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ORIGINAL ARTICLE

DECREASE RANGE OF MOTION AND PROBLEM IN LEARNING OF A NEW SPORT SKILL DUE TO WEIGHT TRAINING IN WEIGHTLIFTERS

Abstract

The aim of this study was to survey the relationship between decrease in range of motion and learning of a new sport skill in people who had experience of weight training. This research was conducted using pre-test, three acquisition test, retention test and transfer test, with two experimental (n=18 weightlifters) and control groups (n=20 non-weightlifters). Data was collected by universal gonimeter and American Alliance for Health Physical Education, Recreation and Dance (AHHPERD) overhand volleyball serve. All of participants had the same schedule program with 120 trials (40 trials in 3 sessions). Date analysis showed that weightlifters shoulder's range of motion was significantly ($p<0.05$) smaller than non-weightlifters. Although diversity of performance from pre-test to retention and transfer test did not indicated that weightlifters learned the skill which they practiced non-weightlifters learned volleyball serve. Therefore we could conclude that weightlifters have worse performance than non-weightlifters in learning of a new sport skill.

Key Words: : Flexibility, Glenohumeral Joint, Weightlifters, Motor learning

Introduction

Physical requirements and specific motor patterns in athletes make occasion for maladaptation in musculoskeletal system (Crockett, 2002). As repeated demands on a musculotendinous unit for long time, may cause shortening and decreasing of joint range of motion (ROM) in athlete (Daneshmandi & Shacklady, 2002). These negative adaptations appeared with reducing ROM, changing biomechanical patterns, decreasing the efficiency of force production, increasing the musculoskeletal system injuries (Hall & Martin, 2002) and faulty posture (Chandler et al., 1990).

Many athletes who lift heavy weights will emphasize on improvement of pectorals, deltoid and abdominal muscles strength automatically (Barlow et al., 2002). Weightlifters try to give further strength and power though hypertrophy (Chiu & Schiling, 2005) as observed those junior olympic weightlifters had a greater muscularity in the upper body part and anterior thigh (Kanehisa et al., 2005). Although hypertrophy has been indicated as a factor on decrease ROM, dynamic shoulder instability in body builder (Barlow et al., 2002), it reduces shoulder ROM of weightlifters in abduction and internal rotation (Calhoon & Fry, 1999; Gross et al., 1993; Kolber et al., 2009; Kolber & Corrao, 2011; Neviaser, 1991). Some researchers reported that limitation in internal rotation and overall rotation of shoulder ROM could have negative effect on motor performance and decrease in arm optimum momentum through biomechanical deficiency (Kibler, 1995; Wilk et al., 1997). Besides decrease in ROM can reduce sport performance at long time (American College of Sports Medicine [ACSM], 2005). Person who has smaller ROM in glenohumeral Joint, encounters many problems in doing of daily routine activities such as donning & doffing clothing, overhead movement, reaching and rotation activities (Murnagham, 1998; Tovin & Greenfield, 2001) therefore, they cannot truly perform individual and social task works (Tovin & Greenfield, 2001).

Flexibility or ROM means joint ability in performing the actions before the movement is limited by skeleton system, ligaments or the volume of the muscles around the joint (ACSM, 2005; Norkin & White, 1995), it is considered as an important factors in evaluation of physical fitness and motor index in people (Hands, 2008). Previous researches' recognized relationship among physical fitness, motor performance and motor ability (Haga, 2009; Hands & Larkin, 2006) so that there has been observed people who have lack of flexibility deal with

many problems for execution of motor skills (i.e. overhand throwing and vertical Jumping) and had worse performance (Hands, 2008). It is suggested that learning disability is highly predictive of restriction of mobility (Beckung & Hagberg, 2002; Chan et al., 2005) furthermore, Beckung and Hagberg (2002) showed that learning disability, activity limitations, and participate restrictions were all clinically strongly associated ($p<0.001$) with each other. Hammond (1995), O'Beirne and Larkin (1991) observed that children who has problem in motor learning, suffered from ROM disorder such as hypo-hyper flexible. Another survey Hands & Larkin (2006) reported that children with 5 to 8 age old, who had some problems in motor learning, had less flexibility than control group. These results have also been observed in older samples (Cantell et al. 2008; Haga, 2008).

