Effects of Low-intensity Scapular Stabilization Exercise in Arthroscopic Shoulder Surgery Patients

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Purpose: The purpose of this study was to compare a control group and an experimental group, consisting of arthroscopic shoulder surgery patients who had received acute rehabilitation treatment and who were to perform scapular stabilization exercise.

Methods: Sixteen subjects were studied. The control group, n=8, received instruction for basic physical therapy intervention. An experimental group, n=8, received instruction for doing scapular stabilization exercise (protraction, retraction, elevation, depression) 10 times, 6 times per week. To evaluate the effects of exercise, subjects were evaluated using a joint position sense of shoulder (JPS), disability of the arm, shoulder index (DASH), shoulder pain and disability index (SPADI).

Results: Participants showed after the intervention, both groups saw their JPS errors at 30°, 60°, and 90° significantly decrease relative to before the intervention (p<0.05). Both groups saw their JPS rates at 90° significantly decrease (p<0.05), with no significant changes in JPS at 30° and 60° (p>0.05). SPADI and DASH significantly decrease after the intervention (p<0.05), with no significant decreases before the intervention (p>0.05). The change rates of SPADI and DASH significantly reduced (p<0.05).

Conclusion: Low-intensity scapular stabilization exercise is considered effective as a clinical treatment for arthroscopic shoulder surgery patients who receive acute rehabilitation treatment.

Keywords: Arthroscopy, Shoulder pain, Stabilization exercise

I. Introduction

Stiffness in the shoulder joint capsule, which can occur in a variety of situations, greatly restricts passive range of motion. Problems arising from shoulder stiffness include adhesive capsule, frozen shoulder, and capsulitis. Adhesive or fusion capsule limits movement or leads to failure in movement, and capsule injuries may trigger operational issues and problems with subacromial bursae, tendons, or muscles outside the capsule. Rotator cuff injuries experienced by 4% to 32% of the population and with growing prevalence in increasing age trigger shoulder pain and weakness together with kinematic movement deformity of the glenohumeral joint. This condition may also occur when the shoulder joint is unstable. The rotator cuff consists of four structurally combined muscles: the supraspinatus, infraspinatus, subscapularis, and teres minor, which harmoniously function for shoulder movement. Weak injury of the partially ruptured area or overall rupture is the operational standard for surgical treatment of rotator cuff injuries. Symptoms that do not respond to traditional treatment methods impair a patient’s normal function.

Superior labrum anterior to posterior (SLAP) is a rupture starting from the biceps brachii tendon and its origin, and extending to the posterior upper subglenoid fossa, to an area before the glenoid cavity notch. This condition exhibits a variety of symptoms, including snapping, pain, and instability. However, there are no symptoms specific to
the disease and physical examination results in no unique observations. This condition is also accompanied by other diseases, such as anterior instability and rotator cuff disease, and therefore, is difficult to diagnose.\textsuperscript{16,17}

Good rehabilitation programs provide the potential for good post-operative results, the return of the patient to functional activities, and an enhanced quality of life.\textsuperscript{18} Stabilization is defined as the ability to regulate a particular movement of a joint. Among all of the joints in the human body, the shoulder joint has the widest range of movement and has a tendency toward instability; therefore, muscles play an important role in the dynamic stability of the joint. The normal movement pattern of the shoulder joint is accompanied by scapular rhythmic stabilization.

The proprioceptive sense is composed of mechanical load information, which is input to special sensory receptors located in the muscles, around the skin, or in the joints, and is delivered to the central nervous system (CNS), where it is integrated.\textsuperscript{19} It is used as basic information for conscious or unconscious balance caused by stimuli resulting from postural change. The proprioceptive sense is the body’s positioning sense (the ability to determine exactly where a particular body part is in space) and plays an important role in maintaining dynamic movement.\textsuperscript{20,21} The sensibility of this sense is weakened by aging, illness, high intensity exercise, or physical injury and may be upgraded by light, low-intensity pre-exercise.\textsuperscript{22,23}

Previous studies applied exercise for between 6 and 8 weeks post-operatively in order to treat the shoulder joint and restore active movement. The subjects under study were patients who had been diagnosed with rotator cuff rupture and SLAP in the shoulder joint, and had undergone arthroscopy, and to whom exercise restriction was made six weeks prior to the performance of the experiment. Appropriate post-operative rehabilitation time had been discussed before the study. Active exercise was applied four weeks post-operatively. At two-year follow-up the results were still positive.\textsuperscript{24} However, there have been no studies regarding low-intensity, scapular stabilization exercise applied to arthroscopic shoulder surgery patients 5 to 10 days postoperatively.

