Effects of Scapular Stabilization Exercise on Function of Paretic Upper Extremity of Chronic Stroke Patients

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Abstract. [Purpose] The purpose of this study was to investigate the therapeutic effects of scapular stabilization exercise on function of the upper extremity of individuals with chronic hemiparetic stroke. [Subjects] Eleven chronic hemiparetic stroke patients participated in a scapular stabilization exercise program conducted in the sitting position for 30 min per session, 5 days per week, for 4 weeks. We used 3 clinical assessments: the Manual Function Test, the Berg Balance Scale, and the Modified Barthel Index. [Results] Manual Functional Test Scores for the paretic upper limb significantly improved after the scapular stabilization exercise program. However, Manual Function Test scores for the non-paretic upper limb did not significantly improve after the scapular stabilization exercise program. The Berg Balance Scale and the Modified Barthel Index scores did not significantly improved after scapular stabilization exercise program. [Conclusion] The results of this study suggest that scapular stabilization exercise can improve the function of the paretic upper extremity of individuals with chronic stroke. However, scapular stabilization exercise did not affect balance or basic daily activities.

Key words: Scapular stabilization exercise, Stroke, Upper extremity

INTRODUCTION

Stroke is the major leading cause of permanent disability among adults, and 70 – 80% of first-stroke survivors have functional disabilities, which frequently manifest as hemiparesis of the contralateral upper extremity1). Approximately one third of all stroke survivors will have significant residual disability, with severity of upper extremity hemiparesis a significant determinant of post-stroke disability and quality of life2). Upper extremity hemiparesis impairs the performance of many daily activities such as dressing, bathing, self-care, and writing, thereby resulting in reduced functional independence. Therefore, stroke survivors need to participate in rehabilitation programs to achieve functional independence3).

Hemiparesis of the upper extremity is often most severe in the most distal regions. Although proximal muscles and joints may be least affected, purposeful movement requiring precise control of the proximal segments is slow, inaccurate, and poorly coordinated4). The distal region of the upper extremity is also capable of comfortable, coordinated movement, despite immobility of the proximal region of the upper extremity. Stroke survivors commonly have an impaired shoulder joint complex, because paretic muscles do not overcome the weight of the arm. Problems secondary to neuromuscular problems, such as shoulder subluxation and pain, suppress functioning of the upper extremity5).

The shoulder joint is particularly affected by scapular stability during movement in cardinal planes. Previous studies of recovery of upper extremity function have investigated the effects of active, repetitive, and functional activities in post-stroke patients. The studies used constraint-induced movement therapy, robot-assisted movement, and electromyography-trigged neuromuscular electrical stimulation6–8). However, these therapeutic approaches mainly focus on fine motor skills in distal extremities, not gross motor skills in proximal extremities, even they have been reported to provide benefits for chronic stroke patients, the necessary elements for correct scapular movement, which is often linked to proper initiation and recruitment, are impaired in stroke patients9). A paretic arm can change scapular orientation, because scapular stabilizers are often so impaired by muscle weakness that they cannot overcome arm weight and maintain anatomical characteristics. Weakness of scapular stabilizers has been shown to increase motor impairment of upper extremities and consequently many stroke survivors of independent daily livings9). Postural control of the trunk is also a critical component of independent performance of activities of daily living. Hsieh et al. investigated the relationship between trunk control and comprehensive activities of daily living9). Stoykov et al. examined the effect of postural control training on the prehensile function of the paretic upper limb10). They suggested that postural control training contributed to recovery of upper extremity function. However, there is a paucity of research on the correlation between postural control and...
upper extremity function.

This study examined the effects of scapular stabilization exercise on fine and gross motor skills in the upper extremity in individuals with chronic hemiparetic stroke. We also investigated the transfer effects of scapular stabilization exercise from upper extremity function to whole body movement, and postural stability, stroke patients. The hypothesis of this study was that there would be improvements in upper extremity function, whole body movement and postural stability after the intervention.