According to Rosenbaum (2006) motor limitations cause limitation in development of perception experience and decline motor learning in people. Although weight training increases strength, power and decreases injury prevalence by many athletes (American Academy of Pediatrics Committee on Sports Med & Fitness, 2001; Starkey et al., 1996) it must be noticed that limitation in ROM is one of the side effects of this kind of training (Barlow et al., 2002; Corrao et al., 2009; Kolber et al., 2009; Kolber & Corrao, 2011; Neviaser, 1991). Furthermore, motor restriction is related to reduction of motor performance and motor learning (Beckung & Hagberg, 2002; Chan et al., 2005; Haga, 2009; Hands, 2008; Hands & Larkin, 2006). Since majority of previous studies focused on the relationship between motor limitations and learning problems in non-athlete and samples with physical disable (i.e. Cerebral palsy persons or children with low motor competence) therefore, this study tried to survey this issue among weightlifters who had experience of heavy weight lifting to answer the following questions; a) Is Shoulder ROM of weightlifters less than non-weightlifters? b) Does ROM limitation lead to motor learning problems in weightlifters?

Method

The present research has been conducted based on semi-experiment design with one experimental and control group. The plan of the study was based on, pre-test, three middle-test (acquisitions test) and post-test (retention and transfer test).

Subjects: In this study, we tried to control other variables that affect the motor learning procedure, i.e. Gender (Dorfberger et al., 2009) and age (Perrot & Bertsch, 2007) that

suggested to affect motor learning. The statistical society of the study was men weightlifters and non-weightlifters with 20-25 years of age that lived on Arak city and didn't have any experience in volleyball practice and education. Weightlifters were people who have been training 3 days a week for the past 3 years (Barlow et al., 2002). At least 18 weightlifters (21.43±2.13 years old) for experimental group and 20 non-weightlifters (21.33±1.57 years old) for control group participated voluntary as statistical sample in this study.

Data collection instruments: We used AHPPERD overhand volleyball serve test (1969) for measuring of performance accuracy of the samples. This test is one of the prevalent methods for evaluation of volleyball serve; in which the samples have to perform 10 efforts. We used the other instruments which including demographic questionnaire, Nordic muscuskeletal injury questionnaire, Edinburgh handedness inventory and Baseline® goniometer standard. Validity and reliability of Nordic muscuskeletal injury questionnaire (Kuorinka et al., 1987), Edinburgh handedness inventory (Williams, 1991), and universal goniometer for assessment of ROM (Kaplan et al., 2011) have been proved previously. This study was approved by the ethical committee of Arak University of Medical Sciences.

Design plan of training and tests: Having attended to weightlifting club of Arak city and distributing questionnaires, information of all weightlifters evaluated. Researchers invited weightlifters who didn't have any injury during the previous week at the time and didn't have any experience in volleyball training and have been right handed to participate in this study. Also non-weightlifters were selected from non-physical education students of Azad University (Arak branch) by the same procedure.

Samples were explained as to the aim of the study and quality performance of serve skill. According to Schmidt's method (1991) pre-practice considerations were taken into practice. Then pre-test was taken by two groups. Participations practiced overhand serve for three sections in one week with 120 trials, therefore they performed 40 trials every day (4 blocks in 10 trials). All of the practice trials were performed from right side of volleyball playground. We gave Summary feedback along acquisition phases about the knowledge of performance (KR) like Weeks and Sherwood (1994) with regularly one KR to five trials. Acquisition tests were taken without feedback at the end of every acquisition phases. Practice sessions of two groups were administered separately, with the same educator and plane design. Retention test was performed after 24 hour from the last acquisition test and transfer test was taken at the left side

of volleyball playground.