The purpose of the present study was to compare a control group and an experimental group, consisting of arthroscopic shoulder surgery patients who had received acute rehabilitation treatment and who were to perform scapular stabilization exercise (retraction, protraction, elevation, and depression) between 5 and 10 days postoperatively, in order to examine the effects of such exercise on pain, function and sensibility.

II. Materials and Methods

1. Subjects

The participants of this study were 16 patients (10 female and 6 male) who were diagnosed with SLAP and rotator cuff rupture by orthopedic doctors at S hospital located in Daejeon. These patients had undergone arthroscopic shoulder surgery between March and April 2012. The purpose of this study was sufficiently explained to the subjects and signed consent was obtained. Those who had neurological problems resulting from cervical disc disorder, complained of vascular problems, an internal disease, or psychological problems were excluded.

2. Experimental methods

1) Measurement

(1) Performance of exercise

After subject selection, their dominant hands were determined. All subjects were right-handed. Three subjects had undergone surgery on the left-hand side and 13 on the right-hand side. They were randomly assigned to an experimental group (8 patients) and a control group (8 patients). Basic physical therapy intervention was applied to all subjects twice per day, six times a week. An ice pack for 10 minutes, ultrasound for 5 minutes, and interferential current therapy for 15 minutes was applied to the surgical area. Passive exercise physical therapy was also applied by therapists once per day for 10 minutes, six times per week. Two skillful therapists, each with 5 years of passive physical therapy experience, conducted the sessions. The experimental group engaged in the scapular stabilization exercise intervention.
(2) Evaluation tools and methods
The two groups recorded their disability of the arm, shoulder index (DASH) and shoulder pain and disability index (SPADI) symptoms and their joint position senses of shoulder (JPS) were measured prior to their participation in the experiment. After the application of the intervention for one week, their DASH, SPADI, and JPS scores were reassessed.

(1) Shoulder JPS
This test was conducted before and after the intervention. Post-operative flexion proprioceptive position was measured using an assessment plate of 180 degrees with 30 degree intervals (30°, 60°, 90°, 120°, 150°). The 30 degree interval was the minimum interval used to divide proprioceptive injuries and differentiate different levels of position sensitivity. Measurements at each angle (30°, 60°, 90°, 120°, 150°) were aimed at preventing assessment errors resulting from a single measurement. In order to control position perception enhancement caused by repeated movement and measurement, measurement at each angle was randomly made twice. Test-retest reliability of the passive reposition test under the above method was Cronbach’s α = 0.86. Given that the standard Cronbach’s α to judge assessment tool reliability is 0.75 or higher, the evaluation method in this study, using the shoulder JPS assessment plate, was acceptable.

Because the experimental group was composed of arthroscopic shoulder surgery patients receiving acute rehabilitation treatment, measurements were made only between 30° and 90°. The subjects in the experimental group were fixed in alignment with the shoulder joint axis of the affected side, with the shoulder joint flexion angle of 0° as a starting position. They were passively held at each angle of 30°, 60°, and 90° by the therapist twice, five seconds each time, and returned to the starting position. They were explained to express “stop” when they perceived a target angle during the shoulder joint passive flexion. After a rest for 10 seconds, a perception test was conducted on targeted angles of the shoulder joint flexion. The points where subjects expressed “stop” were marked on the assessment plate and error ranges from the targeted angles were measured. The error range angles measured were calculated into absolute values and recorded.

(2) DASH
DASH is a self-report questionnaire aimed at evaluating functional physical disabilities or symptoms of the upper extremities (shoulder, elbow, wrist, and hand). It consists of 30 items—21 on upper extremity functions to measure physical activities: 5 on pain, activity-related pain, tingling, weakness, and stiffness; and 4 on emotional matters and social activities, such as the disability to engage in social activities due to pain, repeated problems, and sleep and psychological problems. A score from zero (no disability) to 100 points (the most severe disability) is obtained. In the present study, the DASH measurements were made twice—one before and once after the intervention.

