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Immediate Changes of Shoulder External Rotation Exercise of Various Angle on the Distance of Subacromial Space

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Abstract

Background/Objectives: This study was conducted to examine the distance of the subacromial space when conducting external rotation according to the shoulder joint abduction angle

Method/Statistical Analysis: The study subjects were 40 volunteer participants. The abduction angle of the shoulder joint was set 0°, 45°, 90° and 120° with 10 subjects per angle as a total of 4 groups and the examined changes the subacromial space when conducting external rotation before and after. Ultrasonography was used for the measurement, and the measurement part was the subacromial space.

Findings: 0° and 45° did not show any significant difference before and after exercise. But At 90 degree, there was significant difference, pre-exercise was 10.0±0.92 and post-exercise was 10.3±0.95 ($p<0.05$). And at 120 degree, there was significant difference, pre-exercise was 11.5±2.62 and post-exercise was 12.05±2.51 ($p<0.05$).

Improvements/Applications: The distance changes according to the posture cannot be found. Because it was conducted with normal subjects, it seems to have a heavy burden to apply to patients with shoulder injury. There is a limit to generalize toward all patients. Exercise period for muscles was short. Future studies may provide better results if intervention is conducted for a long period of time in various postures and patients.

Keywords: *Subacromial space, external rotation, abduction, acromion, ultrasonography.*

Introduction

The shoulder joint is the largest range of motion in the body and it is anatomically prone to instability between the acromion and the humeral head. Therefore, shoulder disease is one of the most frequently occurring musculoskeletal diseases[1]. The most common cause of shoulder pain is rotator cuff(RCD), impingement syndrome, bursitis, and tendonitis[2]. Shoulder pain and stiffness may impair work or leisure activities and cause burden on both the patient and society. Most shoulder pain does not go away in a few weeks or months and causes discomfort for long periods of time[3,4]. In particular, impingement syndromes covers the half[5]. Shoulder impingement syndrome refers to a disease that causes pain due to repeated trauma or compression on subacromial bursa, biceps brachii long head tendon and rotator cuff tendon which through the subacromial space becomes narrowed[6-9]. Recently, the distance of the subacromial space is related to the functional disturbance from shoulder disease and the suffering of the patient[9]. Exterior factors affecting the distance of the subacromial space include scapular rotation, shoulder rotation range, length of pectoralis minor muscles, thorax curve and load which are subject to rehabilitation program[10]. The supraspinous muscle tendon goes through the

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subacromial space, and the reduction in the distance of the subacromial space causes impingement in moving the arms[11]. In this course, collision under the acromion causes damage to the rotator cuff[12]. According to the value of this defect, the damaged force in the shoulder joint is noticeable[13]. In general, exercise using external rotation is most well known and commonly used for strengthening the rotator cuff for rehabilitation and prevention of injury[11,14]. In order to increase the subcromial space, it is described that the shoulder internal/external rotation resistance exercise should be regularly conducted in various ways for strengthening the rotator cuff of shoulder impact syndrome patients[14]. In addition, the strengthening of infraspinatus muscle helps some patients to prevent collision syndrome by increasing the subacromial space[11]. It has also been found that the subacromial space changes with the angle of the shoulder abduction and the activity degree of shoulder abductor muscles[15]. The more gradually the shoulder abducted, the more gradually the scapula upward rotation[16]. Sliva and Thomas studied on the relation between the scapular position and the distance of the subacromial space. They reported that the elevation of acromion during upward rotation increases distance of the subacromial space[17,18]. In another study, it is compared with the shoulder abduction at 90 and the external rotation with abduction together, as a result, the subacromial space was wider when having the external rotation with abduction together. In the case of a group, it is compared with giving constant load and non load. And the distance of the subacromial space was wider when there was constant load group than non load group[19]. Ultrasonography shows a successful image in evaluating the rotator cuff. In addition, it can clearly focus on where you want to measure[20]. As such, exercising external rotation is effective in expanding the subacromial space. In particular, it is proved that it is more effective to carry out the external rotation exercise with the shoulder abduction at 90 degree rather than no abduction. However, there is a lack of research on external rotation due to various abduction angles. Thus, this study was conducted to examine the effect of external rotation on the subacromial space at various angle of shoulder abduction through the subjects those who do not have any shoulder joint damage.