Range of motion assessment: according to Norkin and White (1995) method, we measured ROM of internal rotation (IR), external rotation (ER), abduction and extension of shoulder joint. All measures were taken after warm up in the morning. To measure internal and external rotation of the shoulder, the arm was positioned in 90° and the elbow was in flexion of 90°, while the subjects were lying supine. Then participants were required to conduct the rotation up to the end of ROM. After that, the rotation was recorded. To measure ROM of abduction, the angle between the arm bone and trunk was recorded with the participants lying prone on bed and abducting the arm from one side of the body. To measure extension ROM of the shoulder, the arm was elevated from the side of the body in sagittal plane without flexing the elbow while the participants were lying prone on the bed (Norkin & White,1995).

Data Analysis: We used descriptive statistic tests such as mean, standard deviation and Pearson correlation coefficient. Normality was tested with Kolmogorov-Smirnov, and then analysis of variance with repeated measures was used, dependent and independent t-test (α=0.05) was exploited to compare the performance and learning procedure of the two groups. Graphs were drawn by Excel 2007 soft ware.

Result

ROM of Glenohumeral joint: Data analysis of independent t-test revealed that ROM of weightlifters (table 1) is significantly smaller than non-weightlifters in IR, ER, abduction and extension (P<0.001).

Table 1 Compare dominant side of shoulder ROM between weightlifters and control group

Variables	groups	Mean	Levene's Test F	Levene's Test sig	t	sig	Mean Difference
Extension	Weightlifters	25.64±7.27	1.44	0.238	6.543	0.0001	27.69
	Non-weightlifters	53.33±14.44					
Abduction	Weightlifters	180.79±9.64	5.771	0.023	6.545	0.0001	17.99
	Non-weightlifters	198.78±5.82					
Internal rotation	Weightlifters	43.07±15.04	0.249	0.621	3.575	0.001	17.48
	Non-weightlifters	60.56±12.62					
External rotation	Weightlifters	69.86±16.25	0.131	0.58	4.584	0.0001	24.03
	Non-weightlifters	93.89±13.41					

Performance and learning of skill: The comparison of mean score of performance in pre-test indicated that weightlifters didn't have significant differences ($t_{(36)}$ =1.294, p-value = 0.205) with control group in accuracy of overhand volleyball serve performance. Repeated Measure test [2 groups × 6 tests] was used to calculate the variation of the performance from pre-test to transfer test (table 2). Data analysis showed that performance of two groups changed significantly ($F_{(5,\ 65)}$ =13.893; p-value = 0.0001), therefore, practice had affected the performance accuracy of volleyball serve. But the performance of two groups had significant differences along the study ($F_{(1,\ 13)}$ =6.773, p-value = 0.02). Also you can infer the diversity of the performance between weightlifters and control group by figure 1.

Table 2 Comparison of performance for two groups from pre-test to transfer test

Source	Type III Sum of Squares	Mean Square	F	Sig	Partial Eta Squared
Test's	1461.839	292.368	13.893	0.0001	0.517
Group	33.482	33.482	6.773	0.022	0.343
Test's * Group	420.839	84.168	15.243	0.0001	0.540

