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Prospective evaluation of the functional and anatomical results of arthroscopic repair in small and medium-sized full-thickness tears of the supraspinatus tendon

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Objective: The purpose of this study was to analyze the relation between tendon integrity and functional results following the arthroscopic treatment of small- and medium-sized rotator cuff tears.

Methods: Arthroscopic repair was performed on 26 consecutive patients (21 women, 5 men; mean age: 55.9 years; range: 33-72 years) with small- and medium-sized tears of the supraspinatus tendon. Patients were postoperatively evaluated at 12 and 24 months using the Constant and UCLA functional outcome scores and ultrasound examinations.

Results: The supraspinatus tendon did not heal in nine patients (34.6%) and was partially healed in three (11%), 12 months after surgery. Mean postoperative Constant and UCLA scores of these patients were 73.1 and 27.8, respectively, which were not significantly different from those with an intact tendon on the final follow-up (Constant: 78 and UCLA: 30; p=0.107 and p=0.164). Both rating systems reflected significant improvement with treatment (p<0.01). The mean age of patients with a re-tear was 66.8 years, which was significantly higher than those with an intact repair (54 years; p<0.01).

Conclusion: The arthroscopic repair of small and medium-sized supraspinatus tendon tears yields good long-term results independent of tendon integrity. Healing potential may be decreased with increased age.

Key words: Arthroscopy; rotator cuff healing; rotator cuff repair.

The relationship between the integrity of an open rotator cuff repair and the final outcome has been well studied.[1,2] Re-rupture rates have ranged from 13 percent to 68 percent.[3-10] Arthroscopic repair of full–thickness tears of the rotator cuff has been shown to produce satisfactory results. Nevertheless, few studies have evaluated the relationship between the functional and anatomical outcomes after arthroscopic rotator cuff repair. Rates of re-rupture after rotator cuff repair ranged from 17 percent to 95 percent in series with tears of heterogeneous size.[1,3,11-18] The aim of this study was to analyze the relation between tendon integrity and functional results, following the arthroscopic treatment of small- and medium-sized rotator cuff tears.

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Patients and methods

Sixty-eight consecutive patients received arthroscopic repair of a full-thickness tear of the rotator cuff tendon. Of this group, 26 patients (21 women and 5 men) were included in this study. Patients' mean age at the time of the operation was 55.9 (range: 33-72) years. Twenty-one patients had involvement of the dominant shoulder, and five of the non-dominant shoulder. The average duration of the symptoms before surgery was 13 (range: 6-36) months. Eighteen patients had had an average of 1.5 (range: 1-3) preoperative subacromial injections of cortisone administered by either the referring physician (S.A.) or one of us. The criterion for inclusion was a primary full-thickness tear of the supraspinatus less than 3 cm in the anterior-posterior length. Large and massive tears were excluded from the study due to their low healing potential. A minimum of two years of follow-up was required for inclusion in the study. Those individuals who had had a previous procedure on the shoulder, those who had large and massive rotator cuff tears, and those who had partial thickness tears of the rotator cuff were excluded. Patients with an acute tear were also excluded because of the substantial trauma with additional osseous or soft-tissue damage. Surgery indication was the failure of non-operative treatment including a physical therapy program of at least six months.

All patients had a full-thickness rotator cuff tear confirmed by preoperative magnetic resonance imaging (MRI) and ultrasonography. A final ultrasound study was performed twelve months after surgery to determine tendon healing by the same radiologist.

All patients preoperatively and at the one- and two-year follow-ups completed a questionnaire evaluating pain and function. Data were collected using the University of California at Los Angeles (UCLA),[14] and the Constant and Murley rating systems.[19] The UCLA rating scale is a 35-point scale with 10 points for pain, 10 points for function and 5 points each for motion, strength and patient satisfaction. The Constant and Murley rating system is a 100-point scale with 15 points for pain, 20 points for function, 40 points for active range of motion and 25 points for strength.

Active ranges of motion were measured with the Constant and Murley system and included forward elevation, abduction, external rotation with the arm in abduction and internal rotation behind the back. Passive elevation and external rotation (with the arm in adduction) were measured to the nearest 5 degrees with a handheld goniometer. Internal rotation behind the back was recorded as the most cephalad vertebral level reached by the extended thumb.

