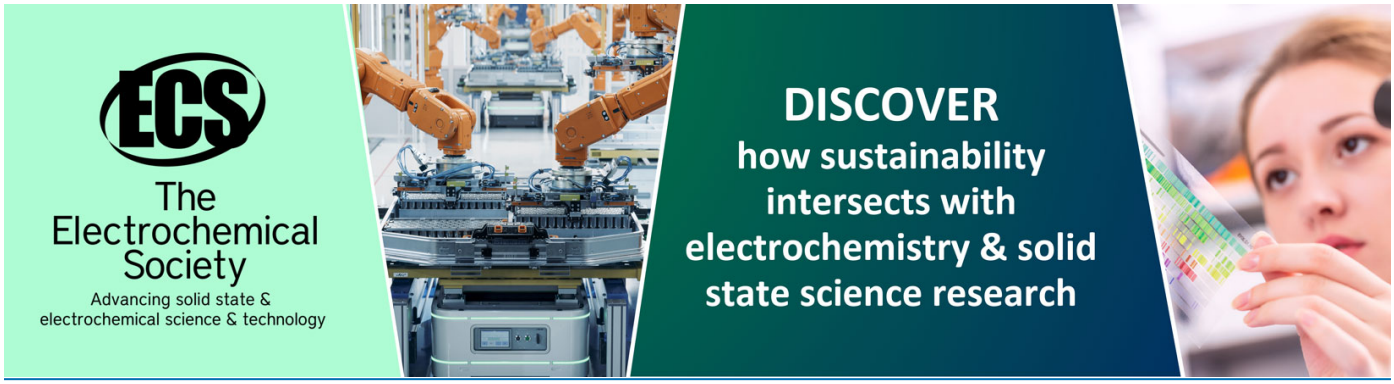
The Effects of Unilateral versus Bilateral Resistance Training on Bilateral Deficit, Unilateral and Bilateral Strength Adaptation among Trained Men



The Effects of Unilateral versus Bilateral Resistance Training on Bilateral Deficit, Unilateral and Bilateral Strength Adaptation among Trained Men

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Abstract. This study aimed to examine the effects of unilateral versus bilateral resistance training and bilateral deficit on unilateral and bilateral strength adaptation among trained men. Thirty recreationally active, resistance trained men were recruited and were divided into three groups; i) unilateral (n=10), ii) bilateral (n=10) and iii) control (n=10). Chest press and biceps curl strength tests were conducted unilaterally and bilaterally before and after six weeks of training intervention. Unilateral bicep curl and chest press training was given to the unilateral group while the bilateral group was asked to undergo bilateral bicep curl and chest press training. 1RM bicep curl and chest press tests were measured unilateral and bilateral strength and bilateral deficit before and after the intervention. The intervention period were six weeks. Mixed design (ANOVA) was used to compare strength during pre- and post-test in groups while MANOVA was used to compare the changes in percentage during pre and post-test between groups. Results showed a significant difference in the test of unilateral strength within groups. Both unilateral and bilateral training groups managed to improve both unilateral and bilateral strength significantly in both exercises but there was a decrease in unilateral and bilateral strength within control group. On the other hand, all the three groups showed no bilateral deficit for bicep curl and chest press test. The findings also revealed that there was a significant difference in the percentage changes between groups. The unilateral group showed a greater change in percentage the in unilateral strength compared to the control group but no significant difference with the bilateral group. While, the bilateral group showed a greater percentage change in bilateral strength compared with the unilateral and control group. In conclusion, this study showed that both of these unilateral and bilateral exercises can increase muscle strength in trained men. However, the unilateral and bilateral strength adaptation is specific to the training performed especially for multi-joint and complex exercise.

1. Introduction

The methods of resistance training is an important elements of getting the best performance after a period of exercise [1]. The effectiveness of resistance training depends on manipulation of variables such as muscles target, load and volume, exercise selection, rest interval, repetitions and training frequency [2], [3]. A proper and systematic resistance training method can improve muscle strength and endurance [2], [3], [4] instead of reduce injury risk and accelerate muscle recovery from injury

[5], [6]. Therefore, a well-planned and strategic training program is very important to prevent injury and to increase performance in order to archive goals.