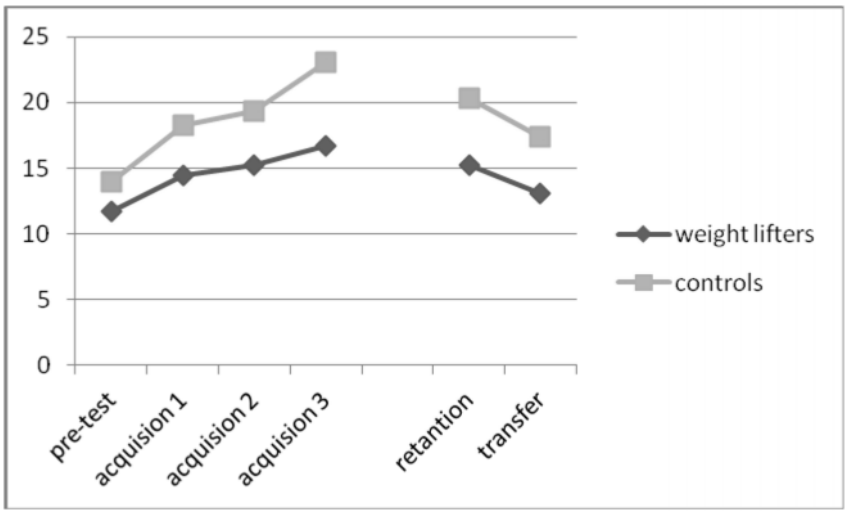

Figure 1 Performance graphs of two groups along this study

In Table 3 shows the result of dependent t-test for two groups. Weightlifters performance didn't have significant differences from pre-test to retention test ($t_{(17)}$ =1.82; p-value=0.092) and pre-test to transfer test ($t_{(17)}$ =1.29; p-value=0.218). But control group had significant differences from pre-test to retention ($t_{(19)}$ =4.332; p-value=0.0001) and to transfer test ($t_{(19)}$ =2.457; p-value=0.025). Therefore, weightlifters performance did not demonstrate the learning of skill which they practiced.

Table 3 Inside comparison of mean score for two groups from pre-test to transfer test

Group	Paired between	Paired Differences			T	Sig
		Mean	Std. Deviation	Std. Error Mean		
Weightlifters	Pre-test & Retention test	3.52	6.644	0.707	1.82	0.092
	Pre-test & Transfer test	1.42	4.512	0.939	1.29	0.218
Control	Pre-test & Retention test	6.33	6.202	1.462	4.332	0.0001
	Pre-test & Transfer test	3.39	5.852	1.379	2.457	0.025

ROM and Performance: Finally, there used Pearson correlation coefficient for the relationship between shoulder ROM and volleyball serve performance of all of the participants (table 4). The results showed that ROM of extension (r (36) = 0.570; p-value= 0.001), abduction (r (36) = 0.510; p-value= 0.003), IR (r (36)= 0.485; p-value=0.005), and ER

(r (36)= 0.610; p-value=0.0001), had liner and positive correlation significantly with the score of performance at retention test, also this result showed for ROM of extension (r (36) = 0.602; p-value= 0.0001), abduction (r (36) = 0.567; p-value= 0.001), IR (r (36)= 0.478; p-value=0.006), and ER (r (36)= 0.579; p-value=0.001) with transfer test.

Table 4 Correlation coefficient between glenohumeral ROM and performance of skill

	Extension	Abduction	Internal Rotation	External Rotation	Pre Test	Retention test	Transfer test
Extension	1						
Abduction	0.783**	1					
Internal Rotation	0.564**	0.614**	1				
External Rotation	0.585**	0.657**	0.715**	1			
Pre-Test	-0.020	0.067	0.080	-0.029	1		
Retention Test	0.570**	0.510**	0.485**	0.610**	0.357*	1	
Transfer Test	0.602**	0.567**	0.478**	0.579**	0.344	0.937**	1

* Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed).

Discussion

The aim of this research was to observe the improvement in performance and learning of a new skill in weightlifters after practice and compare it with non-weightlifters performance. Therefore, we selected purposefully all of the participants among male participants who had the same age range (20-25 years old) to eliminate the effect of gender and age. Besides, participations (weightlifters and control group) didn't have any significant differences ($t_{(36)}$=1.294, p-value = 0.205) in performance of serve skill on pre-test. Therefore, the researchers employed only those who had differences in weight training experience and ROM characteristic. So we intended to examine the hypothesis that decrease ROM as a result of long term weight training might lead weightlifters to some problems for learning of a new motor skill.

