Graft Elongation Occurs Beyond Intraoperative Dimensions After Superior Capsular Reconstruction: An In Vivo Analysis

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Summary:
The graft used in SCR is stretched well beyond its intra-operative length and the length exceeds the graft ultimate strain.

Data:
INTRODUCTION: Superior capsular reconstruction (SCR) has led to favorable clinical outcomes [1,2], but the in vivo behavior of the SCR graft remains unclear. The aims of this study were to determine regional graft elongation after SCR, its relationship to graft healing, and the effects on kinematics. It was hypothesized that anterior and posterior regions of the SCR graft would elongate uniformly, greater graft elongation would be associated with graft failure, and the graft would affect shoulder kinematics by decreasing the distance between graft anchor points after surgery. METHODS: Ten patients with irreparable rotator cuff were enrolled in this IRB approved study. Synchronized biplane radiographs of the shoulder were collected before (PRE) and 1 year after dermal SCR (POST) at 50 frames/s while patients performed 3 trials of both scapular plane abduction and internal/external rotation at 90° of humerothoracic abduction. Kinematics were determined with sub-millimeter accuracy by matching subject-specific digitally reconstructed radiographs of the CT-based models of the humerus and scapula to radiographs using a validated volumetric tracking technique [3]. Intra-op graft lengths were recorded from surgical notes. MRIs were acquired POST to identify anchor locations on bines and to evaluate whether the graft was healed at the four anchor locations. The graft length between anchors was calculated based upon bone motions recorded using biplanar radiography. Differences between the abduction angle at which the graft reached the intra-op length in healed and not healed grafts were evaluated using a Mann-Whitney U test, with significance set at p<0.05.

RESULTS: All SCR grafts elongated beyond their intra-op length. During abduction, the anterior and posterior regions elongated up to 340% and 118% compared to intra-op, while during rotation the anterior and posterior regions elongated up to 222% and 171%. On average, graft elongation occurred when the GH joint passed below 66° of abduction. During rotation, the posterior regions elongated during internal rotation while the anterior region did not elongate (p<0.01). Grafts that were healed at both anterior anchors reached the intra-op length at lower abduction angles than grafts that were not healed at one of the anchors. The posterior anchor points were 2.1±1.5mm and 2.1±3.6mm farther apart POST compared to PRE during abduction (p<0.01) and rotation (p=0.05), respectively, but no difference was found in the distance between anterior anchor points for either motion (all p>0.38).

DISCUSSION: The main finding of this study was that the graft used in SCR is stretched well beyond its intra-operative length and the length exceeds the graft ultimate strain of 24% [4]. The graft regions did not elongate uniformly during rotation, contradicting our first hypothesis. Grafts that were healed in the anterior region became elongated at lower abduction angles than grafts that were not healed, supporting our second hypothesis. The graft lengths were larger in the posterior region during abduction POST than they would have been in the simulated PRE graft, contradicting our third hypothesis.
Summary:
LTTT is a suitable salvage procedure for any degree of fatty infiltration of teres minor, and should be strongly considered as an alternate procedure to latissimus dorsi tendon transfer in patients with high grade teres minor fatty infiltration.

Data:
Introduction: Surgical management of massive irreparable rotator cuff tears has increasingly used salvage procedures such as tendon transfers to preserve the glenohumeral articulation in young patients. Appropriate patient selection for tendon transfers is crucial to surgical success, yet there is a paucity of evidence investigating factors that lead to improved post-operative outcomes. Success of latissimus dorsi tendon transfer has been linked to a low level of fatty infiltration of the teres minor muscle belly. However, the effect of teres minor fatty infiltration has not been studied in newer surgical techniques such as the lower trapezius tendon transfer (LTTT). This study aims to correlate post-operative outcomes of LTTT in massive irreparable rotator cuff tears to the degree of fatty infiltration of teres minor. Materials & Methods: This is a prospective longitudinal observational study. All patients with massive rotator cuff tears undergoing arthroscopic assisted LTTT (as previously described) by a single fellowship trained upper extremity surgeon were screened. The research coordinator undertook the consenting process if the patient agreed to be approached for the study. For all consenting patients, fatty infiltration of teres minor was graded using the Goutallier classification based on pre-operative MRI by two orthopaedic surgeons not involved in performing the surgery. Two groups were created based on teres minor fatty infiltration: Group A included Grades 0 and 1 (no or little fatty infiltration) and Group B included Grades 2 to 4 (moderate to severe fatty infiltration). Participants completed a demographic form, and the SANE score and a satisfaction questionnaire were completed at pre-, 12- and/or 24-months post-operative. At all study time points, range of motion and isometric strength of forward elevation, abduction, and external rotation (ER) in neutral and 90° abduction) using a hand-held dynamometer were measured by a research athletic therapist blind to Goutallier grade. Lag sign test was performed. Between group comparisons were performed using independent t-tests assuming unequal variance and pre vs post-operative comparisons were performed for each group using paired t-tests. Rate of external rotation (ER) lag was compared between groups using Fisher’s exact test. Significance was defined as p < 0.05. Results: Twenty-six patients met the study inclusion criteria, with 18 patients included in Group A and 8 in Group B. There were no differences between groups with respect to pre-operative SANE score, degrees of active forward elevation, and degrees of active ER. Eight of 18 patients (44.4%) in Group A had an ER lag sign, compared to 5 of 8 patients (62.5%) in Group B, but this was not statistically significant (p = 0.672). Significant post-operative improvements in SANE score were found in both groups with no differences between groups. Pre-operative ER strength of the affected arm with the arm adducted was significantly different in Group A (3.9kg) versus Group B (0.58kg; p = 0.011; Figure 1). However, ER strength was similar post-operatively (p = 0.587). Discussion: Lower trapezius tendon transfer provides in-phase motor activity and anatomic line of pull to the infraspinatus and teres minor muscles. In our study, patients with any degree of fatty infiltration of teres minor benefited from LTTT and experienced improvement in patient reported outcomes. Patients with moderate to severe teres minor fatty infiltration (Group B) had lower basal ER strength, but this difference was no longer evident post-operatively. Although overall patient numbers in this study are small given the rarity of this condition and procedure, these outcomes suggest that LTTT provides significant benefit to patients, independent of the degree of fatty infiltration to teres minor. This is in contrast to the latissimus dorsi tendon transfer, which is less successful in patients with moderate to severe teres minor fatty infiltration. Taken together, LTTT is a suitable salvage procedure for any degree of fatty infiltration of teres minor, and should be strongly considered as an alternate procedure to latissimus dorsi tendon transfer in patients with high grade teres minor fatty infiltration.