Many of the previous researches were conducted to compare exercise training methods on physical performance [7], [8], [9]. One of the training methods includes unilateral and bilateral exercise. Both of the methods are simple but the effectiveness of unilateral or bilateral strength training is still being discussed and debated [10], [11], [12]. Unilateral resistance training involves completing exercise using one side of the body. The unilateral movement is a movement that's produced by one limb during training. While, the bilateral resistance training involves completing exercises using both sides of the body in which a movement is produced by both limbs of the body at the same time.

There were many studies stated that the unilateral and bilateral training gave impact in optimizing physical performance. According to [13], unilateral and bilateral training improved maximal strength of knee extensors, change of direction and jumping ability, with no changes in limb symmetry index among young soccer players. The findings were supported by another study [14], stated that unilateral and bilateral training were equally effective for early phase improvement of unilateral and bilateral leg strength and power in untrained men and women. However, both of the studies mentioned stated that no significant difference between the unilateral and bilateral groups.

Besides that, there were also a statements regarded to different effects on physical performance between unilateral and bilateral exercises. A studied was conducted by [15] on identify the differences between unilateral and bilateral training and their effects on female handball players sprint acceleration. The findings of the study showed that unilateral training more effective on the first 5-meters of the 10-meter sprint acceleration test .Whilst bilateral training more effective in improving the total time of the 10-meter sprint acceleration test. Another study by [16], stated that unilateral plyometric was more effective because it was able to increase the jumping power and performance in a shorter period whereby adaptation from bilateral plyometric training to maintain during detraining.

Due to the different findings of previous researches, the effectiveness of unilateral and bilateral training might be influenced by the study designs on manipulation of variables. However, a phenomenon is commonly observed when comparing power and force generation between unilateral and bilateral movements. This is referred to as the bilateral deficit and occurs when there is a reduction in the amount of force from a single limb during maximal bilateral exercise. Therefore, the purpose of this study was to examine the effects of unilateral versus bilateral resistance training and bilateral deficit on unilateral and bilateral strength adaptation among trained men.

2. Methodology

2.1. Participant

A total of 30 trained men were recruited from University Pendidikan Sultan Idris of which (age = 22.56±1.47years, height = 171.06±2.91cm, and body mass = 69.36±4.16kg). Participants were at least physically active and took part in resistance training for the previous six months. Participants commenced free of injury or any medicine, which may have inhibited the performance. Subjects were also screened via Physical Activity Readiness Questionnaire (PAR-Q) and gave their written informed consent after being informed of the aims and possible risk involved in this study

2.2. *Procedure*

Participants were involved in familiarization session, in which demonstration was given by instructor to perform a proper bicep curl and chest press exercise unilaterally and bilaterally. The familiarization session was important so that participants could have a better understanding of the procedure to be conducted during this study. After the familiarization session, 1RM pre-test was conducted for all participants. Participants were randomly divided into three groups, unilateral, bilateral and control group based on the 1RM pre-test score. During training session, unilateral group performed bicep curl and chest press exercise unilaterally, while bilateral group performed bicep curl and chest press bilaterally. All participants needed to lift 75% of their 1RM during the training session. This load was

set up because it had been proven that it could optimize muscle strength [3]. Thus, intensity of both exercise were set to 10 repetitions x 3 set, rest between each set was 2 minutes and rest between both exercise was 3 minutes for unilateral and bilateral group. Thus, if the participants were able to lift the load more than 10 repetitions during the training session, the load would be increased. The order of exercises during training started with chest press and followed by bicep curl. The intervention training was conducted three sessions per week for six weeks. Participants were given a rest of 48 to 72 hours between training days of the week. Post-test was conducted 2 days after completion of training intervention session. The same test procedure as performed during the pre-test was retested during the post-test.

2.3. 1 Repetition Maximum

The 1RM test procedure followed the guidelines by National Strength and Conditioning Association [3]. Participants were asked to warm up with a lightweight load that allowed the participants to perform 5 to 10 repetitions. After series of lifting 2 to 3 repetitions, participants were required to perform 1RM test. All loads and techniques during lifting need to be supervised and approved by the researcher. The loads would be increased or decreased by 4 to 9 kg or 5% to 10% depends on success or failure of the 1RM test. Five minutes rest was given to participants before the next attempt of lifting. Success was defined when the participant could lifted one repetition with a proper full range of motion. While failure was defined as the time point when the participant paused more than 2 seconds during load lifting or if the participant was unable to complete each repetition with a proper full range of motion.

