</td>
<td>2y</td>
<td>E(R)</td>
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<tr>
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<td>f</td>
<td>BH</td>
<td>3y8m</td>
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<td>57</td>
<td>f</td>
<td>BH</td>
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</table>


Table 1. Summary of patient information and the changes in hand control after treatment with whole hand stimulation