Resisted elevation strength was measured using a dynamometer, with the arm elevated 90 degrees in the scapular plane and internally rotated, and recorded in kilograms.

Patients were initially evaluated at a minimum of twelve months after surgery when ultrasound examinations were performed. Patients were subsequently reevaluated at a minimum of twenty-four months after surgery. All ultrasonograms were performed with a Siemens Sonoline Antares (Siemens Medical Systems) and a variable high-frequency linear-broadband transducer (4 to 9 MHz) by a radiologist with 10 years of experience.

During surgery, interscalene block anesthesia, supplemented with general anesthesia, was used for all patients. Patients were placed in the beach chair position. Easy access was afforded to the anterior, lateral, and posterior aspects of the shoulder. First the glenohumeral joint was inspected and intra-articular pathologies were treated if necessary. The majority of intra-articular pathologies were related to the biceps tendon which was treated either with tenotomy or tenodesis. Upon completion of the glenohumeral joint inspection, the arthroscope was removed from the joint. The trocar and cannula were then redirected through the same posterior skin incision into the subacromial space. Any bursa that obscured visualization was removed with a radiofrequency probe or a power shaver. Then the size and shape of the tear was assessed (Fig. 1a). Tear size was measured by comparing it to the length of the arthroscopic probe.

Arthroscopic subacromial decompression was performed. The goal of the acromioplasty was to increase the size of the subacromial space. If the acromion had a lateral slope identified on MRI or plain radiographs, the inferior lateral acromion was thinned further. If preoperative imaging detected osteophytes in the infe-

rior part of the acromioclavicular joint, the inferior one half to one third distal clavicle was then removed with a power burr. Acromioclavicular joint resection was performed only if the patient had symptoms consistent with acromioclavicular joint arthritis. A 4-mm round burr was used to prepare a cancellous bed for the tendons. Then 1-2 mm of the cortical bone was removed until the cancellous bone was visible. Screw anchors (Fastin RC; DePuy Mitek, MA, USA) that did not require pre-drilling and had two sutures and an eyelet large enough to allow the sutures to slide freely were used. For all but the small tears, two anchors were placed. The anchors were placed five or ten millimeters lateral to the greater tuberosity, in order to place the anchor in a bone with an intact cortical surface and to repair the tendon to the tuberosity in an anatomical fashion. Once the suture anchor placement was completed, braided sutures were passed through the torn tendon using a suture punch. The sutures were spaced evenly from the anterior tendon edge to its posterior margin and placed approximately 5 mm proximal to the tendon edge. Knot tying began posteriorly and proceeded anteriorly using Revo-knot technique to place simple sutures (Figs. 1b and c).

The arm was placed in a pillow sling in 15 degrees of abduction. The patients were discharged the morning after surgery. Passive elevation and external rotation exercises were introduced in the early postoperative period and continued at home for six weeks. Active range of motion and stretching exercises were allowed at six weeks and strengthening exercises were encouraged after the twelfth week. The scapular protractors were strengthened to overcome scapular dyskinesia.

SPSS 13.0 for Windows software was used to evaluate the results. The statistical significance was estimated by using Mann-Whitney U and Wilcoxon tests.

Results

The supraspinatus tendon was evaluated ultrasonographically and found unhealed in 9 (34.6%) of the 26 patients; and was partially intact in 3 (11%) at twelve months after surgery. Despite the absence of tuberosity healing in 9 patients at the first evaluation, the average size of the tear was smaller than the primary tear. The Constant-Murley score improved from an average of 43.8 points preoperatively to 83.3 points at twelve months after surgery, and to 82.3 at twenty-four months after surgery. The average UCLA score improved from 13.8 to 29.3 at twelve months after surgery, and to 28.6 at twenty-four months after surgery. Both rating systems reflected significant improvements in the status of the shoulder at twelve months ($p<0.01$) and twenty-four months ($p<0.01$) after surgery (Fig. 2). Nevertheless, a statistically significant change was not observed in the Constant and UCLA scores between years 1 and 2 ($p=0.581$, $p=0.635$).

