INTRODUCTION:

The belly-press and lift-off clinical examinations are often used to help diagnose a subscapularis muscle tear in the clinic. For the belly press test, the patient is asked to place his or her hand on the abdomen region and press that region by rotating the arm internally, with the elbow positioned anterior to the coronal plane (Figure 1, left). If the elbow is moved posterior to the coronal plane, the test is considered positive [1]. However, when a patient is obese, the humerus must be flexed to obtain the appropriate starting hand and elbow position. Thus, obesity may alter or compromise the mechanical validity of this clinical examination. For the lift-off test, the arm is extended and externally rotated, such that the patient places the back of their hand on the small of their back and then attempts to remove (lift the hand) off the back [2] (Figure 2). This test is positive if the patient fails to lift the hand off the small of their back. The purpose of this study was to utilize a computational model to estimate the force in the upper and lower subscapularis muscle during the belly-press and lift-off tests. Additionally, we sought to determine how obesity might affect these values during the belly press test, since an extended (obese) abdomen may create different humeral positions when attempting to perform this test clinically. We hypothesized that the belly press test would best isolate the subscapularis over and above other muscle forces estimated during the lift off test; but that flexion of the humerus, in simulation of an obese person, would reduce the force in the subscapularis and diminish its capacity to isolate the subscapularis.

METHODS:

An upper extremity computer model [3] was used to calculate the individual muscle forces in the shoulder. Nineteen muscles, including the upper and lower portions of the subscapularis, were included in the model. To simulate the force of the hand on the belly, a 10 N force was applied to the hand that pushed the hand anterior to the abdomen. Muscle forces were calculated by solving a static optimization problem that minimized the total stress summed across all the muscles. Three belly-press conditions were simulated. First, the normal belly-press condition was simulated with the hand placed on the abdomen in the belly-press position, respectively (Figure 1). The lift off position was obtained by internally rotating the humerus until the back of the hand rested on the lower lumbar area (Figure 2).

RESULTS:

During the lift-off test, the upper and lower subscapularis muscle produced higher forces than any other muscle (Figure 3). During the belly press test, the lower subscapularis produced more force than the upper subscapularis and this trend remained the same for the obese simulation (Figure 3, Belly Press Flexed). During the obese simulation, the anterior deltoid produced higher forces and the upper subscapularis and lower subscapularis forces reduced in their capacity to generate force compared to the normal belly press condition.

DISCUSSION:

While the lift off test exhibited higher forces in the upper subscapularis forces compared with the lower subscapularis, the belly press showed the opposite trend, exhibiting higher forces in the lower subscapularis. This suggests that each test may isolate upper and lower subscapularis differently, possibly explaining notable differences in sensitivity and specificity rates obtained in previous studies [1, 4, 5]. The lift-off test produced the largest forces in the upper and lower subscapularis compared to the belly press test, suggesting that this test would better isolate the two subscapularis muscle bundles. However, many patients with stiff and/or painful shoulders cannot achieve the lift-off position, and thus the belly press is often employed. The current results indicate that the belly press test with extra humeral flexion (as would occur in an obese patient) would rely less on the subscapularis muscle force and would recruit the anterior deltoid. This may be considered a limiting factor for detecting subscapularis tears when this clinical exam is applied to obese patients, and may also explain notable differences in published sensitivity and specificity rates which have not controlled for obesity in their study populations [1, 4, 5].

REFERENCES:


ACKNOWLEDGEMENT:

Supported by Steadman Hawkins Research Foundation and the National Football League Charities.