Differences in Rheobase and Chronaxie between the Paretic and Non-Paretic Sides of Hemiplegic Stroke Patients: a Pilot Study

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Absract. [Purpose] Rheobase and chronaxie are used to confirm muscle degeneration. For stroke patients, however, the uses of rheobase and chronaxie in determining paretic side muscle degeneration is not yet fully understood. Thus, in this study, we examined the electrical properties of the quadriceps muscles of stroke patients’ paretic side and compared them with their respective values on the non-paretic side. [Method] The subjects were six stroke patients (three females, three males). The pad of an electrical stimulator was applied to the vastus lateralis and vastus medialis regions to measure rheobase and chronaxie until the contractive muscle response to electrical stimulation became visible. [Result] Rheobase was significantly increased on the paretic side compared to that of the non-paretic side of hemiplegic stroke patients. Furthermore, chronaxie was significantly increased on the paretic side compared to the non-paretic side of hemiplegic stroke patients. [Conclusion] These results suggest that stroke affects the sensitivity of skeletal muscle contraction. Therefore, this data may contribute to our understanding of the muscle status of stroke patients.

Key words: Rheobase, Chronaxie, Hemiplegic stroke patients

INTRODUCTION

Upper motor neuron injury, as occurs in stroke, is believed not to result in muscular atrophy, and only a few studies have examined muscle abnormalities after stroke and their relationship with fitness and function. However, a recent study showed that stroke patients suffer from disproportionate muscle atrophy and other detrimental tissue composition changes on the paretic side. This is the reason that many stroke survivors move using abnormal movement patterns. Muscle weakness develops rapidly after stroke, adversely affecting motor performance, and contributing to reduced functional ability. Especially, lower-extremity muscle weakness, particularly in the quadriceps muscle, has profound functional consequences. Post-stroke rehabilitation therapy aims to restore partially lost functions. Electric therapy in particular, such as functional electrical stimulation (FES) of the muscle, is known to be an effective method of improving the motor function of stroke patients. Thus, electrical properties such as rheobase and chronaxie are important factors in electrotherapy for rehabilitation.

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position, until the muscle contraction response became visible. A chronaxie measurement pad was applied to the same regions until muscle contraction responses became visible using double the rheobase current intensity (Fig. 1). After one side had been measured, subjects rested for 5 minutes; then, the process was repeated on the other side. Data were expressed as mean ± standard error (SE). A p value of < 0.05 was considered statistically significant. SPSS Version 18.0 (International Business Machines, Armonk, USA) for Microsoft Windows was used for data analysis in this study. The protocol for the study was approved by the Committee of Ethics in Research of the University of Yongin, in accordance with the terms of Resolution 5-1-20, December 2006.

RESULTS

To confirm whether stroke state affects the sensitivity of skeletal muscle contraction, the rheobase and chronaxie properties of stroke patients were compared between the paretic and non-paretic sides. Rheobase was significantly higher on the paretic side than on the non-paretic side of hemiplegic stroke patients (Table 2). Furthermore, chronaxie was significantly higher on the paretic side than on the non-paretic side of hemiplegic stroke patients (Table 2).

DISCUSSION

Stroke is a leading cause of neurological disability among adults and often leads to functional deficits in motor control4, 5, 11, 12. Stroke involves muscle weakness, spasms, disturbed muscle timing, and a reduced ability to selectively activate muscles5, 6, 9). Quadiceps weakness in particular is a common finding in stroke patients13, 14). Quadiceps muscle weakness is associated with decreased gait speed, balance, stair-climbing ability, and ability to rise from a seated position, as well as with an increased risk of falls15). Thus, quadiceps muscle function improvement is of utmost importance in stroke patients’ rehabilitation. Electrotherapy is known to be an effective method of improving motor function and is currently used in many forms to facilitate changes in muscle action and performance16). For example, FES has been widely used to treat patients with lesions in the central nervous system arising from stroke.

