PUSH UP BARS AND HAND POSITION AFFECT UPPER EXTREMITY MUSCLE ACTIVITY DURING THE PUSH UP EXERCISE

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INTRODUCTION

The push up is an upper body exercise common to many training regimens. From a prone position, the subject maintains toe-ground contact while using the upper extremity to raise and lower the extended body. The exercise utilizes the anterior chest (pectoral muscles) and posterior arm (triceps brachii) muscles, along with synergistic and stabilizing muscles in the forearm and shoulder. The use of push up bars (Figure 1) allows a user to easily alter hand position while performing the exercise to further alter muscle activity patterns. Research shows altering hand position changes muscle activation (Cogley et al. 2005; Gouvali & Boudolos 2005) and elbow joint loads (Donkers et al, 1993) during the push up. Our purpose was to determine the effect of bar use and altered hand position on muscle activity, hypothesizing that recorded muscle activity would reflect the altered loading demands of different segment orientations during the push up.


Figure 1. Push up bars

METHODS

Thirteen male university students (age: 21.8 ± 1.9 y; height: 180.8 ± 8.6 cm; mass: 85 ± 15 kg) were randomly recruited. All signed informed consent. Hand spread was controlled at 150% of the subjects biacromial width across the two hand positions (forward and laterally rotated) crossed with the use or non-use of the bars. Muscle activity was recorded (1000 Hz) using surface electrodes from the pectoralis major (PM), triceps brachii (TB), and flexor carpi ulnaris (FCU) simultaneously with opto-electronic tracking (200 Hz) of reflective markers defining the trunk, upper arm and forearm. Subjects performed five repetitions of the push ups in each of the four hand position-bar use conditions. Linear envelopes of the EMG data from each repetition were created by rectifying and digitally filtering the raw signal, and expressed as a % of an isometric reference position (% IRP). The activity of each muscle was integrated during the descent and ascent phase of each repetition, using the elbow angle to identify the phases. The five trial means of each subject were entered into a three-way (phase x hand position x bar use) repeated measures ANOVA ($\alpha = 0.05$) to identify statistically significant differences in muscle activity.

RESULTS AND DISCUSSION

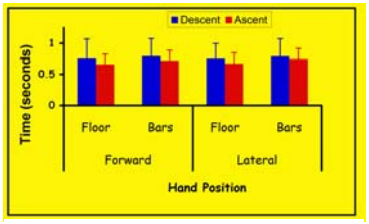

Figure 2. Phase time descriptors

Analysis of temporal aspects of the lifts indicated that it took about 100 ms longer to perform a push up using the bars (figure 2).

The grand ensemble curves of each muscle are presented in figure 3. The PM activity was not affected by hand position or bar use.

There was a significant phase by bar use interaction for the TB (figure 4); when using the bar, the TB was about 33% more active during the ascent phase. Bar use allows for greater elbow flexion during the push up, so it is likely that the TB increase reflects an increased demand for elbow extension torque in the more compromised position.

There was a significant bar use by hand position interaction for the FCU (figure 4). The muscle was more than 2x as active in the forward hand position than laterally rotated; in addition, with the hands in the forward position, there was nearly twice the activity in the FCU when using the bars, although there was no significant difference with the hands laterally rotated. When a forward hand position is used with the bars, the wrist tends to be hyperextended throughout the push up, compared to a more neutral wrist position with laterally rotated hands. With a hyperextended wrist, body weight creates a greater hyperextension torque that must be countered by an increased flexor torque. The increased FCU activity likely reflects its' recruitment to contribute to the flexor torque.

SUMMARY/CONCLUSIONS

These results indicate that both hand position and bar use affect muscle activity during the push up. Bar use affects segment orientation to increase the demands of the push up, and this effect can be maximized with hands in the forward position. Manipulating hand position and incorporating bar use provide an effective means to alter the overload and add variation to the push up exercise.

REFERENCES

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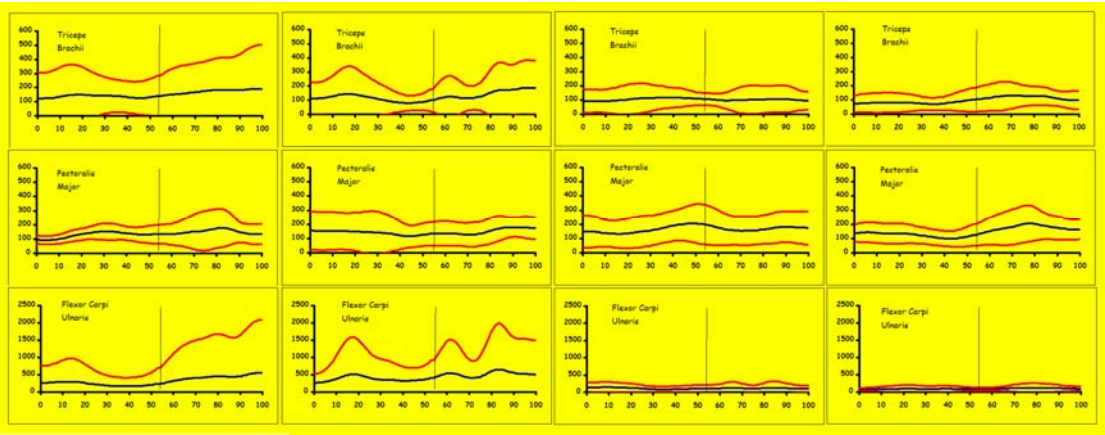

Figure 3. Grand ensemble muscle activity (blue) +/- 1 SD (red). Columns left to right: No bars, hands forward; bars, hands forward; no bars, lateral rotation; bars, lateral rotation. Haxis: % lift; Vaxis: % IRP. Vertical line mx flexion

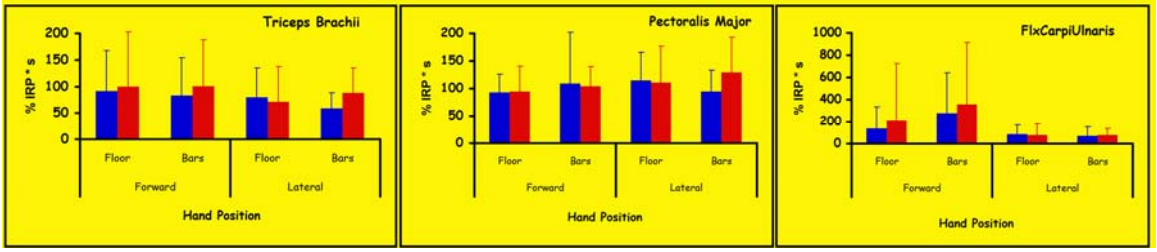

Figure 4. Descriptive statistics of integrated EMG by hand position-bar conditions.