(3) SPADI
SPADI is a self-report questionnaire to evaluate pain and function in those with pathological problems of the shoulder, musculoskeletal pain, and neurological problems. It is composed of 13 items—5 on the severity of pain and 8 on physical function problems. Scores granted on this questionnaire are the same as those of a Visual Analog Scale. Zero points refers to no pain/no difficulties and 10 points means the worst pain imaginable, and movement so difficult that the subject requires help. All the point scores were added for a total percentage ranging from 0 to 100, with 0 indicating the best and 100 indicating the worst. In the present study, SPADI measurements were made twice—one before and once after the intervention.

(4) Scapular stabilization exercise
Scapular stabilization exercise of low-intensity was applied to the subjects in the experimental group 5 to 10 days after arthroscopic shoulder surgery. Each motion of protraction, retraction, elevation, and depression was applied at a set of 10 times per a day for 5 minutes six times per week. An ice pack was applied to each of the subjects after the scapular stabilization exercise for 10 minutes. The intensity of the exercise varied among the patients, according to their state. A 3-minute rest time was given after each movement. A skilled physical therapist with over 2 years of experience guided the subjects in the exercises.
3. Statistical analysis
All data obtained in this study were analyzed using SPSS ver. 18 for Windows (SPSS Inc., Chicago, IL, USA). Description analysis (mean ± SD) of the general characteristics of the two groups was made. The Wilcoxon signed-rank test was conducted in order to examine differences in the results from each group before and after the intervention and the Mann-Whitney U test was used to look at differences between the groups. The level for statistical significance was set at 0.05.

III. Results

1. General characteristics of the participants
The participants consisted of 16 adults—6 males and 2 females in the control group and 5 males and 3 females in the experimental group. The general characteristics of the participants are shown in Table 1.

2. Variations in the results of JPS at 30°, 60°, and 90° in the control and experimental groups
After the intervention, both groups saw their JPS errors at 30°, 60°, and 90° significantly decrease relative to before the intervention (p<0.05). Both groups saw their JPS rates at 90° significantly decrease (p<0.05), with no significant changes in JPS at 30° and 60° (p>0.05). Data is shown in Table 2.

3. Variations in the results of SPADI and DASH in the control and experimental groups
Both groups saw their SPADI and DASH significantly decrease after the intervention (p<0.05), with no significant decreases before the intervention (p>0.05). The change rates of SPADI and DASH significantly reduced (p<0.05). Data is shown in Table 3.

IV. Discussion
This study examined the effects of low-intensity scapular stabilization exercise on JPS, DASH, and SPADI in patients

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Table 1. General characteristics of the test subjects (n=16)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group (n=8)</th>
<th>Experimental group (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>56.8±6.6</td>
<td>56.3±7.8</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.1±4.5</td>
<td>165±10.1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>59.8±7.9</td>
<td>62±12.9</td>
</tr>
</tbody>
</table>

Values are mean±standard deviation.

Table 2. A comparison of JPS30, JPS60 and JPS90 between the pre control and experimental groups and the post control and experimental groups (n=16)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group (n=8)</th>
<th>Experimental group (n=8)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPS 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>15.75±6.02</td>
<td>14.75±6.58</td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>10.30±5.98</td>
<td>7±4.14</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.000*</td>
<td>0.002*</td>
<td></td>
</tr>
<tr>
<td>Change rate (%)</td>
<td>37.14±20.92</td>
<td>53.38±23.38</td>
<td>0.224</td>
</tr>
<tr>
<td>JPS 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>9±4.57</td>
<td>13.73±6.94</td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>6.13±4.12</td>
<td>6.88±4.52</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.034*</td>
<td>0.003*</td>
<td></td>
</tr>
<tr>
<td>Change rate (%)</td>
<td>28.25±29.21</td>
<td>49.25±18.55</td>
<td>0.181</td>
</tr>
<tr>
<td>JPS 90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>12.75±6.58</td>
<td>13.13±5.94</td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>7.88±4.01</td>
<td>5.13±2.1</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.010*</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>Change rate (%)</td>
<td>27.75±36.79</td>
<td>59.38±9.43</td>
<td>0.014*</td>
</tr>
</tbody>
</table>

Values are mean±standard deviation.

