



Muscle Activation during Unilateral and Bilateral Biceps Curl Exercises among Trained Men

Ali Md Nadzalan, Nur Ikhwan Mohamad, Asmadi Ishak, Zulezwan Ab Malik, Wan Firdaus Wan Chik Sivaguru Muthusamy

Abstract: The aim of this study was to determine and compare the muscle activation during unilateral and bilateral biceps curl exercises. Thirty recreationally active, resistance-trained men (age: 20-23 years old) were recruited as research participants. Participants were asked to perform biceps curl exercise using 85% of their 1RM value unilaterally and bilaterally in a randomized order. Muscle activation of biceps brachii and triceps brachii were obtained during the movement using electromyography method. Repeated measure analysis of variance (ANOVA) was conducted to compare the muscle activations between both unilateral and bilateral biceps curl. Results showed that no significant differences were found on both biceps brachii and triceps brachii muscle activation between both biceps curl methods. Despite our prediction that unilateral exercise create more instability to movement that will cause more muscle activation, it was not found in this study. The simple movement during this bicep curl exercise might be the possible reason of no differences that existed.

Index Terms: EMG, unilateral, bilateral, muscular strength

I. INTRODUCTION

Resistance training has been widely regarded as one of the main training methods to improve muscular strength. As a way to enhance the effectiveness of training, currently, we can find many sources including journals and books to find the ways on how to design a resistance training program [1-6]. Several variables can be manipulated during the design such as needs analysis, exercise selection, training frequency, exercise order, loads, repetitions, volumes and rest interval. These variables are believed to affect how the body responses and adapt.

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This current study aims to put focus on one of the simple, yet important things to be considered during resistance training i.e. the way we perform an exercise. Just get into the gym, we can see practitioners often performed strength training exercises in two different ways, that is either unilaterally (using one limb at a time) or bilaterally (using both limbs simultaneously). Unilateral movement is a movement that is produced by one limb. Unilateral exercises only place stress on one limb that is being used for the exercise. On the other hand, bilateral exercises shares resistance between two limbs. It is a movement that is produced by two limbs at the same time. Bilateral exercises work both sides of the body, meaning both limbs share the stress.

Previous studies had compare the ability of performing an exercise unilaterally and bilaterally and had found that the sum of both loadings lifted by right and left hand was greater compared to if the exercise was performed bilaterally. This condition has been referred to as bilateral deficit. The bilateral deficit condition is the difference in maximal or near maximal force generating capacity of muscles when they are contracted alone or in combination with the contralateral muscles. A deficit occurs when the summed unilateral force is greater than the bilateral force. Considering bilateral deficit, the sum of force produced by each limb in a unilateral condition is generally greater than that produced by them in a bilateral condition.

Despite several studies had been conducted on comparing the effectiveness of unilateral and bilateral ways to perform an exercise, to the authors' knowledge, lack of studies had compared the muscle activation during an exercise that was done unilaterally and bilaterally. Muscle activation can be analysed through the electromyography (EMG) method. The information on muscle activation is important, as it reflect the level of neural drive or voluntary activation in a muscle. Voluntary activation is affected by both the motor unit frequency and the degree of muscle recruitment and is closely related unfatigued muscles' force production [7-9]. Muscles' EMG activity during an exercise has been shown to be associated with long-term improvement in muscle size in that part of muscle, when performing that exercise in a resistance training program [10, 11].

Thus, this study was conducted to determine and compare the muscle activation between unilateral and biceps curl exercise. Bicep curl was chosen as the exercise of interest due to its widely used among practitioners.

II. METHODOLOGY

A. Participants

Thirty recreationally active, resistance-trained men were recruited as participants in this study. Participants had the experience of at least six months in resistance training, been currently active, and were able to perform the exercise of interest in this study, i.e. bicep curl in a proper technique.

All participation were based on volunteerism. Before participation, participant had filled in the PAR-Q and informed consent.

B. Procedures

1 Repetition Maximum

After familiarization session and resting for 72 hours, participants underwent one repetition maximum (1RM) test to identify the maximum load that can be lifted in biceps curl exercise unilaterally and bilaterally. The 1RM testing procedure followed the guidelines provided by National Strength and Conditioning Association [12]. 1RM test started with participants were asked to warm up with light resistance. After series of lifting 2 to 5 repetitions, participants were required to try for the 1RM lift. All the loads lifted were based on the participants' experience with the agreement of researcher. Any success or failure will cause the loads to be increased or decreased by 4 to 10 kg and 5 minutes rest was given before participants were asked to do the next attempt. The amount of repetitions would not be considered if participants did the exercises with wrong technique. Failure was defined as the time point when the participant paused more than 2 seconds during lifting load or if the participant was unable to complete each repetition in a full range of motion. To avoid errors and bias during the 1RM test, a brief explanation about the test procedures were given by researcher during the familiarization session and again before the test was carried out.