The mean age of patients with a re-tear was 66.8 years, which was significantly different from those with an intact repair (54 years; $p<0.01$). The mean preoperative tear size for the group with a defect on the postoperative ultrasound was 19.3 (range: 12-30) mm, which was not significantly different from the preoperative tear sizes of those with an intact repair (17.9 mm; range: 4-30 mm) ($p=0.287$). The mean postoperative Constant and UCLA scores of those

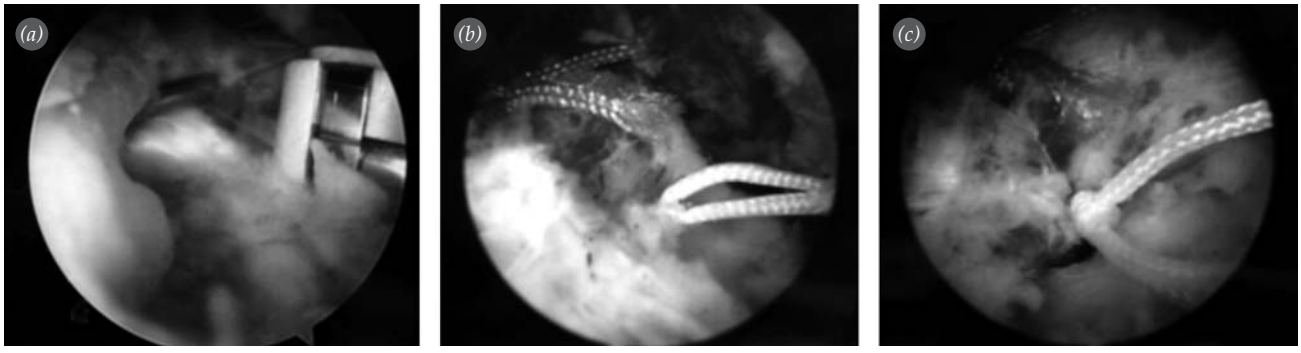

Fig. 1. **(a)** Arthroscopic view of a medium-sized supraspinatus tear of the right shoulder; **(b)** view of the repaired tendon from the posterior portal, using single-row, simple suture technique; **(c)** view of the repaired tendon from the lateral portal.

patients with a defect on imaging after repair was 73.1 and 27.8, respectively, which were not significantly different from those with an intact repair on the final follow-up (Constant: 78 and UCLA: 30; p=0.107 and p=0.164) (Fig. 3). The mean abduction strength improved from 3.2 to 5.8 kilograms. Abduction strength in the patients who had re-tear was 3.6, compared to 6.3 kilograms in patients with intact tendons (p<0.05).

All patients were satisfied with their results and stated that they would not decline the procedure. None of the patients required an additional surgical procedure. The UCLA rating scale was used to rate satisfaction level. The average score for satisfaction was 0.8 points preoperatively and 4.5 points postoperatively. Preoperatively, no patient rated his/her satisfaction as good or excellent (a score of 4 or 5 points). Postoperatively, 23 (88%) of the 26 patients rated their satisfaction as good or excellent and three (12%) rated it as fair or poor (a score of 0 to 3 points)

Two patients with biceps tenosynovitis had tenotomies, three patients with inferior acromioclavicular osteophytes had co-planing of the inferior part of the distal clavicle, and sixteen patients with intra-articular synovitis had a synovectomy. All patients had a tear of the supraspinatus tendon. Four tears were small (less than 1 centimeter), and 22 were medium (1 to 3 centimeters). The average length was 19 (range: 4-30) mm. All tendons were repaired anatomically. Side-to-side repair was performed in only one patient. Metallic screw-in suture anchors with an average of 1.8 mm were used. The average duration of the operation was eighty-eight (range: 60-125) minutes.