Method

This study was conducted on 40 healthy male and female students attending S University in Asan, Chungnam. The subjects were selected as those who had no pain or discomfort of shoulder disease, nor undergone previous shoulder surgery. After determining their health status, subjects who are able to move their arms more than 120° abduction and external rotation were selected. This study provided the

participants with sufficient explanation and understanding of the purpose and method of the study. They participated in the study voluntarily. And the general characteristics of the subjects are shown in [Table 1]. 40 subjects were randomly assigned to the 0 degree group, the 45 degree group, the 90 degree group, and the 120 degree group according to shoulder abduction angle. In this study, dumbbells were used as exercise equipment. When conducting exercise depending on different loads, 2kg (4lb) showed the largest muscle activity. In the previous paper, the target of male only conducted experiment with 4kg (6lb). Based on this, the load applied to the subjects of all groups. It was set to 6lb for male and 4lb for female. And experiments were conducted on the dominant side. The 0 degree group, the 45 degree group, the 90 degree group, and the 120 degree group used the protractor to conduct three sets of external rotation exercises 10 times at each shoulder joint abduction angle [Figure 1] An experiment was conducted using metronome to measure the speed of all subjects' movements at the same speed. Measurements were carried out with the shoulder abduction angle at 0 degree sitting in the chair. For accuracy, the mean value was calculated by repeating the measurement three times before and after exercise according to the corresponding angle. For measurement tool, ultrasonography (eZono 3000, Germany, 2011) was used for the measurement, and the measurement part was the subacromial space. The length between humeral head and acromion was measured. The frequency was 7~10MHz and the image was fixed at a depth of 3cm. The position of the probe was parallel to the flat part of acromion and humeral head and located in slightly behind the upper side and middle of acromion. Data were analyzed using the IBM SPSS ver.20.0 statistical program. One-way analysis of variance (ANOVA) was used for the normality test to determine the difference in subacromial space depending on shoulder joint abduction angle. In addition, the study was conducted using LSD as a post test to examine the difference before and after intervention in group. The significance level (p) was set 0.05 for all statistical tests.

Result

The results of this study was no significant difference

between groups as a result of the external rotation according to shoulder joint abduction angle($p>0.05$). As a result of comparing the results before and after the external rotation exercise depending on shoulder abduction angle (0°, 45°, 90°, 120°) [Table 2], 0° and 45° did not show any significant difference before and after exercise. But At 90 degree, there was significant difference, pre-exercise was 10.0±0.92 and post-exercise was 10.3±0.95 ($p<0.05$). And at 120 degree, there was significant difference, pre-exercise was 11.5±2.62 and post-exercise was 12.05±2.51 ($p<0.05$).

Table 1. General characteristics of the study subjects (N = 40)

	0° group	45° group	90° group	120° group	F
Height	163.7±7.84	165.9±9.78	162.7±6.29	172.2±11.44	2.22
Weight	58.9±8.29	60.7±9.78	58.1±9.56	66.9±11.88	1.60
Age	22.3±2.90	21.4±1.07	22.6±1.95	21.9±1.70	0.66

Table 2. Before and after external rotation motion depending on shoulder joint abduction angle

	0° Exercise Group	45° Exercise Group	90° Exercise Group	120° Exercise Group	F
Before Exercise	10.5±1.15	10.5±0.52	10.0±0.92	11.5±2.62	1.715
After Exercise	10.6±1.17	10.7±0.96	10.3±0.95	12.05±2.51	2.315
t	-1.66	-1.09	-4.21*	-4.89*	