Bench Press

Participants grasped the barbell with the wrist in neutral position. Participants lifted the barbell through full elbow flexion. Participants' body should be stationary (minimum movement) and not swung during the movement.

EMG procedure

Electromyography (EMG) signals have been recorded from biceps brachii and triceps brachii using wireless electrodes (Trigno, Delsys, USA). The Surface EMG for Non-Invasive Assessment of Muscles (SENIAM) was used as guideline to conduct the EMG test for both muscles including the maximum voluntary contraction (MVC) test. Participants perform only two repetitions for each exercises. For each muscle, the EMG signals were collected from the beginning of the movement upon the completion of the movement for three trials. The recorded muscle activity was converted to percentage of MVIC and was presented in mean to be compared between unilateral and bilateral. The setting of EMG for data collection and analysis followed previously published studies with similar research design [13].

Procedures

Participants were first involved in familiarization session, which in this session they were required to demonstrate their ability to perform bicep curl exercise unilaterally and bilaterally. Major failure in performing correct technique that

is thought to be risky in terms of injury will cause participants dropped from being a research participant. During the familiarization session, 1RM test was conducted. The tests were important as participants will need to lift 85% of their 1-RM value during the data collection. 48 hours after familiarization and 1RM session, participants again present at the laboratory for data collection. The participants were randomly organized in terms of order of exercises performed (unilateral and bilateral) to avoid order effects. Half of the participants performed unilateral method first for three trials then followed by bilateral methods also for three trials (48 hours after). The other half performed those exercise in other way round, starting with bilateral methods and followed by unilateral methods (also 48 hours after).

C. Statistical Analysis

Descriptive statistics was conducted to determine the mean and standard deviation of participants' age, height, body mass, and muscle activation. Repeated measure analysis of variances (ANOVA) was conducted to compare the muscle activation between unilateral and bilateral biceps curl exercise. All statistical analyses were run using Statistical Package for Social Science (SPSS) version 23.

III. RESULTS

Table 1 showed the physical characteristics (age, body mass, height) of participants involved in this study.

Table 1. Physical Characteristics of Participants

Variables	Mean ± SD
Age (years)	21.56 ± 1.28
Body Mass (kg)	71.63 ± 4.92
Height (cm)	171.47 ± 5.27

Table 1 showed the physical characteristics (age, body mass, height) of participants involved in this study.

EMG during concentric phase of biceps curl

Analysis of concentric phase data showed no significant main effects were found in this study for both triceps brachii $F(1, 29) = 8.012$; $p = 0.08$ and biceps brachii, $F(1, 29) = 2.07$; $p = 0.13$. Table 2 showed EMG reading during concentric phase of biceps curl.

Table 2. EMG reading during concentric phase of biceps curl

EMG	Unilateral	Bilateral
TB mean (% MVIC)	21.90 ± 2.43	19.38 ± 4.52
BB mean (% MVIC)	70.46 ± 3.78	73.86 ± 2.90

TB: triceps brachii

BB: biceps brachii

EMG during eccentric phase of bicep curl

Analysis of eccentric phase data showed no significant main effects were found in this study for both triceps brachii $F(1, 29) = 0.119$; $p = 0.73$ and biceps brachii, $F(1, 29) = 5.11$; $p = 0.48$. Table 3 showed EMG reading during eccentric phase of biceps curl.

Table 3. EMG reading during eccentric phase of biceps curl

EMG	Unilateral	Bilateral
TB mean (%MVIC)	22.85 ± 3.74	23.97 ± 2.07
BB mean (%MVIC)	34.39 ± 3.87	31.20 ± 5.04

TB: triceps brachii
BB: biceps brachii

IV. DISCUSSIONS

This study was conducted to determine and compare the muscle activation during unilateral and bilateral biceps curl exercises among trained men.

Muscle activation of biceps brachii and triceps brachii were obtained and compared between unilateral and bilateral methods of biceps curl using electromyography method.

During concentric phase, it was found that both muscle activation of triceps brachii and biceps brachii muscles were not significantly differences between unilateral and bilateral methods. Similar finding was also found during eccentric phase. No significant differences in muscle activation of triceps brachii and biceps brachii muscles were seen between unilateral and bilateral methods.

Despite our prediction that unilateral exercise create more instability to movement that will cause more muscle activation, it was not found in this study. The simple movement during this bicep curl exercise might be the possible reason of no differences that existed.

V. CONCLUSIONS

As the conclusion, performing a simple exercise (i.e. biceps curl in this study) unilaterally or bilaterally did not create any differences in terms of muscle activation. Future studies should look into more complex exercises (e.g. multi-joint) if any differences would occur.

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