THE EFFECT OF HAND POSITION ON SUBSCAPULARIS FORCE DURING THE BELLY-PRESS TEST

Takashi Yanagawa [1], Michael R Torry [1], Kevin B Shelburne [1], Marcus G Pandy [2]
[1] Steadman Hawkins Research Foundation, Vail, CO, USA
[2] The University of Melbourne, Melbourne, VIC, AUS
E-mail: takashi.yanagawa@shsmf.org, Web: www.shsmf.org

INTRODUCTION

The "belly-press test" is often used to help diagnose a subscapularis muscle tear in the clinic. A patient is asked to place his or her hand on the abdomen and press that region by rotating the arm internally with the elbow positioned anterior to the coronal plane. If the elbow is moved posterior to that plane, the test is considered positive (Gerber et al, 1996). If the patient is obese with an extended abdomen, the humerus must be flexed to obtain the starting hand and elbow position of the belly press test. It is unknown whether the flexed position of the humerus compromises the validity of the test. The purpose of this study was to calculate the force in the subscapularis during the belly-press test and compare the value to that calculated when the humerus is flexed.

We hypothesized that flexion of the humerus would reduce the force in the subscapularis.

METHODS

An upper extremity computer model (Garner and Pandy, 2001) was used to calculate the muscle forces in the shoulder. Nineteen muscles including upper and lower portions of the subscapularis were included in the model. To simulate the force of the hand on the abdomen, a 10N force was applied to the hand that pushed the hand anterior to the abdomen (Figure 1). Muscle forces were calculated by solving a static optimization problem that minimized the stress in the muscles. Three belly-press conditions were simulated: First, a normal belly-press was simulated with the hand placed on the abdomen of the model. Then, to represent obesity, the hand was moved 5 cm and 9.4 cm anteriorly, which added 10° and 20° of extra humeral flexion to the normal belly-press position, respectively (Figure 1).

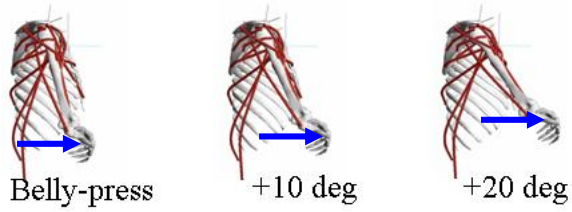

Figure 1: Belly-press test and its variations with extra flexion of 10° and 20°.

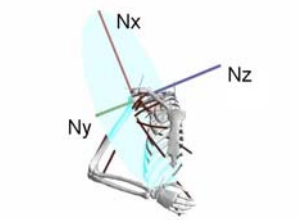

Figure 2 An external force frame was placed on the plane that is parallel to the external force of the abdomen.

The torque produced by the shoulder muscles was calculated about an axis that was perpendicular to the plane created by the glenohumeral joint and the external force (Figure 2). This way, the torque produced by each muscle could be compared to the torque produced by the belly-press force.

RESULTS

The lower subscapularis produced the largest force (Figure 3) and the most torque among the rotator cuff muscles in all the conditions (Figure 4). As the humerus was flexed, and the hand was placed further anterior to the body, both upper and lower subscapularis forces decreased (Figure 3).

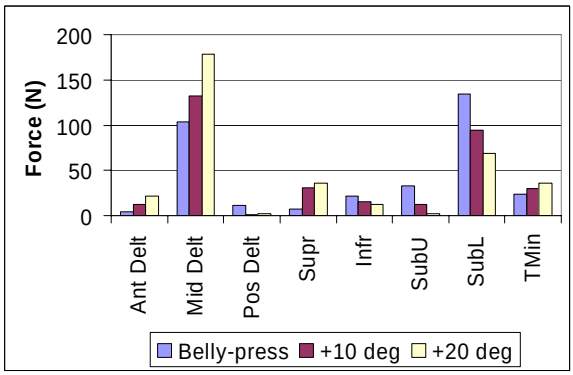

Figure 3: Muscle forces with increasing flexion of the humerus.

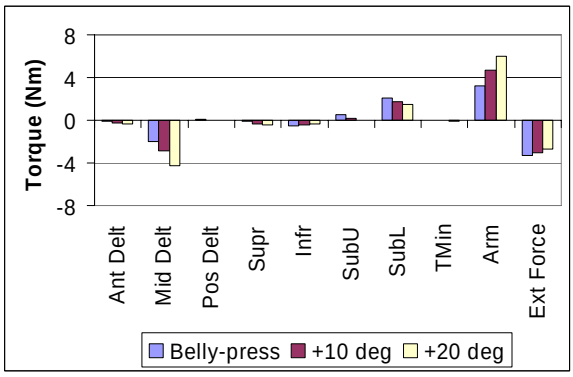

Figure 4: Muscle torques about Nz, arm weight and external force in the external force frame.

The sum of all the positive torques increased, as the hand moved away from the belly region (Figure 5). However, most of the increase came from the weight of the arm. Subscapularis torque decreased as a percentage of the total positive torque from 42% to 19%.

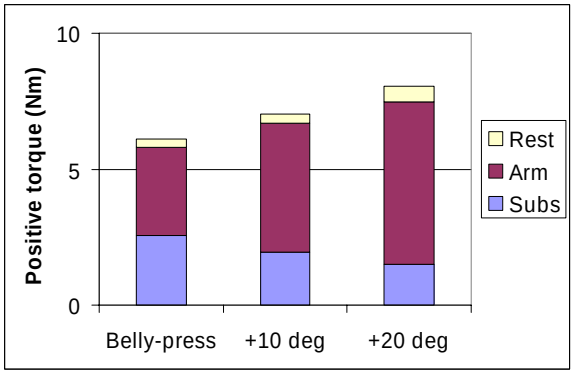

Figure 5 Positive torque about the Nz axis.

DISCUSSION

These results indicate that the belly-press test with extra flexion would rely less on the subscapularis muscle force. As arm flexion increased, the torque needed to press the belly with 10N of force was increasingly composed of the weight of the arm. Thus, the test with extra flexion may not be as effective as the normal belly-press position.

SUMMARY

Subscapularis force decreased with increasing flexion of the humerus. With the humerus flexed, torque was dominated by the weight of the arm. Therefore, the utility of the belly press test in the obese may be diminished.

REFERENCES

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ACKNOWLEDGEMENT

Supported in part by the Steadman Hawkins Research Foundation and the NFL Charities