

GLENOHUMERAL JOINT REACTION FORCES FOLLOWING LATISSIMUS TENDON TRANSFER

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INTRODUCTION

Massive rotator cuff tears often produce superior migration of humeral head and limit shoulder function. For irreparable cuff tears, latissimus tendon transfer is an option to restore shoulder function (Gerber, 1992). Margermans et al. (2004) calculated moment arms of the transferred latissimus muscle and compared different attachment sites. However, they did not report glenohumeral joint reaction forces (GHJRFs), which mainly determine the stability of the humeral head in the glenoid. Thus, the purpose of this study was to compare the GHJRFs between the intact shoulder, the shoulder with a rotator cuff tear, and shoulder with the rotator cuff tear following latissimus tendon transfer. We hypothesized that the shear forces at the glenohumeral joint would decrease following latissimus transfer in the rotator cuff torn shoulder.

METHODS

Measured 3D clavicular, scapular, and humeral positions during abduction were applied to a 3D model of the upper extremity (Garner and Pandy, 1999, Yanagawa et al. in review). A static optimization problem was solved to compute the muscle forces needed to abduct the arm in four muscle conditions: 1) normal, 2) rotator cuff tear (RCT), 3) tendon transfer to the supraspinatus insertion (Supr), 4) tendon transfer to the infraspinatus insertion

(Infr). In the rotator cuff tear condition, no force was transmitted in the supraspinatus and infraspinatus muscles. To simulate muscle weakness, the tendon transfer calculations were repeated with the strength of the remaining cuff muscles, subscapularis and teres minor, reduced to 20% of maximum. Stability ratios (shear force divided by compression force) as proposed by Fukuda et al. (1988) were calculated to show the effect on glenohumeral stability

RESULTS AND DISCUSSION

The resultant GHJRF increased in the RCT condition (Figure 1). Transfer of the latissimus tendon to either the supraspinatus or the infraspinatus insertion reduced the resultant GHJRF closer to, but below, normal levels.

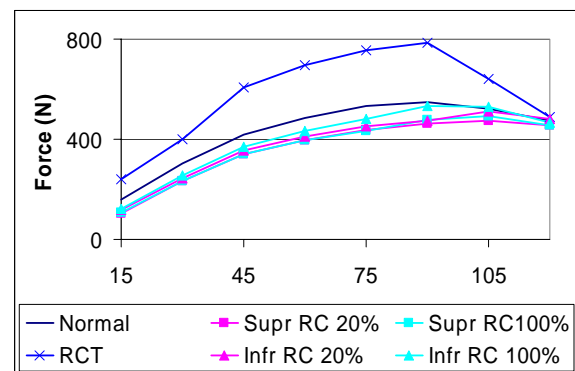


Figure 1: Resultant joint reaction force during abduction from 15° to 120°.

The magnitude of compressive component of the GHJRF was higher than the anterior

or superior components in any condition (Figure 2). The tendon transfer conditions (Supr and Infr) produced lower compression forces than those of the normal and RCT conditions (Figure 2). Because of the low compressive force and high shear force, anterior and superior stability ratios tended to be higher for the Supr and Infr conditions compared to those of the normal shoulder for most of the angles (Figure 3 and Figure 4).

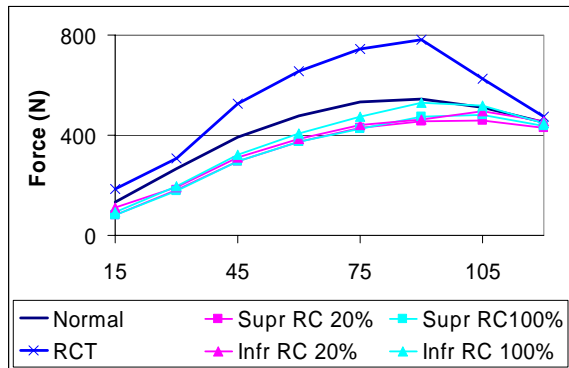


Figure 2: Glenohumeral joint compression force during abduction.

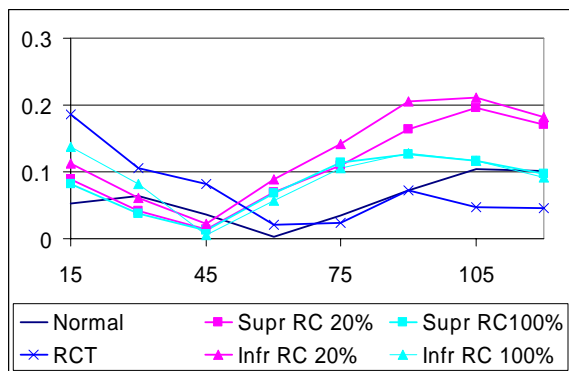


Figure 3: Anterior stability ratios.

When the remaining rotator cuff muscles were weakened to 20% of their normal strengths, the anterior stability ratios tended to be larger than normal (Figure 3). This suggests that retaining the potential strength of subscapularis and teres minor would assist in centering the glenohumeral joint in the fore-aft direction.

CONCLUSIONS

The goal of the latissimus tendon transfer surgery is to restore shoulder function. In this study, the tendon transfer to either the Supr or Infra locations produced near normal magnitudes of resultant. However, the stability ratios of the tendon transfers were higher than normal. Thus, the shoulder with tendon transfer may be less stable than the normal shoulder. The anterior stability ratios were even higher when the remaining rotator cuff muscles were weakened to 20%. As suggested by Gerber (1992), this indicates that the success of the surgery may depend on the strength of the subscapularis and teres minor muscles.

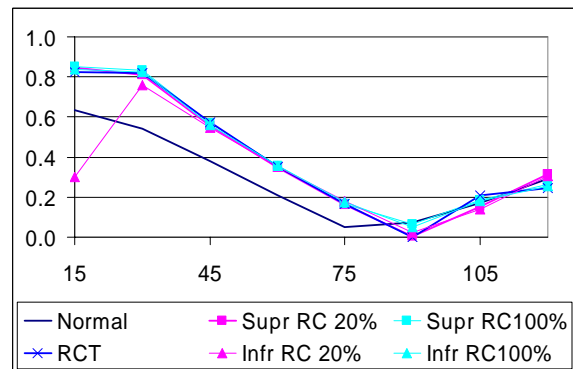


Figure 4: Superior stability ratios.

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