Table 1. Clinical characteristics of the hemiplegic stroke patients

<table>
<thead>
<tr>
<th>No</th>
<th>Age (year)</th>
<th>Gender</th>
<th>BMI (kg/m^2)</th>
<th>Time post stroke (month)</th>
<th>K-MMSE (Score)</th>
<th>PS</th>
<th>Lesion site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>Male</td>
<td>27.9</td>
<td>42</td>
<td>30/30</td>
<td>L</td>
<td>Left thalamic ICH</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>Male</td>
<td>28.7</td>
<td>68</td>
<td>30/30</td>
<td>L</td>
<td>Middle cerebral artery</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>Female</td>
<td>23.5</td>
<td>40</td>
<td>30/30</td>
<td>R</td>
<td>Middle cerebral artery</td>
</tr>
<tr>
<td>4</td>
<td>64</td>
<td>Female</td>
<td>18.4</td>
<td>42</td>
<td>30/30</td>
<td>R</td>
<td>Left thalamic ICH</td>
</tr>
<tr>
<td>5</td>
<td>67</td>
<td>Female</td>
<td>27.9</td>
<td>61</td>
<td>28/30</td>
<td>L</td>
<td>Basal ganglia ICH</td>
</tr>
<tr>
<td>6</td>
<td>63</td>
<td>Male</td>
<td>24.1</td>
<td>18</td>
<td>30/30</td>
<td>L</td>
<td>Basal ganglia ICH</td>
</tr>
</tbody>
</table>

BMI, body mass index; K-MMSE, Korean version of mini mental status examination; PS, paretic side; L, left side; R, right side; ICH, intra-cerebral hemorrhage

Table 2. Differences in rheobase and chronaxie between the paretic and non-paretic sides of hemiplegic stroke patients

<table>
<thead>
<tr>
<th></th>
<th>Non-paretic side</th>
<th>Paretic side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheobase (mA)</td>
<td>12.3 ± 0.3</td>
<td>15.1 ± 0.4*</td>
</tr>
<tr>
<td>Chronaxie (msec)</td>
<td>0.1 ± 0.0</td>
<td>0.2 ± 0.0*</td>
</tr>
</tbody>
</table>

Mean±SE. *, Significantly different from the non-paretic side p < 0.05.
or spinal cord injury in order to improve motor control[17]. Thus, we measured rheobase and chronaxie to gain a better understanding of their implications in electrical therapy for stroke patients, because they are commonly accepted as parameters predicting the efficacy of electrical stimulation[8]. Rheobase is measured as the threshold stimulus current for an active response with a long-duration pulse and chronaxie is the pulse width at twice the rheobase threshold current[9].

There have been few studies that have focused on physical therapy using rheobase and chronaxie, and whether it should be applied differently based on these differences. Thus, we investigated this issue. All patients showed lower rheobase and chronaxie on their non-paretic sides than on their paretic sides. Based on the results of our study, we can carefully provide an important basis for electric current and duration when performing electrotherapy for stroke patients. In other words, the paretic sides of stroke patients require a higher current and longer pulse duration for quadriceps muscle reaction than the non-paretic sides. Therefore, it is necessary to consider the proper intensities for electrotherapy. A major limitation of this study is the lack of measurements of the other muscles. However, since few studies have been performed on differences in muscle electrical characteristics, we consider the present results are meaningful for physical therapy. Further studies including investigation of diverses muscle of stroke patients would contribute to the development of clinical physical therapy and to electrotherapy. In summary, there were significant differences in rheobase and chronaxie between the paretic and non-paretic sides of hemiplegic stroke patients. Rheobase and chronaxie of the paretic side had greater values than the non-paretic side. In this study, we found that there was a difference between the electrical properties of the paretic and non-paretic sides of hemiplegic stroke patients. Therefore, when performing physical therapy, the electrical properties of muscle of each stroke patient need to be carefully considered.

REFERENCES