THE ACUTE EFFECT OF UPPER EXTREMITY PLYOMETRIC TRAINING

Chun-ta Lin[1], Chia-hsiang Chen[2], Hung-sheng Hsieh[3], Jui-hung Tu[3], Chang-fu Huang[1]

National Taiwan Normal University, Taipei, Taiwan[1]
National University of Kaohsiung, Kaohsiung, Taiwan[2]
National Pingtung University, Pingtung, Taiwan[3]

The purpose of this study was to probe the acute effect of the performance of upper extremity muscle groups after the plyometric training intervention. The participants were 13 healthy male college students. The force transducers (300kg, 200 Hz) and EMG sensor (1000 Hz) were taken to diagnose the acute effects of strength and muscle activation done by upper extremity pre and post plyometric training (load :24kg, 12 repetition times /set, 3 set), and pair t-test was taken to test the significance(α=.05). The result showed that the strength after the upper extremity plyometric training intervention obviously had decreased 8% (p<.05), and the upper extremity maximum voluntary contraction [MVC] had increased 26% (p<.05). The intervention of upper extremity plyometric training could make the muscle tired.

KEY WORDS: muscle activation, fatigue

INTRODUCTION: In order to promote the performance of athletic sports, both strength and power training are important. Even though there are a variety of ways to train the muscle power, the most effective way to develop the neuromuscular performance would be plyometric training (Brown. et al., 2007; Eduardo. et al, 2009).
This way of practice which contraction follows eccentric contraction is called stretch-shortening cycle, SSC (Komi, 2011) and the training can effectively increase the performance of upper extremity maximum muscle strength.
Nowadays, plyometric training can be divided into two parts which upper extremity and lower extremity. Lower extremity plyometric training is usually did by counter movement jump, drop jump and squat jump, and upper extremity training mostly depends on medicine ball. (Villarreal, González-Badillo & Izquierdo, 2008; Markovic, Jukic, Milanovic & Metikos, 2007). When doing lower extremity training, we can control the exercise intensity by adjusting the different heights, and for upper extremity training the exercise intensity can adjusted by the different weights of medicine ball (Jacob & William, 2010). In this study, we had developed the upper extremity plyometric weight training apparatus, which can provide specific training loading. The purpose of this study was to probe the acute effect of the performance of upper extremity muscle groups after plyometric training intervention.

METHODS: The participants were 13 healthy male college students. The heights, weights and age were 173.8±4.5 cm, 72.3±8.6 kg and 19.2±0.8 years respectively. This group of participants had no cases of injury in upper limbs in past one year, and they were all familiar with the topic and the content of the experiment before we started. The project was approved by the Human Subjects Research Ethics Academia Sinica.
The upper extremity plyometric weight training apparatus can provided the extra loading during the eccentric process, which can turn on the SSC mechanism. The figure1 showed the operational process. In the project, the main loading is 15kg and the extra loading is 9kg. There are 3 samplings in each of the pre- and post- test. The test time is 5 seconds and the rest time between each sampling is 2 min. The collected parameters are the synchronous maximum pulling force and the EMG indexes of related muscle group. During the test process the participants were asked to maintain a seated posture and to keep the elbow joints at approximately 90 degrees.

The sampling principle was depends on the maximum pulling force of 3 samplings. Every set would be conducted 12 times, and there would be 3 sets. The post-test would immediately be conducted after the third set. (Figure 2)

