Lesser Tuberosity Osteotomy in Total Shoulder Arthroplasty – A Biomechanical and Clinical Evaluation

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INTRODUCTION

Subscapularis compromise from routine division and repair in shoulder arthroplasty is common.[1-8] Subscapularis dysfunction may at times be subtle and result in decreased motion, weakness, and diminished satisfaction following shoulder arthroplasty. In a recent study, over 65% of shoulder arthroplasty patients had subscapularis dysfunction following a standard soft tissue subscapularis repair.[6] Rupture of the subscapularis is a devastating problem that can lead to the challenging problem of gross anterior instability. Reported rates of subscapularis rupture have been up to 3% of all primary arthroplasties[1]. Some degree of shoulder instability is common following arthroplasty and is the most frequent complication leading to revision surgery.[2-4,7-10]

In order to strengthen our repairs and to prevent subscapularis rupture, we have been performing a lesser tuberosity osteotomy (LTO) to take down the subscapularis and expose the humerus in shoulder arthroplasties. The repair of the LTO provides a strong, secure closure that allows bony healing and does not injure the subscapularis tendon. Furthermore, the integrity of the repair can easily be assessed on standard radiographic axillary views. If the lesser tuberosity fragment is noted in the proper position, then disruption is unlikely.

The purpose of this report is to describe the technique of this novel repair and to evaluate the biomechanical and clinical outcomes of the repair.

METHODS

Technique of the Lesser Tuberosity Osteotomy (LTO) Repair

A deltopectoral approach is used to provide routine exposure to the anterior shoulder. The bicep tendon is cut and tagged and the anterior humeral circumflex vessels are cauterized. The lesser tuberosity is the osteotomized with a curved osteotome placed in the bicipital groove. The goal is to remove a quarter-sized, 4-5 mm thick wafer of the lesser tuberosity. The wafer with the attached subscapularis is tagged to prevent medial retraction.

The humeral head osteotomy, glenoid preparation and humeral canal preparation are performed in the standard fashion. Before the humeral component is placed, a small drill is used to create four parallel rows of drill holes on each side of the wafer osteotomy. A large, nonabsorbable suture is passed transosseously in the lateral hole and out the medial hole of each set of drill holes. The bridge of suture within the humeral canal is then pulled out of the canal and the implant is inserted in such a way that each suture now encircles the stem of the humeral component. The lesser tuberosity with the attached subscapularis is repaired to the shaft back in its original anatomic position using modified Mason-Allen stitches. This technique assures that each suture is transosseous and looped around the stem in the intramedullary canal. Unless the suture breaks, it is virtually impossible for the suture to cut out. The remaining surgical closure is then completed in routine fashion.

BIOMECHANICAL TESTING

The LTO technique described above was compared with two commonly used subscapularis repairs. The first repair was that of a soft tissue (ST) subscapularis release 1 cm medial to the insertion onto the lesser tuberosity.[11] The second repair was a transosseous (TO) repair following removal of the subscapularis off of the lesser tuberosity.[11] Each repair was secured with four large nonabsorbable sutures using modified Mason-Allen stitches. Nine cadaveric specimens were tested for each repair.

After each repair was performed, the specimen was evaluated with a servo hydraulic material testing system (MTS Systems Corporation, Eden Prairie, MN). Testing parameters were similar to previous rotator cuff repair protocols.[12-16] Standard statistical analysis was used to determine whether the differences in cyclic displacement and maximum load to failure were significant.

CLINICAL EVALUATION

Following IRB approval, we reviewed the clinical results of a consecutive series of 80 total shoulder arthroplasties by the senior authors (J.P.W. and P.J.M.) in which the LTO repair was used. Exclusion criteria included history of prior shoulder arthroplasty, known subscapularis injury, patients with rheumatoid arthritis, or patients having immediate postoperative

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infection. Patients were evaluated for subscapularis rupture or dysfunction. Dysfunction was defined as the inability to achieve terminal internal rotation with an abnormal belly-press test, lift-off test, or inability to perform a shirt-tuck test.[6] Axillary radiographs were reviewed to follow the status of the LTO repair and to determine the time to osseous healing of the LTO repair. All radiographs were reviewed by an independent reviewer (RSA).