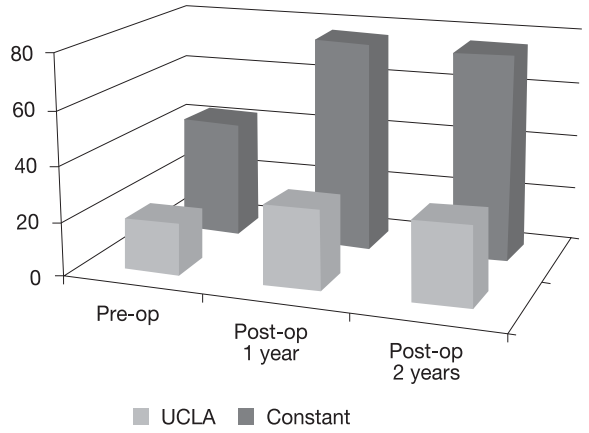

Fig. 2. The UCLA and Constant scores compared preoperatively, at 12 months and 24 months after surgery.

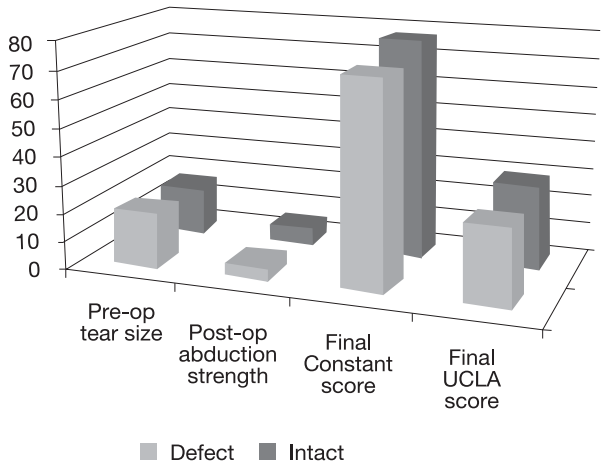

Fig. 3. Preoperative tear size, postoperative abduction strength and the final Constant and UCLA scores of patients with a defect and with an intact repair.

Discussion

Many studies on the arthroscopic repair of rotator cuff tears have shown favorable results in terms of pain relief and function.[2,11,14,15,17] Our anatomical failure rate of 34.6% compares favorably with rates of 17% to 95% reported for arthroscopic rotator cuff repair.[1,3,12,13,16,18]

It should be noted that the current study included a homogeneous group of patients with small- and medium-sized supraspinatus tendon tears with a single row repair and a simple suture configuration. Lichtenberg et al. found re-tear rates of 24.5% after arthroscopic repair of isolated supraspinatus tears using the single-row Mason-Allen suture technique.[16] With the exception of age, they did not find any negative prognostic factor for a re-tear. Boileau et al. reported a 29% anatomic failure rate using the arthroscopic technique, in which a medially placed inverted horizontal mattress suture was combined with a laterally placed self-locking anchor.[3] Ninety-seven percent of their patients had Stage 1 and 2 tears classified in the coronal and sagittal planes, according to a modification of the system described by Thomazeau et al.[10] Factors that were negatively associated with tendon healing were increased age

and associated delamination of the subscapularis or infraspinatus tendon. Our study showed the mean age of patients with a defect or re-tear was significantly different from those with an intact repair. The mean postoperative functional scores of those patients with a defect on imaging after repair were not significantly different from those with an intact repair.

The ideal fixation technique of the rotator cuff tendon to the bone, suture configuration and placement for arthroscopic surgery have yet to be determined.[16,20-22] Despite excellent surgical repairs, structural integrity cannot always be obtained. However, our arthroscopic repair technique resulted in a 64.5% tendon healing rate. There are few studies in the literature that compare results at 1 and 2 years after arthroscopic rotator cuff repair. In Galatz et al.'s series of 18 patients with either large or massive tears, the authors reported a mean ASES score of 89.6 at 1 year and 79.9 at the final follow-up at 2 years, demonstrating a decrease rather than an increase in patient-reported functional status.[13] Cole et al. reported 32 patients for whom complete clinical follow-up was available at both 1 and 2 years postoperatively, and significant improvement was observed in the Constant, Rowe and SST scores between years 1 and 2.[12] Their series consisted of 9 small (18%), 29 medium (60%), 2 large (4%), and 9 massive tears (18%). We evaluated 26 patients with either small- or medium-sized tears at both 1 and 2 years postoperatively. Statistically significant change was not observed in the Constant and UCLA scores between years 1 and 2 (p=0.581, p=0.635).