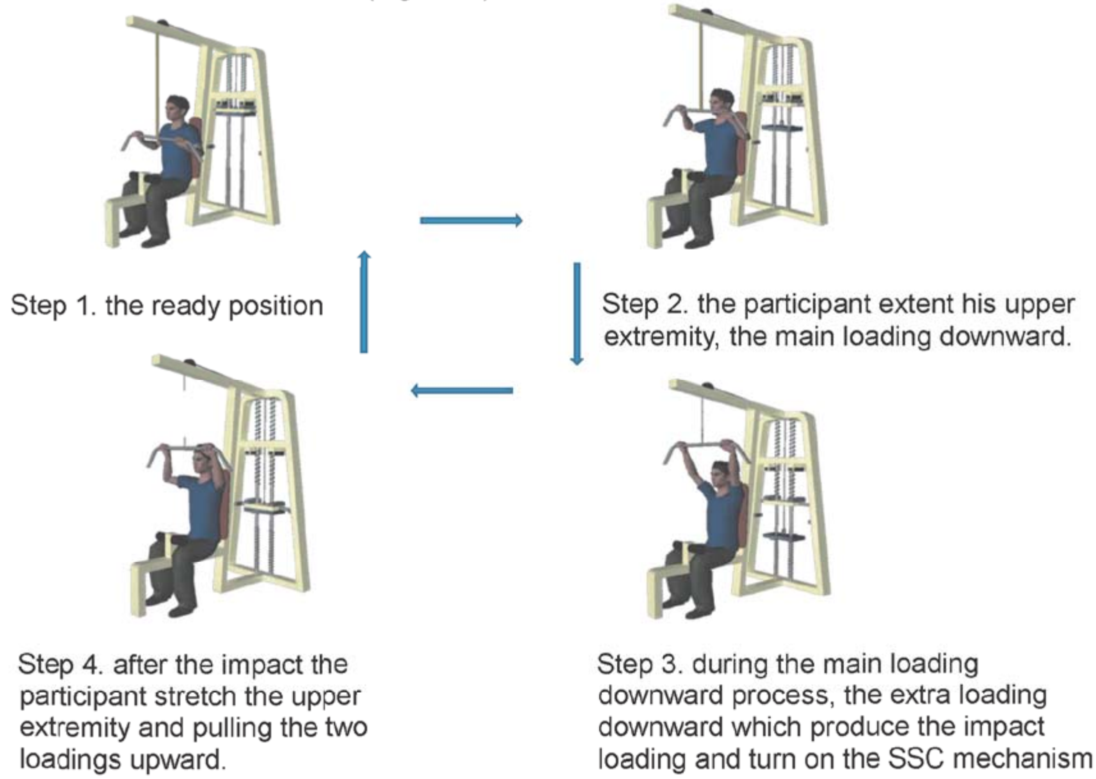

Figure 1: The upper extremity plyometric weight training apparatus operational process.

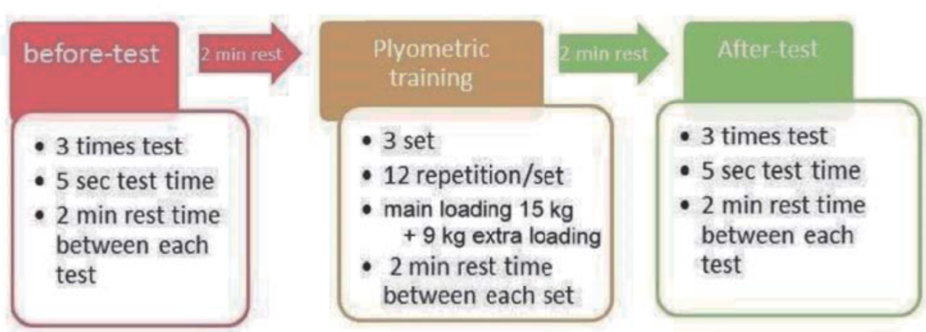

Figure 2: The experimental process

The main experimental apparatus are the force transducers (Load Cell 616, 300kg, 200 Hz, Sensor Techniques Ltd, Cowbridge, UK) and EMG sensor (Vernier-BTA,1000 Hz, Vernier Software & Technology, Oregon, USA). (Figure 3) The signal was converted by an analog to digital converter box (NI USB-6211, National Instruments, Texas, USA). The electrodes were pasted to the muscle groups of Pectoralis major, Deltoids, Biceps and Latissimus Doris.

The sampling frequency of EMG was set at 1000 Hz, and Butterworth (Signal processing filters) from LabVIEW 8.5 was used to filter (Band pass filter, 20~500Hz) and smooth (linear envelope, 6Hz) the EMG signal.

In order to exclude the influence of muscle activation by different muscle strength, the standardized EMG signal would be collected from the EMG signal of the three-second MVC before the experiment, and the signal was represented by MVC%. SPSS 21.0 statistical software was used and pair t-test was used to test the significance (α=.05) between pre and post-test.