**SUBJECTS AND METHODS**

Subjects with chronic hemiparetic stroke were recruited from a rehabilitation center. All 11 participants had a good understanding of the study’s purpose and methods and gave their written consent prior to participation. Inclusion criteria were as follows: first stroke at least 6 months before; no cognitive deficits (Mini-Mental State Examination); no other neurological or orthopedic deficits; and no spatial and visual neglect or apraxia. Patients were excluded if they had a history of cervical surgery or cervical spine fracture; temporomandibular surgery; pathologic trauma; or psychosocial problem. They study protocol was approved by the local ethics committee. Table 1 summarizes the characteristics of the study subjects.

All subjects performed scapular stabilization exercise for 30 min per session, 5 days per week, for 4 weeks. The scapular stabilization exercise was comprised of 4 stages: patient position, therapist position, exercise, and relaxation stages. The patient sat on a chair and maintained a stable posture without any neck or upper extremity movements while bending the knees with the feet flat on the floor. The therapist placed a hand on the scapula and axillary areas. The patient then relaxed the entire body. While breathing deeply and holding the shoulder and neck in a relaxed and comfortable posture, the patient held the shoulder joint at 90° and the elbow joint at 180° and protracted the scapula for 10 seconds, and then returned to the starting position.

The patient performed 3 sets of 10 movements, with 1 min breaks between sets.

The Manual Function Test (MFT) developed at the Research Facility for Rehabilitation Medicine at Tohoku University, is a performance-based assessment for upper limbs with paresis caused by stroke. The MFT consists of 32 criteria for 8 tasks in 3 categories: arm motions, grasp and pinch, and arm and hand activities. It offers reliable and valid methods for assessing paretic upper extremities of individuals with chronic stroke. The Berg Balance Scale (BBS) is a performance-based assessment developed by Kathy Berg. Widely used in older persons and individuals with neurological disorders, the BBS tests the ability of the subjects to maintain an upright posture and to make appropriate adjustments for voluntary movement. The BBS consists of 14 items scored on a 5-point scale, with a maximum possible score of 56 points. The BBS demonstrates good test-retest and interrater reliability and good internal consistency in patients with chronic stroke. The Modified Barthel Index (MBI) is a performance-based clinical assessment of independence daily activities. It is scored in increments of 5 points (highest possible total score = 100) and covers 10 domains: bowel control, bladder control, grooming, toilet use, feeding, transfers, walking, dressing, climbing stairs, and bathing. The MBI has been shown to be highly valid and reliable. The internal consistency of the MBI in stroke patients is good. The inter-rater reliability is sufficient at the item level. Its overall inter-rater agreement is good.

The independent variable was scapular stabilization exercise, and the dependent variables were MFT, BBS, and MBI scores. The paired t-test was used to compare the pre-intervention and post-intervention scores of each group. The level of statistical significance was chosen as p<0.05. The Program PASW Statistics 18.0 (SPSS Inc., Chicago, USA) was used for statistical analysis.

**RESULTS**

Table 2 shows the results of scapular stabilization exercise for the chronic stroke patients. The MFT score was significantly higher in the paretic upper extremity after 4 weeks of scapular stabilization exercise compared to before the training. However, the MFT score for the non-paretic upper extremity was not significantly altered by the training. Performance of the balance activities measured by the BBS was not significantly different after training. The pre-

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**Table 1. General characteristics of the subjects in this study (N=11)**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Men (n=8)</th>
<th>Women (n=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30–39</td>
<td>1 (9.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>40–49</td>
<td>3 (27.3)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>50–59</td>
<td>1 (9.1)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>60–69</td>
<td>3 (27.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Hemiparetic side, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>6 (54.5)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Left</td>
<td>2 (18.2)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Post-stroke duration, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 1 year</td>
<td>5 (45.4)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>1–2 years</td>
<td>3 (27.3)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Brunstrom stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Stage 5</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 2. Comparison of the pre- and post-test outcome measures (N=20)**