Ultrasonography was used in this study to assess the integrity of the rotator cuff repair. Several previous studies have used this imaging modality as well.[5,13,23-25] Teefey et al. reported the comparisons of ultrasonographic, magnetic resonance imaging, and arthroscopic findings in 71 consecutive cases.[25] They found that ultrasonography and MRI had a comparable accuracy in identifying and measuring the size of full-thickness and partial-thickness rotator cuff tears. Ultrasound examinations were performed twelve months after surgery as in several previous studies.[2,13] Ultrasound assessment at 1 and 2 years postoperatively was not statistically significant in many studies.[12,26] A recent study by Nho et al. postoperatively evaluated 127 patients at the 1- and 2-year time point and found a statistically significant increase in the percentage of healed tendon at 2 years, compared to 3 months and 1 year.[27] However, the major limitation of their study was the number of patients lost to follow up (34.2%). Additionally, multiple surgeons performed the surgeries by similar but not identical techniques. In their demographic information they reported a 15.7% margin convergence technique, which was never mentioned in the discussion of the study.

There are many factors affecting tendon-to-bone healing.[3] The failure of the repair may be due to both mechanical and biological factors. In our series, the mean age of patients with a re-tear was 68.8 years, which was statistically significant from those with an intact repair. Possible explanations include that osteoporotic bone; weak, degenerative tendons and decreased healing potential with increasing age are the main factors affecting the success rate of the rotator cuff repairs. Cole et al. found age of 70 years or older has a significant association with presence of a recurrent tear.[12] In Nho et al.'s study, the average age of patients with an intact rotator cuff based on postoperative ultrasound was 56.6±9.7 years old versus 63.1±8.6 years old in the defect group ($p<0.01$).[27] Boileau et al. reported only 10 (43%) of 23 patients over the age of sixty-five years had completely healed tendons.[3]

The present study has some weaknesses. The follow-up period was relatively short; we can present the results over a longer period of time as the follow-up continues. There is evidence, however, that the maximum improvement occurs in the first year after repair of the rotator cuff and that additional improvement afterwards is unlikely. This study represents only one arthroscopic technique by a single surgeon, and thus, the reproducibility of the technique by multiple surgeons is unknown.

Our anatomical failure rate of 34.6% compares favorably with other studies reported in the literature. Regardless of the type of the repair technique and the tear size, rotator cuff tears may not heal. Therefore, basic-science studies are needed to improve the biological healing of the rotator cuff repairs.

In conclusion, arthroscopic repair of small and medium-sized supraspinatus tendon tears yields good long-term results in virtually all outcomes measured independent of tendon integrity.

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Conflicts of Interest: No conflicts declared.