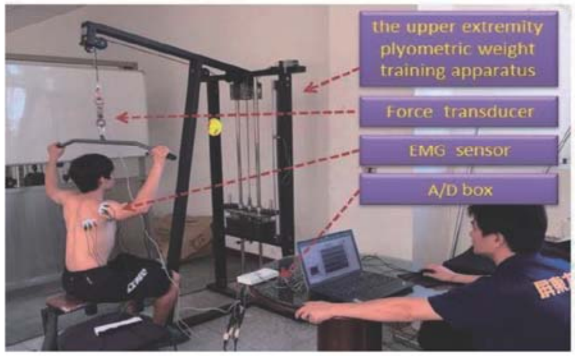

Figure 3: The arrangement of experiment

RESULT: In the muscle strength diagnosis from the upper limbs plyometric training, the maximum muscle strength (pulling force) of the pre-test is 99.10±14.76 kg, and post-test is 91.50±16.43 kg. A significant difference were shown between the pre-test and the post-test. As a result, after the training, the maximum muscle strength decreases 8% (Figure 4).

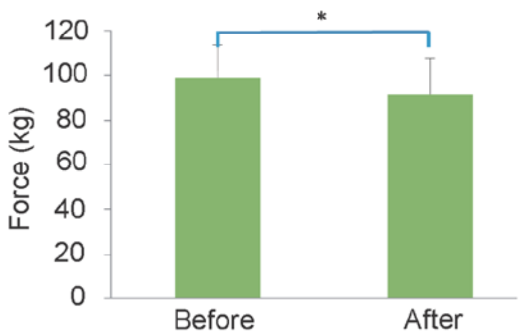

Figure 4: The max muscle strength before and after the training

Assessment of upper limb muscle activation effects following acute training shows that pectoralis major was activated by 26% (from 44.63±9.25 Votage[V] to 56.21±17.38 V, t value= 2.639), Biceps 26% (from 41.52±7.08V to 52.40±10.95 V, t value= -2.868, p<.05), Deltoids 29% (from 41.05±8.92 V to 53.08±10.44 V, t value= -4.244, p<.05), Latissimus dorsi 31% (from 1.88±10.99 V to 41.65±10.65, t value= -2.583, p<.05). (Figure 5).

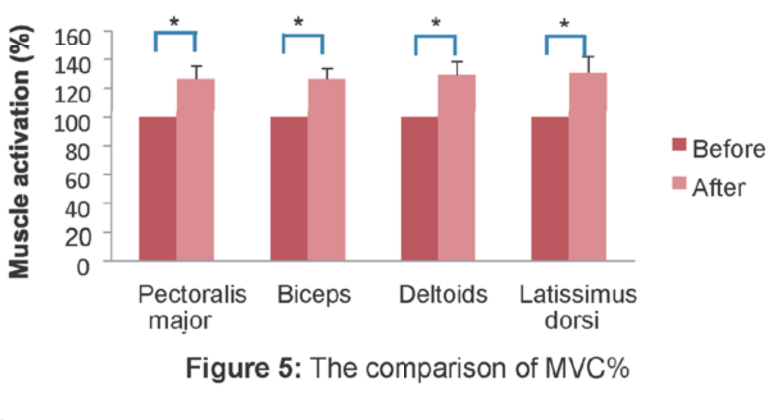

Figure 5: The comparison of MVC%

DISCUSSION:

Hrysomallis and Kidgell (2001) found that 3 minutes after 5RM bench press exercises there was no significant difference for the 3 repetition jumping push-ups as assessed by a force plate. Therefore, a brief training intervention failed to improve exercise performance, and

there was no increase in muscle strength. And there is no increase of muscle strength. These results are consistent with the results of the current study. Another reason might be the lack of rest time. Jensen and Ebben (2003) believe that lack of rest time would negatively affect the acute exercise performance, and some research suggests that the best effect would be shown after a three to four minutes break (Ebben, Jensen & Blackard, 2000). The rest time of this study is 2 minute, which might be a reason of the tiredness. In the research on upper limbs plyometric training, a short training was processed after the pre-test, and after the training follows a post-test. Because of the shortness of break time, the maximum muscle strength in the post-test bears an obvious decrease, which shows the tiredness. However, in order to maintain the same maximum muscle strength as the pre-test, the body calls for more muscle fibers to do the contraction, and therefore, the EMG index in the post-test is a lot higher than the pre-test, which bring the statistics to a significant difference.
Potvin (1997) increased EMG amplitude and decrement in the median frequency in the presence of fatigue in the 5 × 10 Rel protocols in both pre-training and post-training may be primarily attributed to additional motor unit recruitment and / or increased spatial or temporal motor unit synchronization, presumably to compensate muscle fiber fatigue.

Conclusion: A plyometric training intervention by the upper extremity plyometric weight training apparatus caused a strength decrease, but resulted in more muscle activation. Therefore, this way of plyometric training could make the muscle tired and achieve an acute training effect.

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