J. Phys. Ther. Sci.
20: 239–242, 2008

Effects of the Shoulder Horn and Lightweight Dumbbell Training on Shoulder External Rotators

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Abstract. [Purpose] The purpose of this study was to investigate the effects of a strength training program using a shoulder horn and lightweight dumbbells on the shoulder external rotators. [Subjects] Twenty healthy adults were randomly assigned either to an experimental group (shoulder horn and dumbbell training) or a control group (dumbbell training). [Methods] Subjects were pre- and post-tested in maximal external rotation torque of the shoulder at 60°/sec and 180°/sec using an isokinetic dynamometer. The experimental group lifted dumbbells with the shoulder at 90° abduction and the elbow at 90° flexion using the shoulder horn. The control group lifted dumbbells with the shoulder at 90°abduction and the elbow at 90° flexion. Both groups received training three times per week for three weeks. Performance was assessed by recording the mean peak torque value. [Results] The experimental group exhibited a significant gain on the right side at 60°/sec ($p<0.05$). The overall gain of mean peak torque in the experimental group was 148% greater than that of the control group. [Conclusion] These results suggest that the combined use of a shoulder horn and dumbbells in strength training is more effective than the use of dumbbells alone.

Key words: Rotator cuff, Muscle strength training, Shoulder horn

(This article was submitted May 29, 2008, and was accepted Jul. 14, 2008)

INTRODUCTION

One of the most important components in the prevention and rehabilitation of rotator cuff injuries is the strengthening of the external rotator muscles in the shoulder. Lightweight dumbbells are frequently used as the primary method of therapeutic exercise in the prevention of shoulder injury and in the strengthening of the external rotator muscles[1, 2)]. Dumbbells are graduated weights that are either held or applied to the extremities, and help strengthen the external rotator muscles during rehabilitation following rotator cuff repair[2)]. There are various ways to strengthen weak muscles including the use of isolated movement patterns, such as theraband tubing. This effectively trains the shoulder decelerators, including the infraspinatus, teres minor, and deltoid muscles[3, 4)]. Several exercise programs, including the "empty-can exercise"[5)], "full-can exercise"[6–10)], and "prone full-can exercise"[11)] are beneficial in strengthening the supraspinatus. Specific exercise positions progressing from 0° to 90° abduction of the scapular plane should be used in strength training of the shoulder rotators. Studies have shown that the maintenance of a scapular plane at 90° shoulder abduction and 90° elbow flexion enhanced muscular strength in the throwing position[12, 13)].

Table 1. Subject characteristics

Group		N	Age (years)	Height (cm)	Weight (kg)	Hand dominance	
						Rt	Lt
Men	Control	7	24.6 (3.3)	176.0 (4.1)	65.0 (6.1)	6	1
	Experimental	7	23.8 (3.1)	173.1 (5.1)	66.1 (7.3)	6	1
Women	Control	3	22.5 (4.7)	158.2 (2.1)	57.2 (4.1)	3	0
	Experimental	3	21.8 (3.7)	163.0 (3.1)	56.5 (4.5)	3	0

Values are means ± standard deviations.
Rt: right; Lt: left.

The shoulder horn was created to assist athletes in the performance of external rotation exercises and is thought to provide maximum efficiency in strengthening the external rotator muscles. The shoulder horn secures the arms in a stable position to exercise the shoulder external rotators with dumbbells, and stabilizes the arms with 90° shoulder abduction and 90° elbow flexion. Extraneous motion is limited and the external rotator muscle can be isolated by securing the shoulder. Physical training programs using both shoulder horns and dumbbells may result in greater increases in external rotator muscle strength than dumbbells alone.

To our knowledge, there are no studies that have evaluated the effectiveness of an external rotator training program comparing the shoulder horn and dumbbells. The purpose of this study was to investigate the strengthening effects of both the shoulder horn and dumbbells on the shoulder external rotators.

SUBJECTS AND METHODS

Subjects

The study sample consisted of 14 healthy male subjects (mean [SD] age = 24.2 [3.2]) and 6 healthy female subjects (mean [SD] age = 22.2 [4.2]) with no underlying neurological or orthopedic impairments. Subjects had an average weight of 61.2 kg and an average height of 167.6 cm. Subjects were randomly allocated to the experimental group (n=10) and the control group (n=10). All participants signed an informed consent form. Subject characteristics are summarized in Table 1.

Methods

A shoulder horn (QFAC, Inc., Colleyville, TA, USA) was adjusted to a close and comfortable fit which supported 90° shoulder abduction. We used the Biodex Isokinetic dynamometer (Biodex Medical System, Shirley, NY, USA) to measure the isokinetic strength of shoulder external rotators before and after training. A pair of dumbbells (mean weight, 6.5 lbs; range, 5–8) were used for training. The amount of dumbbell load was determined for each subject by form and fatigue. The weight was sufficient to cause fatigue by the 10th repetition but not compensation via body rotation or elbow motion.

Active range of motion and manual muscle tests for shoulder external rotators were performed in all subjects and were within normal limits. The Biodex Isokinetic testing chair was used for an isokinetic test of shoulder external rotator torque. Subjects were asked to sit on the testing chair with their trunk and upper body secured and stabilized by Biodex velcro straps. With the elbow joint flexed to 90° and the glenohumeral joint abducted to 90° subjects were asked to perform three submaximal contractions (below maximum effort) and three maximal contractions (at maximum effort). Resistance was applied to the distal forearm just proximal to the volar wrist crease. Shoulder movements were performed at speeds of 60°/sec and 180°/sec in external rotation with the glenohumeral joint abducted to 90°. Four repetitions were performed at 60°/sec and 180°/sec speeds and subjects were randomly assigned to begin testing. Mean peak torque measurements of maximal shoulder external rotation were calculated from four trials.