2.4. Chest Press

Participants grasped the barbell with both wrist in neutral position during bilateral chest press test. For unilateral chest press, participants grasped the dumbbell with right wrist followed by left wrist in neutral position. Participants lifted the barbell or dumbbell through full elbow extension. Participants' body should be stationary and not swung during the movement.

2.5. Bicep Curl

Participants grasped the barbell with both wrist in neutral position during bilateral bicep curl test. While participants grasped the dumbbell with right wrist followed by left wrist in neutral position during unilateral bicep curl test. Participants lifted the barbell or dumbbell through full elbow flexion. Participants' body should be stationary and not swinging during the movement.

2.6. Statistical Analysis

Statistical analyses were run using Statistical Package for Social Science (SPSS) version 20. Descriptive statistics was conducted to determine the mean and standard deviation of participants' age, height, body mass and strength. Mixed design (ANOVA) was used to compare strength during pre- and post-test within groups while MANOVA was used to compare the percentage changes in the pre and post-test between groups. The significant level for all tests was set at <0.05.

3. Result

3.1. Demographic Data

The average age for the participants in the study was (22.56±1.47years), followed by height (171.06±2.91cm) and body mass (69.36±4.16kg).

Table 1. Physical characteristics of (age, body mass and height) of participants.

Variables	Mean ± SD
Age	22.56 ± 1.47
Body Mass (kg)	69.36 ± 4.16
Height (cm)	171.06 ± 2.91

3.2. The Effect of Unilateral and Bilateral Exercise on Unilateral Strength Adaptation among Trained Men.

There was main effect of pre- and post-test within the group, F (1,27) = 528.353, p <.000, η2 = .99. Unilateral and bilateral groups revealed that there was a significant increased in the muscle strength during the post-test for unilateral right bicep curl, left bicep curl, right chest press and left chest press compared to all pre-test. While, the control group showed significant decreased in all post-test compared to the pre-tests.

Table 2. Effect of unilateral and bilateral exercise on unilateral strength adaptation among trained men

		BC(right) M±SD	BC(left) M±SD	CP(right) M±SD	CP(Left) M±SD
Unilateral	Pre	16.60±1.91	16.35±1.87	23.30±1.60	23.05±1.49
	Post	21.30±2.33	21.20±2.42	29.75±2.48	29.40±2.68
Bilateral	Pre	16.65±1.81	16.20±1.70	23.55±1.97	23.35±1.98
	Post	21.55±2.69	20.90±2.61	29.00±2.10	28.25±2.05
Control	Pre	16.90±1.74	16.05±1.96	23.80±0.88	23.25±1.31
	Post	15.30±1.45	15.20±1.45	21.95±1.70	21.30±1.67

**BC=bicep curl, CP=chest press, M=mean, SD=standard deviation*

3.3. The Effect of Unilateral and Bilateral Exercise on Bilateral Strength Adaptation among Trained Men.

There was a main effect of pre- and post-test on the group, F (1,27) = 530.569, p <.05, partial η2 = .95. Unilateral and bilateral groups revealed that there was a significant increased in the muscle strength during the post-test for bilateral bicep curl and chest press compared to both of the pre-test. While, the control group showed significant decreased in both of the post-test compared to the pre-test.

Table 3. Effect of unilateral and bilateral exercise on bilateral strength adaptation among trained men.

		BBC (M± SD)	BCP (M ± SD)
Unilateral	Pre	37.50±3.72	58.25±4.09
	Post	44.00±4.28	65.00±4.56
Bilateral	Pre	37.75±5.06	57.75±3.80
	Post	47.00±3.87	67.00±4.21
Control	Pre	37.50±4.85	56.50±3.94
	Post	35.25±3.21	54.75±3.98

**BBC=bilateral bicep curl, BCP=bilateral chest press, M=mean, SD=standard deviation*

3.4. The effect of unilateral and bilateral exercise on bilateral deficit among trained men.

There was no main effect for pre- and post-bilateral deficit testing in the group, F (1,27) = 0.207, p> .05, partial η2 = .01. No significant difference between group on bilateral deficit bicep curl and chest press.

