ELECTROMYOGRAPHIC ANALYSES OF STANDING SHOT PUT THROW

[1]Hsiente Peng, [2]Hsiensen Peng and [1]Chenfu Huang
[1]National Taiwan Normal University, Taipei, Taiwan;
[2]National Taipei Teacher College, Taipei, Taiwan; email: sid125@ms35.hinet.net

INTRODUCTION

The throwing arm plays an important and crucial part in the shot put event. Shot put is a heavy-weighted throwing event compared with others, such as baseball pitching and javelin throw. Standing shot put throw is a basic training movement for the throwing technique in thrust. Electromyography (EMG) of throwing had been studied by many researchers. Nevertheless the applications on studies of upper extremity of throwing events focused mostly on the baseball pitching [1,2,3,4,]. The baseball is a light-weighted throwing event (about 0.145 kg.). There are few studies on the EMG activity of a heavy-weighted throwing event. So, we selected the shot put as our study. The weight of a shot put for adult male is 16 lb. (7.26 kg.). We also asked the subjects to throw lighter shot puts, which are weighted 8 lb. and 12 lb. This study used dynamic EMG analysis to compare the muscle actions in different shot put weight, and to investigate the sequences of the muscular function and the patterns of the muscular activity.

METHODS

Seven shot putters (age of 20±3 years; height of 178±9 cm; weight of 100±24 kg) served as subjects to perform the standing throw with three weights of the shot put (8, 12 and 16 lb.). Each subject at least performed two throws successfully. The best performance was selected to analyze. Two Redlake high-speed cameras (sampling rate: 125Hz; Motion Scope, San Diego, USA.) and one Biovision system (sampling rate: 1250Hz; Biovision, Wehrheim, Germany.) were synchronized to collect the data. The surface EMG of thirteen muscles was recorded. Raw EMG signals were band-pass filtered (20-400Hz), full wave rectified, and passed through a linear envelope at 10Hz for final interpretation. Integrated EMG signals (IEMG) from the onset of thrust to shot put release of the standing throw trials were then normalized by the maximal signal (%max), which was highest EMG value obtained during the standing throw, for each muscle to indicate relative activation levels. The nonparametric statistical test of Friedman two-way analysis of variance by ranks was conducted for the normalized IEMG of each muscle ($p<0.05$).

RESULTS AND DISCUSSION

The distances of 8, 12 and 16 lb. shot put throw were 15.58± 1.97, 13.87±2.27 and 11.57±2.42 m, respectively. Figure 1 shows the activation levels of the thirteen muscles. The lower, middle and upper trapezius, anterior deltoid and middle deltoid demonstrated stronger activity than the other muscle groups during the standing shot put throws (23 to 28%max). In addition, forearm extensor and flexor also demonstrated strong activity in 16 lb. shot put throw (23%max). There was a trend in majority of the muscle groups, which showed higher EMG activities when throwing the heavier shot put. Only the forearm flexor demonstrated the statistical significance between the three weights of shot put. Figure 2 shows the time to peak EMG of thirteen muscles of seven subjects. The sequences of the muscular function were a little different in three weights of shot put. Generally, the time to peak EMG sequences corresponded to the proximal-distal segmental sequence. But the serratus anterior was an exception. It's time to peak EMG was emerged just before shot put release.

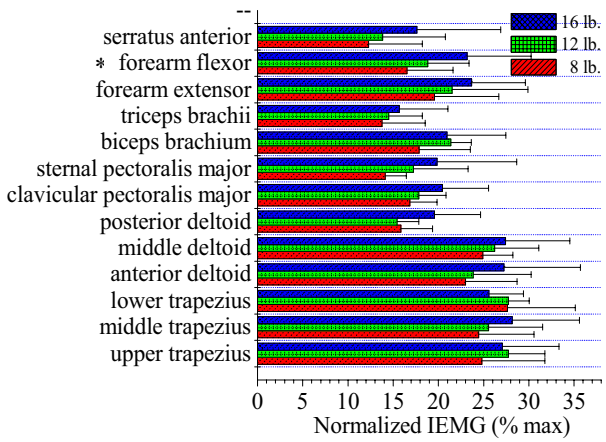

Figure 1: Normalized IEMG of thirteen muscles of seven subjects (mean ± %max) throwing with three weights of shot put (8, 12 and 16 lb.). * The statistical significance was found between the three weights.

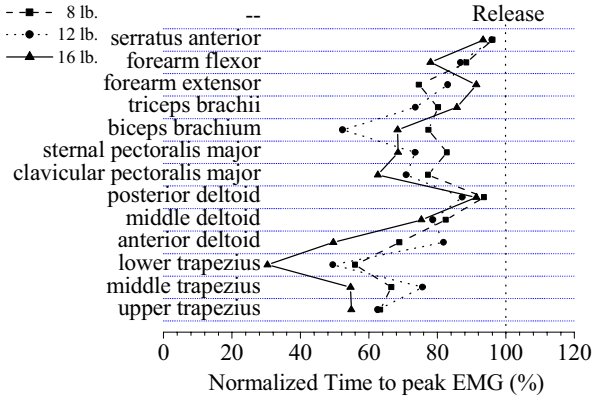

Figure 2: Time to peak EMG of thirteen muscles of seven subjects (mean). Time was normalized to standing throw duration (100%).

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