RESULTS

Biomechanical Testing

The LTO repair had the least cyclic displacement and the highest average load to failure value of the three repairs tested. The values were statistically significant ($P<.05$) in both testing conditions.

Clinical Evaluation

Subscapularis testing revealed a dysfunction rate under 15%. There was a single subscapularis rupture. There were no nonunions.

SUMMARY/CONCLUSION

Subscapularis dysfunction is a frequently occurring complication after shoulder arthroplasty. Subscapularis rupture is a much less frequent complication. Both dysfunction and rupture can result in abnormal subscapularis function and lead to revision surgery. The LTO repair is a biomechanically superior repair technique with clinical rates of dysfunction and rupture less than with traditional repairs. We believe that the addition of the LTO subscapularis repair to routine shoulder arthroplasty will help to reliably allow excellent outcomes in shoulder arthroplasties.

References

1. **Moeckel BH, Altcheck D, Warren RF, Wickiewicz TL, Dines DM.** Instability of the shoulder after arthroplasty. *J Bone Joint Surg* 1993; 75A: 492-497.
2. **Wirth MA, Rockwood CA Jr.** Complications of shoulder replacement -arthroplasty. *J Bone Joint Surg 1996; 7*8A: 603-616.
3. **Hennigan SP, Iannotti JP.** Instability after prosthetic arthroplasty of the shoulder. *Orthop Clin North Am* 2001; 32: 649-659.
4. **Sanchez-Sotelo J, Sperling JW, Rowland CM, Cofield, RH.** Instability after shoulder arthroplasty: results of surgical treatment. *J Bone Joint Surg* 2003; 85A: 622-631.
5. **Cofield RH, Edgerton BC.** Total shoulder arthroplasty: complications and revision surgery. *Instr Course Lect* 1990; 39:449-462.
6. **Miller SL, Hazrati Y, Klepps S, Chiang A, Flatow EL.** Loss of subscapularis function after total shoulder replacement: A seldom recognized problem. *J Shoulder Elbow Surg 2003;* 1: 29-34.
7. **Gerber A, Ghalambor N, Warner JJP.** Instability of shoulder arthroplasty: Balancing mobility and stability. *Othrop Clin North Am* 2001; 32: 661-670.
8. **Gill TJ, Warren RF, Rockwood Jr. CA, Craig EV, Cofield RH, Hawkins RJ.** Complications of shoulder surgery; *Instr Course Lect* 1999;48: 359-374.
9. **Wirth MA, Rockwood CA Jr.** Complications of shoulder arthroplasty. *Clin Ortho Related Research* 1994; 307: 47-69.
10. **Brenner BC, Ferlic DC, Clayton ML, Dennis DA.** Survivorship of unconstrained total shoulder arthroplasty. *J Bone Joint Surg* 1989; 71A: 1289-1296.
11. **Rockwood Jr, CA,** The Technique of Total Shoulder Arthroplasty. *Instr Course Lect.* 1990; 39: 437-447.
12. **Waltrip RL, Zheng N, Dugas JR, Andrews JR.** Rotator cuff repair. A biomechanical comparison of three techniques. *Am J Sports Med* 2003; 31: 493-497.
13. **Craft DV, Moseley JB.** The fixation strength of surgical repairs of the rotator cuff: a biomechanical study on cadavers. *J Bone Joint Surg* 1992; 74B: 585-588.
14. **Burkhart SS, Esch JC, Jolson RS.** The rotator crescent and rotator cable: An anatomic description of the shoulder's "suspension bridge." *Arthroscopy* 1993; 9: 611-616.
15. **Gerber C, Schneeberger AG, Beck M, Schlegel U.** Mechanical strength of repairs of the rotator cuff. *J Bone Joint Surg* 1994; 76B: 371-380.
16. **Ikai M, Fikunaga T.** Calculation of muscle strength per unit of cross-sectional area of human muscle. *Int Zeitshcrift Angewandte Physiol Einschliesslich Arbeitsphysiol* 1968; 26: 26-31.