<table>
<thead>
<tr>
<th>Clinical tool</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Function Test on the affected side</td>
<td>17.1±9.3</td>
<td>18.6±9.3*</td>
</tr>
<tr>
<td>Manual Function Test on the less affected side</td>
<td>28.8±4.0</td>
<td>29.7±1.9</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>35.9±16.1</td>
<td>36.7±15.3</td>
</tr>
<tr>
<td>Modified Barthel Index</td>
<td>64.9±15.9</td>
<td>66.3±15.5</td>
</tr>
</tbody>
</table>

*Mean±Standard deviation
*p<0.05
intervention MBI score was not significantly different from post-intervention MBI score.

**DISCUSSION**

The main purpose of this study was to examine the therapeutic effects of scapular stabilization exercise on the function of the upper extremities, balance, and the performance of daily activities by individuals with chronic hemiparetic stroke. The efficacy of the scapular stabilization exercise at improving balance and performance of daily activities by chronic stroke patients was also investigated. An important finding was a statistically significant improvement in the function of the paretic upper extremity after the scapular stabilization exercise. However, the function of the paretic upper limb did not improve. Balance and performance of basic, daily activities did not significantly improve after the exercise intervention.

Mobility of the upper limbs is vital for daily activities, function required of community-dwelling individuals, and quality of life,[2] and upper limb paresis following stroke is the most common chronic impairment related to limitations of daily activities, functional activities, and social roles. Upper limb paresis in individuals with chronic hemiparetic stroke may compromise many essential and meaningful functions of daily living.[3] Therefore, relearning motor skills and restoring function of the paretic upper limb are the major goals of rehabilitation exercise in clinical settings. Strengthening the scapular stabilizers is especially important.[4]

Previous studies have suggested that strength training for the glenohumeral and scapulothoracic regions improves the functionality of the paretic upper extremities.[5, 6] They reported that these muscles play an important role in the stability of the shoulder complex and that stability is necessary to achieve an appropriate range of motion in the shoulder joint during arm elevation, as well as in the distal joints such as the wrist and fingers.[7]

Mandalidis and O’Brien reported that the efficient movement and proper range of motion of the muscles that act on a distal joint are only possible when the proximal joints are efficiently stabilized by the surrounding musculature.[8, 9] They suggested that it is important to strengthen the scapular stabilizers in order to restore the function of the distal joints of the upper extremity. The results of the present study support their suggestion.

Relatively small changes in the scapular muscle affect the alignment and forces around the shoulder complex. Because the scapula plays a critical role in controlling the shoulder joint position and joining it with the humeral head, Nascimento et al. suggested that weakness of the rotator cuff muscles negatively affects upper limb functionality during daily activities performed by individuals with stroke.[10] They also suggested that the functionality of the glenohumeral and scapular muscles should be monitored in a clinical setting. However, evaluations of scapular stabilizers have been commonly neglected in rehabilitation, despite previous studies indicating that strong scapular muscles are among the major factors contributing to functional restoration of the upper extremities.[11] The present study demonstrated significant functional improvements after scapular stabilization exercise was performed by individuals with hemiparetic stroke. Therefore, scapular stabilization is an important consideration for functional restoration of paretic upper extremities. However, scapular stabilization exercise did not affect balance or performance of daily activities.

Limitations of this study were related to the study protocol, such as the small sample and lack of a control group. The participants had chronic stroke, and future studies with larger samples including subjects with various levels of upper limb impairment may be necessary to better control for confounding factors and enhance the generalizability of the present findings to the entire stroke population.

**REFERENCES**

20) Moraes GF, Faria CD, Teixeira-Salmela LF: Scapular muscle recruitment patterns and isokinetic strength ratios of the shoulder rotator muscles in individuals with and without impingement syndrome. J Shoulder Elbow...