*$p<0.05$

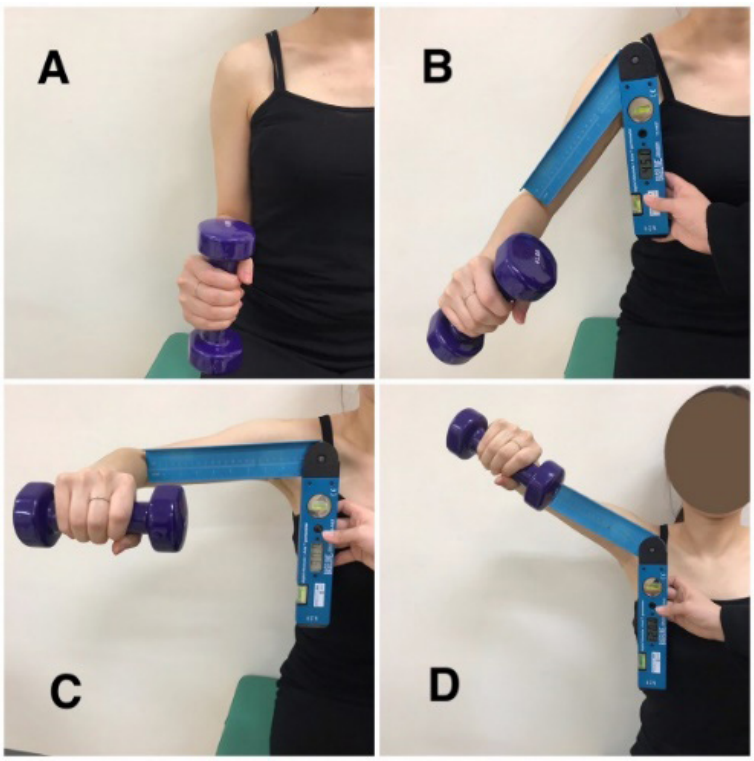

Figure 1. Four Positions of Shoulder Joint abduction A : 0°, B : 45°, C : 90°, D : 120°

Discussion

Recently, shoulder disease among musculoskeletal diseases is one of the most frequent diseases[1]. In particular, shoulder impingement syndrome and rotator cuff tear are the most common[5]. For those patients, the distance of the subacromial space is considered clinically important. The subacromial space causes a source of interference when moving arms. In this process, the

interference is repeatedly generated and causes rupture of supraspinatus tendon which passes through the space. Therefore eventually, it causes inflammation or damage[21]. This suggests that it is necessary to focus on broadening the subacromial space when planning a treatment program[22]. The measurement consists of various method and instruments[23]. Sasiponganan measured the subacromial space using clinical radiography and magnetic resonance imaging (MRI) [24] and Lochmuller measured the subacromial space using 3D computer image. The subacromial space is reported as three dimensional space within the human body[25]. However, it is only possible to be measured in a two-dimensional space for radiation measurement, and it is difficult to change the posture of the patient when measuring the subacromial space and it is risky to exposure of radiation. Ultrasonography can move during measurement and use fast[20]. The shoulders of 40 subjects were measured in sitting position. The external rotation was measured at 0 degree, 45 degree, 90 degree and 120 degree. The women subjects received 4lb dumbbell and the men subjects received 61b dumbbell. As a result, there was no significant difference between the groups because it was instant effect. It should have carried out for a long time in order to activate the muscles. However, as the shoulder abduction angle increases more than 90 degrees, the subacromial space tends to increased. Therefore, it is considered that as the angle increases, the space can be increased. In the comparison group, there was a significant difference at shoulder joint abduction 90 degrees and 120 degree when conducting external rotation exercise. Celeste et al. have reported that reinforcement of adductor muscle such as latissimus dorsi and the teres major when abduction shoulder joint may be effective for the treatment of subacromial pain syndrome[26]. Alizadehkhaiyat et al. have said that the muscle activity of latissimus dorsi muscle, muscle teres major and rotator cuff increases when conducting external rotation at 90 degree rather than 0 degree from shoulder abduction[27]. It is considered that there is no significant difference because there was low activity of muscle in 0 and 45 degree compared to 90 and 120 degree. According to this study, the effect of adductor muscle of eccentricity and strengthening exercise of adductor muscle and rotator cuff pulls humeral head down. There were limitations in this study. First, it was not measured in various postures such as prone and supine and the measurement was made only in the sitting position. Therefore the distance changes according to the posture cannot be found. Second, because it was conducted with normal subjects, it seems to have a heavy burden to apply to patients with shoulder injury. Therefore, there is a limit to generalize toward all patients.

Conclusion

In the conclusion, there was no significant difference between the groups and there was no significant difference at 0 degree and 45 degree 120 degree. Based on this study, it is considered that the patients with shoulder pain impingement in the subacromial space, and the space was increased by mechanically moving the shoulder bone head downward with the most effective rotator cuff at 120 degree in the group. However there was a significant difference at 90 degree and 120 degree. Especially, there was a big difference in 120 degree. Based on this study, it is considered that the patients with shoulder pain impingement in the subacromial space, and the space was increased by mechanically moving the shoulder bone head downward with the most effective rotator cuff at 120 degree.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Nil

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