INTRODUCTION:
Shoulder impingement syndrome is a painful condition which occurs during overhead activities as the rotator cuff is compressed between the humerus and the acromion. Unrecognized secondary causes of impingement syndrome may lead to treatment failure. Posterior capsular tightness, believed to alter shoulder joint kinematics, is often cited as a secondary cause but scientific evidence is lacking. The objective of this study is to evaluate the effect of posterior capsular tightness on pressure in the subacromial space during abduction in the scapular plane.

METHODS:
Ten fresh-frozen shoulder specimens from seven donors (4 males, 3 females, mean age 72 years) with no signs of osteoarthritis or trauma were acquired following ethics approval from our institution. Specimens were stored at -20 degrees and thawed 24 hours prior to testing. All soft tissues except for the rotator cuff, joint capsule and coracoacromial and glenohumeral ligaments were removed. The humerus was transected and a weight was attached distally to simulate the effective arm weight. The dissected shoulder was mounted on a custom designed testing apparatus (Figure 1) adapted from previously published cadaveric shoulder simulators. For each static position, the deltoid force was held constant and the cuff loads were applied with static weights to achieve the prescribed ratios.

In the reference position, the humerus was aligned in neutral rotation with 45N applied to the deltoid to prevent subluxation. Three initial trials to 90 degrees of glenohumeral abduction were completed by sequentially increasing the deltoid force: 1.00 deltoid, 0.18 supraspinatus, 0.42 infraspinatus and teres minor and 0.40 subscapularis. A cable attached to a bone screw at the deltoid insertion applied the primary abductor force with a materials testing machine (MTS Sintech 1G, Eden Prairie, MN). For each static position, the deltoid force was held constant and the cuff loads were sequentially increased to 30N deltoid increments and 10N increments around the impingement position. Pressure between the rotator cuff and the undersurface of the acromion was measured with a resistive sensor (model 5051, K-scan™, Tekscan, Boston, MA). Glenohumeral kinematics were measured with an optical tracking system (Polaris, NDI, Waterloo, ON). The scapula and humerus coordinate systems were defined following the ISB recommendation. Peak pressure and glenohumeral kinematics at the impingement position were compared between groups using a repeated measures ANOVA with the level of significance set at p<0.05.

RESULTS:
Eight specimens were included in the analysis; one specimen was excluded due to pressure exceeding the saturation pressure of the sensor and a second specimen exhibited no contact pressure. Peak subacromial pressures (mean±sd) were similar between groups: 410±213 kPa and 330±164 kPa for the intact, 1cm and 2cm plication respectively (p>0.05) (Figure 2). Similarly, no significant difference was found for mean contact pressure, area or force.

DISCUSSION:
It is generally believed that a tight posterior shoulder with positive impingement signs originates from a thick and shortened capsule but a recent case report suggests that it may also originate from muscular contractures of the infraspinatus and teres minor. The main strength of this study is to isolate the effect of posterior capsular tightness. Our findings indirectly support the hypothesis of muscular contraction as posterior capsular tightness did not increase subacromial pressure during scapular abduction. The study is not without its limitations. The muscle force ratio was held constant and thus functional adaptation due to tightening of the capsule or muscle contraction was not included. The posterior capsule is most stretched at the limits of flexion where capsular tightness may contribute to obligate anterior and superior translation and increased subacromial pressure. In conclusion, posterior capsular tightness, as a sole variable, does not contribute significantly to increased pressure in the subacromial space during abduction in the scapular plane.

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