Comparison of Muscle Activation between Traditional, Diamond and Knuckle Push Up Among Trained Men

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Abstract. This study was conducted to compare the muscle activation during traditional, diamond and knuckle push up among trained men. Thirty men that had at least one year experience in fitness training involved as participants in this study. Participants were required to perform all the three kinds of push up in a randomised order to avoid bias effects in exercise order. Electromyography method was used to obtain the pectoralis major, triceps brachii and anterior deltoid muscle activation. Muscle activation was reported as percentages of maximal voluntary contraction. One way repeated measure analysis of variances (ANOVA) was conducted to compare the muscle activation between the three push up protocols. Results showed that the muscle activation of pectoralis major and anterior deltoid were highest during traditional push up while being the lowest during diamond push up. However, the muscle activation of triceps brachii was highest during diamond push up and lowest during traditional push up. As the conclusion, we can see that the position and distance of hands on the floor will give effects on the muscle activation. As the implication of this study, coaches, athletes and individuals can manipulate techniques while performing a movement to obtain more muscle activation to specific muscle of interest during a movement.

1. Introduction

Push up is one of the most commonly used body weight exercises to improve muscle strength, mass, and endurance of the upper body [1-4]. Targeted muscles during push up includes anterior deltoid, pectoralis major, serratus anterior and trapezius [5]. Push up can be done in many variations. Variations was used to make push-up exercises easier or harder and to target different muscles during training. Push up were used in strength and conditioning training as well as in recovery programs for shoulder dyskinesis, which causes conditions such as subacromial syndrome [6].

Hand positioning can change muscle activation and scapular kinematics during push up exercise [7]. The positions of the hands that have been studied in previous research include internal and external rotation, wide, narrow, standard, and lay hands on various surfaces [8].

Pectoralis major muscle showed higher muscle activation during wide hand position, while triceps brachii muscle activation was more active during narrow hand position [9]. The anterior deltoid showed greater amount of muscle activation on the unstable surface compared to stable surface [10]. Meanwhile, serratus anterior was showed to be highly activated all types of push-ups [11].

As stated above, previous studies proved that changing the method of push up exercise have an impact to muscle activation. However, researchers have found that no studies directly conducted on
comparison of muscle activation between traditional push-up, push-up diamonds and knuckle push up. Therefore, the main purpose of this study was to compare the difference of pectoralis major, anterior deltoid and tricep brachii muscle activation in these three different types of push up.

2. Methodology

2.1. Participant

Thirty healthy active men aged between 20-25 old were involved as participant in this study. The inclusion criteria includes; i) can perform all three methods of push up (traditional, knuckle and diamond) with correct techniques, ii) currently active, iii) had at least one year experience in fitness training, and iv) have no injuries.

2.2. Instrument and Procedure

Electromyography (EMG) method was used as the instrument to measure muscle activation in this study. All electrodes was placed on the right side of participant. Surface EMG for non-invasive assessment of muscles (SENIAM) was used as a guide to determine muscle position [12].

For pectoralis major muscle, electrode was placed in the middle of the sternum and the shoulders. For triceps brachii muscle, electrodes was placed in the parallel line between the posterior crista of the acromion and the olecranon. While for anterior deltoid muscles, electrode was placed in distance of 1 finger width in line between the acromion and the thumb.

Participants were first involved in a familiarization session for the researcher to brief on the objectives and procedures of data collection. Two days after the familiarization session all participants underwent a maximum voluntary contraction (MVC) test to get the maximum contraction value of the muscles. 48 hours after the MVC session, participants underwent a push-up test. Participants were randomly assigned to three orders of push up task, as a way to avoid order effects. During testing, participant performed 10 times of push up by following the beat of metronome for each push up method. Participant performed 3 trials for each push up method. Participants were required to perform each of the push up protocol as powerful as they can.