Table 3. A comparison of SPADI and DASH between the pre control and experimental groups and the post control and experimental groups (n=16)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group (n=8)</th>
<th>Experimental group (n=8)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPADI</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pre</td>
<td>85.58±8.35</td>
<td>84.66±7.96</td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>83.30±6.84</td>
<td>55.66±17.54</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.060</td>
<td>0.006*</td>
<td></td>
</tr>
<tr>
<td>Change rate (%)</td>
<td>9.64±9.40</td>
<td>33.13±21.96</td>
<td>0.010*</td>
</tr>
<tr>
<td>DASH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>77.68±11.81</td>
<td>78.79±6.72</td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>68.40±18.23</td>
<td>47.06±13.11</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.155</td>
<td>0.000*</td>
<td></td>
</tr>
<tr>
<td>Change rate (%)</td>
<td>15.88±25.94</td>
<td>39.38±16.80</td>
<td>0.046*</td>
</tr>
</tbody>
</table>

Values are mean±standard deviation.

SPADI: shoulder pain and disability index, DASH: disability of the arm, shoulder index.
*p<0.05.
who had undergone arthroscopic shoulder surgery. After the intervention, the experimental group saw overall increases in their JPS while the control group’s increase was confined to a JPS of 30°.

The shoulder joint, the human joint with the widest range of motion, has an anatomically thin glenoid fossa, which enables the performance of a wide range of exercise. Additionally, this is where many muscles and ligaments cross the joint, generating joint stability. Therefore, pain in the shoulder joint, causing limitations to movement, creates difficulties in the activities of daily living. 

The proprioceptive sense receives information regarding the position and movement of the musculoskeletal system and joints. Mechanoreceptors perceive movement and tension of the muscles and ligaments and the positions and movements of the joints. According to their positions, sensitive receptors are classified into skin, internal, muscle, and joint receptors. Muscle and joint receptors are categorized as proprioceptive sense receptors. According to the shoulder JPS test results, the control group saw their errors regarding JPS significantly decrease only at 30°, whereas the experimental group’s errors regarding JPS significantly decreased at all angles: 30°, 60°, and 90°. This result suggests that scapular stabilization exercise, which is an active repetitive exercise, is effective in recovering JPS compared to general physical therapy, which leads to only a slight increase in JPS function. Mottlam reported that scapular stabilization exercise is used to improve movement dysfunction related to abnormal scapular position and abnormal dynamic coordination and primarily offers stability to the overall scapular area. Scapular stabilization exercise influences rearrangement of protein fibers and reduces muscle stiffness in the process of delivering information to the CNS regarding tension and pressure on different joints and the length of muscles related to a variety of joint positions. Bartlett and Warren reported that repeated exercise increases body temperature, lowers the mechanoreceptor threshold, induces vascular expansion, and increases nerve root reflexes, heightening exercise senses. In DASH and SPADI, tools to assess the effects of low-intensity scapular stabilization exercise on pain and function, the control group did not see any significant differences between prior to the intervention and after the intervention. On the other hand, the experimental group’s DASH and SPADI significantly decreased after the intervention. Both assessment tools are widely known and commonly used methods.

In current reports, rehabilitation periods were shorter in patients who had received acute rehabilitation treatment after arthroscopic shoulder surgery. In a study of active range of motion exercise applied to patients 10 days postoperatively, Habermek et al. observed that a survey after two years showed normal function, movement, and force. Other reports showed that resurvey after five years demonstrated no difference. Düzgün et al. observed that pain decreased both in a group that performed active exercise three weeks postoperatively and in a group that performed active exercise six weeks postoperatively. Prior studies reported that acute rehabilitation treatment did not bring about negative results in pain and function. Similarly, in the present study, there was no pain increase or functional decrease when scapular stabilization exercise was applied to patients who had received arthroscopic shoulder surgery.

As the first limitation of this study, scapular stabilization exercise was conducted by the subjects themselves and there were probably individual differences in exercise intensity. In other words, accurate intensity of the exercise was not expressed, which is unsatisfying. Second, the intervention period was too short. Third, the number of study subjects was small, lowering the reliability of the results.

Author Contributions

Research design: Yoon HY, Choi JD
 Acquisition of data: Yoon HY
 Analysis and interpretation of data: Yoon HY
 Drafting of the manuscript: Yoon HY, Choi JD
 Administrative, technical, and material support: Choi JD
 Research supervision: Choi JD

References