	BDBC (M ± SD)	BDCP (M ± SD)

Unilateral	Pre	-4.55±0.92	-11.90±1.54	
	Post	-1.50±1.54	-5.85±1.82	
Bilateral	Pre	-4.90±1.64	-10.85±1.59	
	Post	-4.55±1.95	-9.75±1.41	
Control	Pre	-4.55±1.58	-9.45±2.26	
	Post	-4.75±1.51	-11.5±1.87	

Table 4. Effect of unilateral and bilateral exercise on bilateral deficit among trained men.

*BDBC= bilateral deficit, BDCP= bilateral deficit chest press, M=mean, SD=standard deviation

3.5. Changes of the percentage from post compared to pre unilateral and bilateral exercise on strength adaptation among trained men.

MANOVA analysis showed a significant difference in the percentage change in unilateral, bilateral and bilateral muscle strength after intervention between unilateral, bilateral and control groups, $F(16,40) = 32.124$, $p < .05$; Wilk's$\Lambda = .005$, partial $\eta 2 = .92$. There was a significant difference in the percentage change in muscle strength after intervention on the right unilateral bicep curl muscle strength test, $F(2,27) = 339.827$, $p < .05$, partial $\eta 2 = .96$; left bicep curl $F(2,27) = 103.735$, $p < .05$, partial $\eta 2 = .88$; right chest press $F(2,27) = 201.358$, $p < .05$, partial $\eta 2 = .93$; left chest press, $F(2,27) = 95.581$, $p < .05$, partial $\eta 2 = .87$; bilateral bicep curl, $F(2,27) = 73.571$, $p < .05$, partial $\eta 2 = .84$ and bilateral chest press, $F(2,27) = 112.374$, $p < .05$, partial $\eta 2$; bilateral deficits in bicep curl, $F(2,27) = 6.916$, $p < .05$, partial $\eta 2 = .33$ and chest press, $F(2,27) = 15.792$, $p < .05$, partial $\eta 2 = .53$ between groups.

Table 5. Percentage of change from post compared to pre unilateral and bilateral exercise on strength adaptation among trained men.

	Unilateral M±SD(%)	Bilateral M±SD(%)	Control M±SD(%)	p value
BC(right)	44±3.97	29.27±4.40	-9.35±2.78	.000*
BC(left)	74±4.75	28.97±7.97	-4.91±5.20	.000*
CP(right)	60±4.18	23.27±3.34	-7.83±5.19	.000*
CP(left)	43±5.83	21.24±6.63	-8.32±6.04	.000*
BBC	41±4.50	25.35±7.56	-5.50±5.21	.000*
BCP	11.63±2.93	16.06±2.27	-3.04±3.59	.000*
BDBC	-67.66±34.91	15.67±82.27	9.71±37.22	.004*
BDCP	-48.91±21.25	-8.28±19.52	-29.23±45.48	.000*

4. Discussion

This study was conducted to examine the effects of unilateral versus bilateral resistance training and bilateral deficit on unilateral and bilateral strength adaptation among trained men. Both unilateral and bilateral groups managed to improve in unilateral and bilateral strength. However, the control group showed decreased in unilateral and bilateral strength after the six weeks of intervention. The findings of this study supported previous researches that the unilateral and bilateral strength training can increase muscle strength and performance [10], [12], [14], [17]. The findings of this study also proved that the manipulation of the variables in unilateral and bilateral training programme could improve the

muscle strength after six weeks intervention. In addition, all the three groups showed no bilateral deficit in bilateral bicep curl and chest press test. Although unilateral and bilateral training methods are different but with the well planned training programme, it's not impossible to achieve the performance goals [2], [3].

Apart from this, the unilateral group showed a significant greater percentage change in unilateral strength tests compared to the control group but no significant difference compared to the unilateral and bilateral groups. Meanwhile, the bilateral group showed a significant greater percentage change in both of the bilateral strength tests (bicep curl and chest press) compared to the control groups. Researcher expected that individuals might require a period of time to adapt a training sessions in order to archive the maximal strength and performance [18], [19].

5. Conclusion

As a conclusion, performing upper body exercise (biceps curl versus chest press) unilaterally and bilaterally can enhance strength adaptation among trained men. The findings of this study demonstrated that the unilateral and bilateral strength adaptation is specific to the training performed especially for multi-joint and complex exercise. It is that in future studies suggested the analysis on muscle activity to relate of different exercise in order to observe any effects on sport performance.

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