References

1. Anderson K, Boothby M, Aschenbrener D, van Holsbeeck M. Outcome and structural integrity after arthroscopic rotator cuff repair using 2 rows of fixation. Am J Sports Med 2006;34:1899-905.
2. Bishop J, Klepps S, Lo IK, Bird J, Gladstone JN, Flatow EL. Cuff integrity after artroscopic versus open rotator cuff repair: a prospective study. J Shoulder Elbow Surg 2006;3:290-9.
3. Boileau P, Brassart N, Watkinson DJ, Carles M, Hatzidakis AM, Krishnan SG. Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal? J Bone Joint Surg Am 2005;87:1229-40.
4. Calvert PT, Packer NP, Stoker DJ, Bayley JI, Kessel L. Arthrography of the shoulder after operative repair of the torn rotator cuff. J Bone Joint Surg Br 1986;68:147-50.
5. Gazielly DF, Gleyze P, Montagnon C. Functional and anatomical results after rotator cuff repair. Clin Orthop Relat Res 1994;(304):43-53.
6. Gerber C, Fuchs B, Hodler J. The results of repair of massive tears of the rotator cuff. J Bone Joint Surg Am 2000; 82:505-15.
7. Harryman DT 2nd, Mack LA, Wang KY, Jackins SE, Richardson ML, Matsen FA 3rd. Repairs of the rotator cuff. Correlation of functional results with integrity of the cuff. J Bone Joint Surg Am 1991;73:982-9.
8. Jost B, Pfirrmann CW, Gerber C, Switzerland Z. Clinical outcome after structural failure of rotator cuff repairs. J Bone Joint Surg Am 2000;82:304-14.
9. Knudsen HB, Gelineck J, Søjbjerg JO, Olsen BS, Johannsen HV, Sneppen O. Functional and magnetic resonance imaging evaluation after single-tendon rotator cuff reconstruction. J Shoulder Elbow Surg 1999;8:242-6.
10. Thomazeau H, Boukobza E, Morcet N, Chaperon J, Langlais F. Prediction of rotator cuff repair results by magnetic resonance imaging. Clin Orthop Relat Res 1997;(344):275-83.
11. Burkhart SS, Danaceau SM, Pearce CE Jr. Arthroscopic rotator cuff repair: Analysis of results by tear size and by repair technique-margin convergence versus direct tendon-to-bone repair. Arthroscopy 2001;9:905-12.
12. Cole BJ, McCarty LP 3rd, Kang RW, Alford W, Lewis PB, Hayden JK. Arthroscopic rotator cuff repair: prospective functional outcome and repair integrity at minimum 2-year follow-up. J Shoulder Elbow Surg 2007;16:579-85.
13. Galatz LM, Ball CM, Teefey SA, Middleton WD, Yamaguchi K. The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am 2004;86-A:219-24.
14. Gartsman GM, Khan M, Hammerman SM. Arthroscopic repair of full-thickness tears of the rotator cuff. J Bone Joint Surg Am 1998;80:832-40.
15. Lee E, Bishop JY, Braman JP, Langford J, Gelber J, Flatow EL. Outcames after artroscopic rotator cuff repairs. J Shoulder Elbow Surg 2007;16:1-5.
16. Lichtenberg S, Liem D, Magosch P, Habermeyer P. Influence of tendon healing after arthroscopic rotator cuff repair on clinical outcome using single-row Mason-Allen suture technique: a prospective, MRI controlled study. Knee Surg Sports Traumatol Arthrosc 2006;14:1200-6.
17. Liu SH, Baker CL. Arthroscopically assisted rotator cuff repair: correlation of functional results with integrity of the cuff. Arthroscopy 1994;10:54-60.
18. Sugaya H, Maeda K, Matsuki K, Moriishi J. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. J Bone Joint Surg Am 2007;89:953-60.
19. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 1987; (214):160-4.
20. Burkhart SS, Diaz Pagàn JL, Wirth MA, Athanasiou KA. Cyclic loading of anchor-based rotator cuff repairs: confirmation of the tension overload phenomenon and comparison of suture anchor fixation with transosseous fixation. Arthroscopy 1997;13:720-4.
21. Gerber C, Schneeberger AG, Perren SM, Nyffeler RW. Experimental rotator cuff repair. A preliminary study. J Bone Joint Surg Am 1999;81:1281-90.
22. Meyer DC, Fucentese SF, Koller B, Gerber C. Association of osteopenia of the humeral head with full-thickness rotator cuff tears. J Shoulder Elbow Surg 2004;13:333-7.
23. Bryant L, Shnier R, Bryant C, Murrell GA. A comparison of clinical estimation, ultrasonography, magnetic resonance imaging, and arthroscopy in determining the size of rotator cuff tears. J Shoulder Elbow Surg 2002;11:219-24.
24. Martín-Hervás C, Romero J, Navas-Acién A, Reboiras JJ, Munuera L. Ultrasonographic and magnetic resonance images of rotator cuff lesions compared with arthroscopy or open surgery findings. J Shoulder Elbow Surg 2001; 10:410-5.
25. Teefey SA, Rubin DA, Middleton WD, Hildebolt CF, Leibold RA, Yamaguchi K. Detection and quantification of rotator cuff tears. J Bone Joint Surg Am 2004;86-A:708-16.
26. Levy O, Venkateswaran B, Even T, Ravenscroft M, Copeland S. Mid-term clinical and sonographic outcome of arthroscopic repair of the rotator cuff. J Bone Joint Surg Br 2008;90:1341-7.
27. Nho SJ, Shindle MK, Adler RS, Warren RF, Altchek DW, MacGillivray JD. Prospective analysis of arthroscopic rotator cuff repair: subgroup analysis. J Shoulder Elbow Surg 2009;18:697-704.