Push up movement was started with the body facing the floor. For traditional push up, both hands were shoulder-width apart, and fingers pointing forward. For knuckle push up, participant was required to make a fist with both hands. For diamond push up, participant was required to form shaped in hand area between index finger and thumb like a diamond. All types of push-up required the participant to lower their chest distance until was 2 inches from the floor.

2.3. Data and Statistical Analyses

Descriptive statistics were performed to determine the mean and standard deviation (SD) of demographic profile. Repeated measure ANOVA was used to compare muscle activation between the three different types of push up.

3. Result

Table 1 showed the demographic profile of participants involved in this study.

| Table 1. Anthropometry Profile |
|------------------------------|
| Demographic                  | (Mean ± SD) |
| Age                          | 21.57 ± 2.54 |
| Weight (kg)                  | 167.94 ± 5.83 |
| Height (cm)                  | 66.94 ± 4.52 |
Table 2. showed that there was significant main effects found for pectoralis major $F(1,29)=8237.29, p<.05$; anterior deltoid $F(1,29)=2803.13, p<.05$ and triceps brachii, $F(1, 29) = 452.13, p<.05$. Using pairwise comparison, results showed the activation of pectoralis major and anterior deltoid were significantly greater during traditional push up compared to knuckle push up and diamond push up. Both muscles also were shown to be significantly greater during knuckle push up compared to diamond push up. In contrast, the activation of triceps brachii was found to be significantly greater during diamond push up compared to the other two. Triceps brachii was also shown to be significantly more activated during knuckle push up compared to traditional push up.

Table 2. Muscle activation

| Types of push up          | Pectoralis Major (Mean ± SD) | Anterior Deltoid (Mean ± SD) | Tricep Brachii (Mean ± SD) |
|--------------------------|------------------------------|------------------------------|----------------------------|
| Traditional Push up (% MVC) | 57.59 ± 1.29                | 47.50 ± 2.35                | 42.45 ± 2.45               |
| Knuckle Push up (% MVC)   | 55.03 ± 1.30                | 44.83 ± 2.30                | 45.53 ± 2.49               |
| Diamond Push up (% MVC)   | 51.71 ± 1.19                | 29.13 ± 2.01                | 48.26 ± 2.55               |

4. Discussion
This study aimed to compare the muscle activation during three different push up methods on upper body muscle activation. Results showed that there were differences in muscle activation of pectoralis major, anterior deltoid and tricep brachii during traditional, diamond and knuckle push up. The finding was parallel with what was found by Cogley et al. [9], in which pectoralis major muscle activation was higher when the hand is wide (i.e. traditional and knuckle push up), while tricep brachii muscle activation was higher when distance of hand is narrow (i.e. diamond push up).

Different muscle activation occurred because different angles during the movement will change the length of the muscle, and can affect the amount of tension that was produced [13, 14]. It is clear that the differences of muscle activation in this study was due to the different position of the hand when performing traditional push-ups, knuckle push up and diamond push up that causes muscle length of triceps brachii, pectoralis major, and anterior deltoid muscles also changed.

The findings of this study suggested traditional push up was more effective for athletes or individual who want to increase the strength, endurance and size of the pectoralis major and the anterior deltoid, while diamond push was more effective for the functional improvement of triceps brachii. As for those that new to the diamond push up, it is advisable to ensure the techniques is properly done, by positioning both hands together so both two indexes and thumbs are touching. The space in between the two hands should form a triangle shape. It is also easy to allow the elbows to flare out to the side while lowering the body to the ground. It is easy with a close grip push up to allow the elbows to flare out. To keep the true form, the elbow need to be remain tucked close to the sides.

5. Conclusion
In conclusion, this study proved that muscle activation of pectoralis major and anterior deltoid were higher during traditional push up while being the lowest during diamond push up. However, the muscle activation of triceps brachii was highest during diamond push up and lowest during traditional push up. It was suggested for future study to compare the differences of muscles activation during many more different kind of push up such as using equipment or more challenging protocol.
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