Exercises were performed in a sitting position and both arms were trained. Subjects attempted to maintain 90° abduction while training with the shoulder horn and dumbbells (experimental group) or simply dumbbells (control group). Each subject performed three sets of 10 repetitions, three times per week for three weeks. All subjects completed the full three-week training. Post-test peak torques of maximal shoulder external rotation were measured in both groups after the training period. The subjects went through similar testing procedures to those used in the isokinetic pre-testing procedures. Subjects were instructed in proper breathing and proper shoulder alignment during the exercises.

Comparison of the changes in peak rotation torque before and after training between the experimental and control groups were made by multivariate repeated-measures analysis of variance (MANOVA). MANOVA analyses were performed by combining data of mean peak torque of both the right and left sides, and by combining data drawn from 60°/sec and 180°/sec speeds before and after training in the experimental and control groups. Follow-up procedures were performed with independent sample t-tests on data with significant MANOVA findings and $p<0.05$ indicated statistical significance.

RESULTS

Changes in peak rotation torque between the two groups before and after training are summarized in Tables 2 and 3. MANOVA results indicated that the velocities by side variables were not significantly different after training in the experimental ($p=0.065$) or control ($p=0.75$) groups. However, there was a significant difference in the mean peak torque at the two (60°/sec and 180°/sec) velocities between the experimental and control groups after training ($p<0.01$). Multiple comparisons revealed a significant difference in the mean peak torque between pre- and post-test on the right side at 60°/sec in the experimental group ($p<0.05$). No significant difference was seen in the left side at 60°/sec and both sides at 180°/sec in the experimental group, nor in both sides at any velocity in the control group, between pre- and post-test.

Table 2. Mean peak torques (Nm) of shoulder external rotation between pre- and post-test in the experimental group

Velocity (°/sec)	Pretest	Posttest
Rt 60°/sec	17.7 ± 6.8	21.7 ± 7.9*
Lt 60°/sec	16.0 ± 6.6	17.3 ± 7.9
Rt 180°/sec	15.5 ± 5.4	17.7 ± 7.4
Lt 180°/sec	14.2 ± 7.2	15.9 ± 8.3

*$p<0.05$ change compared with pre-test.
Values are expressed as means ± standard deviations.
Rt: right; Lt: left.

Table 3. Mean peak torques (Nm) of shoulder external rotation between pre- and post-test in the control group.

Velocity (°/sec)	Pre-test	Post-test
Rt 60°/sec	17.0 ± 8.4	19.0 ± 9.9
Lt 60°/sec	16.3 ± 8.8	17.9 ± 8.1
Rt 180°/sec	15.0 ± 9.0	16.2 ± 7.5
Lt 180°/sec	14.6 ± 9.3	16.0 ± 7.7

Values are expressed as means ± standard deviations.
Rt: right, Lt: left.

DISCUSSION

To our knowledge, studies comparing gains in peak rotation torque of the shoulder external rotator muscle before and after training with shoulder horns and dumbbells have not been performed. This study attempted to investigate the effects of the shoulder horn exercise program on strength of rotator cuff muscles.

This study found a statistically significant difference in peak rotation torque on the right side at 60°/sec in the shoulder horn group. Mean rotation torques in the experimental group increased by 23% on the right side at 60°/sec after shoulder horn training, and increased by 8.1% on the left side at 60°/sec after shoulder horn training. Small sample sizes may have affected the findings of our study. In addition, right hand dominance may have also played a factor, as 18 of the 20 subjects displayed right hand dominance. A significant difference between the two velocity variables after training in the experimental and control groups was noted in this study. These results are consistent with findings from other studies[14, 15] which revealed increased torque at decreased speeds. Ellenbecker et al.[14] noted that a slow speed of 60°/sec generates more tension and requires more time to recruit motor units during peak torque production. This phenomenon may have had an impact on the current findings. Cahalan et al.[15] reported that peak torque decreased as speed increased in mean peak torque measurements at multiple speeds.

Although no significant differences were noted in bilateral mean torque measurements at 180°/sec in the experimental group, mean torque gains were much greater on both the right (83%) and left (21%) sides than in the control group. However, the mean peak torque in the control group increased by 9.9% at post-test as compared to pre-test. In addition, the overall gain in mean peak torque after training was 148% greater in the experimental group. This suggests the positive influence of the use of the shoulder horn in strengthening the shoulder external rotators.

One of the aims of a rehabilitation program for patients with shoulder injuries is to encourage recovery as soon as possible and to encourage a return to functional activity. Overhead athletes such as swimmers and tennis players have frequent shoulder pain and weakness. The most common cause of shoulder dysfunction in young athletes is anterior instability due to increased demands in the range of motion of overhead sports, leading to secondary impingement[16]. Both glenohumeral instability and impingement syndrome are the result of internal and external rotator muscle imbalance, excessive capsular laxity, and loss of capsular flexibility[13]. Muscular imbalances occur when opposing muscles develop unequal levels of strength[17]. If internal and external rotator imbalance is uncorrected, the shoulder's integrity may be affected, resulting in chronic pain and injury.

Therapies for shoulder injuries necessitate isolation and strengthening of the individual rotator cuff muscles, initially with small weights and with progression to larger weights[5]. The results of this study suggest that the combined use of the shoulder horn and dumbbells was more effective than the use of only dumbbells. Further work is necessary, with larger sample sizes, to study the therapeutic efficacy of the shoulder horn and dumbbells in rotator cuff injury.

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