The results demonstrated that weightlifters had shoulder ROM smaller than non-

weightlifters ($p<0.05$). These results were in the line with previous studies which administered on weight trainers (Barlow et al., 2002; Calhoon & Fry, 1999; Daneshmandi et al., 2010; Gross et al., 1993; Kolber et al., 2009; Kolber & Corrao, 2011; Neviaser, 1991). Barlow et al (2002) indicated that internal and external rotation shoulder's ROM of bodybuilders was smaller than the control group. Another research reported that power lifters had smaller ROM than ordinary people (Chang et al., 1988). Also Kolber et al (2009) and Kolber & Corrao (2011) showed that recreational weightlifters ROM in IR, abduction and flexion were significantly smaller than non-weightlifters. Identifying shoulder joint in weight training endure inappropriate position and maximum external rotation (Gross et al., 1993; Kolber & Corrao, 2011). Also upper extremities programs in weight training primary focus on hypertrophy and increase strength of large muscles, thus they disregard the fine muscles which have a stable effect on shoulder joint (Barlow et al., 2002; Kolber et al., 2009). In previous studies hypertrophy (Barlow et al,2005; Calhoon & Fry, 1999; Gross et al., 1993) posterior shoulder tightness (Kolber et al., 2009; Kolber & Corrao, 2011), negative musculoskeletal adaptation or maladaptation through repeated motions under specific ROM (Daneshmandi et al., 2010), unfavorable positions of shoulder during weight lifting with heavy loads and training for a long time (Corrao et al., 2009; Kolber et al., 2009; Kolber & Corrao, 2011) were mentioned as the important reasons of ROM decrease in weightlifters. Meanwhile scholars suggested that posterior shoulder tightness along with hypertrophy and muscle imbalance make smaller overall ROM of weightlifters than non-weightlifters (Kolber et al., 2009).

Findings also showed that there were significant differences ($F_{(1, 13)}=6.77$; p-value=0.022) in performance of two groups from pre-test to transfer test (table 2). In addition, the results of dependent t-test indicated that performance of weightlifters in retention and transfer test was not significantly better than pre-test, but the performance of control group was better than the pre-test (table 3). Learning procedure might be inferred from performance diagram of participations (Schmidt, 1991), so figure 1 indicated that weightlifters made different procedure from non-weightlifters. Since, shoulder joint has considerable function on performance of overhand volleyball serve and weightlifters in this study had a shoulder ROM smaller than control group, consequently, these findings had been predicted that weightlifters would have worse performance than non-weightlifters. Because

based on Hands (2008) findings, people who have had low flexibility would perform defectively to overhead throwing skills.

Then we observed there was positive significant correlation between shoulders ROM and mean score of participant's performance in retention and transfer phrases (table 4). This finding is in the line with the results of previous studies which reported "there is a strong correlation between ROM and hands performance" (Bland et al., 2008; Cooper et al., 1993). So they suggested that limited shoulder ROM affect the decrease performance of hands in healthy young participants (Bland et al., 2008). Beckung & Hagberg (2002) declared learning disabilities correlated with motor limitations and decrease ROM affect performance of gross and fine motor skills. Hammond (1995), O'Beirne and Larkin (1991) reported a strongly correlation between learning problems and flexibility deficit. Also Hand & Larkin (2006) observed children who had some problems in motor learning suffered from low flexibility in comparison with the control group. Normal shoulder function requires a delicate balance between mobility and strength of muscle groups that function synchronously during activities (Kolber & Corrao, 2011). Therefore weak performance of weightlifters in volleyball serve may attribute to low ROM of weightlifters. Therefore, the results of this research are similar to previous studies. Certainly, this study has some limitations, for example cognitive abilities of participants were not evaluated precisely, so it was tried to carry out the research on two groups with same level of education. Also presumption of skill learning was implemented by observation of results performance. Therefore, roughly speaking, weightlifters had worse learning procedure and performance of motor skill than non-weightlifters. Thus researchers recommend this issue to be surveyed with exquisite instrument of learning evaluation on larger samples in the future.

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