The Tensile Properties of the Supraspinatus Muscle Tendon Unit

Suggested author list : J.Y. Cho, M. Apreleva, M. Parsons, R. Tantisira, F.H. Fu, S.L-Y. Woo, J.J.P. Warner

PURPOSE OF STUDY: Clinical experience suggests that the degree of rotator cuff muscle atrophy and fatty degeneration is an important prognostic factor for outcome after surgical repair of chronic rotator cuff tendon tears. Some surgeons have suggested that the quality of the tendon tissue may correlate with these muscle changes. Yet there is no information about the tensile properties of the muscle-tendon unit of the rotator cuff muscles. Thus, the purpose of this study was to develop a method for measurement of the tensile properties of the supraspinatus muscle-tendon unit in normal cadaveric shoulders. This data, which is currently unknown, would then serve as a baseline for future in vivo measurements of tensile properties of the rotator cuff in patients undergoing rotator cuff repair.

METHODS: We developed a tensiometer which consists of an aluminum frame, a tension-compression load cell (FUTEK Model L1650, Laguna Hills, CA) and a DVRT (MicroStrain DVRT, Burlington, VT) to measure the load-elongation properties of the supraspinatus muscle-tendon units. Nine fresh-frozen normal cadaveric shoulders (average age, 72.6 years) were tested. The supraspinatus tendon was detached from its humeral insertion site and released from the labrum and the rotator interval. The tensiometer was fixed to the proximal humerus with 3 Steinmann pins. The free edge of the anterior strip of the tendon was grasped with a No.2 Ethibond suture using a modified Mason-Allen stitch and connected to the load cell. The DVRT probe was inserted in the anterior strip of tendon, 5 mm proximal to the suture. Data acquisition was performed using a laptop computer. For preconditioning, each specimen was stretched at a rate of 2 cm/min to 10% beyond the resting length, L_0 and returned to L_0 at the same rate for 15 cycles. Afterwards, the muscle-tendon units were stretched at the same rate until the failure point was reached. Data analysis included the peak tension at each cycle during the preconditioning. The stiffness, ultimate load and elongation at failure were obtained from the load-elongation curve. A multiple ANOVA Duncan test was performed for determining the effect of cyclic stretching on preconditioning.

RESULTS: During preconditioning, we found that there was a 44.6% decrease in the peak tension between the first and last cycles. Each of the peak tensions from the first four cycles showed a statistically significant difference ($p<0.05$) from the other nine peak tensions. In the tensile test, the stiffness was 7.6 $\pm$ 2.3 N/mm. The ultimate load was 68.9 $\pm$ 13.6 N. Elongation at failure was 26.1 $\pm$ 4.7 mm. All specimens failed along the interface between muscle and fascia.

CONCLUSION: The designed tensiometer enabled us to measure the tensile properties of the supraspinatus muscle-tendon unit. The data obtained in our experiment is essential for developing a method for in vivo measurements. The changes in tensile properties of the cuff muscles in patients undergoing rotator cuff repair, could hold significant prognostic potential for determining the degree of muscle atrophy and degeneration.