The First Rotator Cuff Surgery Fail: How to Approach Revision Surgery

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DISCLOSURES

1. Royalties: Arthrex, Elsevier
2. Consultant: Arthrex
3. Miscellaneous Support: Arthrex
4. Basic Science/Research Support: Arthrex, Smith and Nephew, Ossur, Miomed, DJOrtho, Conmed Linvatech, Athletico
5. Editorial Board: Orthopedics Today (Chief Medical Editor), Journal of Shoulder and Elbow Surgery, Techniques in Shoulder and Elbow, Techniques in Sports Medicine, Sports Health, Orthopedics
6. Publisher Support: Elsevier (Textbook), Orthopedics Today
The First Rotator Cuff Surgery Fail: How to Approach Revision Surgery

- Definition of failure
- Pathophysiology
- Incidence
- Patient evaluation
- Causes of failure
What is a “Failed” Rotator Cuff Surgery?

- Patient dissatisfaction with RTC re-tear on imaging
- Patient dissatisfaction with intact cuff on imaging
  - Continued pain (source?)
  - Loss of function
  - Stiffness
Pathophysiology of Tendon Healing after Repair

- Following repair, tendon healing to bone does not re-create native histological structure.
- Interposed fibrous scar tissue is present.

Rodeo et al. JSES 2007
“Historical” Failure Rates

• Mixed tears (Open)
  – 20% failure rate in supraspinatus repairs
  – 50% failure rate in tears involving the supraspinatus plus at least one other tendon

  Harryman et al. JBJS 1991

• Large/massive tears (Arthroscopic)
  – 17/18 showed recurrent tears on U/S
  – 13/18 had recurrent tears of the same size as before surgery

  Galatz et al. JBJS-Am 2004
“Modern” Failure Rates

• Isolated supraspinatus repair
  – Five year follow-up
  – Single tendon healing rates were 70%
  – Constant score higher for healed tendons but overall patient satisfaction 93%

  Djahangiri et al. JSES 2013

  NO SIGNIFICANT CHANGE OVER 20 years?

• Approx three year follow up
  – 71% healing rate based on imaging following arthroscopic repair of supraspinatus tears
  – Healing correlated to improved functional testing

  Boileau et al. JBJS-Am 2005
Patient Evaluation

- Age of the Patient
- Comorbid Conditions
- Duration of pain
- Date of initial injury (Acute vs Chronic)
- Did symptoms improve after initial repair?
  - If so, when/how did pain begin again?
- Prior surgical details
- Rehabilitation course following prior surgery
• 408 patient with post-operative evaluation of cuff integrity by CTA or U/S
  – Found age was significantly associated with re-tear rate
    Chung et al. AJSM 2011

• Demonstrated evidence that vascularity of rotator cuff decreases with age
  – All four regions of interest in native human cuff showed decreased blood flow in patients > 40 vs. < 40 years of age
    Rudzki et al. JSES 2008
Rotator Cuff Tear and Age:
- 588 patients, Ultrasound for Shoulder Pain
  - No cuff tear: 48.7 years average
  - Unilateral tear: 58.7 years average
  - Bilateral tear: 67.8 years average
Factors Affecting Healing Rates After Arthroscopic Double-Row Rotator Cuff Repair

Robert Z. Tashjian,* ‡ MD, Anthony M. Hollins,‡ BS, Hyun-Min Kim,‡ MD, Sharlene A. Teeffy,§ MD, William D. Middleton,§ MD, Karen Steger-May,‖ MA, Leesa M. Galatz,‖ MD, and Ken Yamaguchi,‡ MD

Investigation performed at Washington University Orthopedics, Barnes-Jewish Hospital, Washington University School of Medicine, St Louis, Missouri

TABLE 3
Relationship Between Patient Factors and Tendon Healing: Multivariate Logistic Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>P</th>
<th>Adjusted Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at surgery, y</td>
<td>.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.42 (0.19, 0.92)</td>
</tr>
<tr>
<td>Years postoperative at follow-up</td>
<td>.005&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.15 (0.04, 0.56)</td>
</tr>
<tr>
<td>&gt; 1 tendon involved</td>
<td>.20</td>
<td>0.37 (0.08, 1.67)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adjusted odds ratios reflect the increased odds of healing for a 1-unit increase in the variable, after adjusting for all other variables in the model. Adjusted odds ratios for age are expressed in units of 10 years. For dichotomous variables, the category not listed is the reference category for the odds ratio. CI, confidence interval.

<sup>b</sup>Significant difference.
Outcomes of Arthroscopic Rotator Cuff Repair in Patients Aged 70 Years or Older


• RCR shown to have better results than debridement in elderly
• Limited outcome studies available, specifically with regard to
  – Age > 70
  – Arthroscopic approach
Clinical Recommendation:

Decision to operate should be based on history, physical examination, and failure to respond to conservative management,

*Not based only on patient’s age!*
Factors Predicting Rotator Cuff Retears

An Analysis of 1000 Consecutive Rotator Cuff Repairs

Predictors of Re-Tear

- Patient age
- Anteroposterior tear length
- Medial lateral tear length
- Tear size (cm$^2$)
- Tear Thickness
- Operative Time

Conclusion: A rotator cuff retear is a multifactorial process with no single preoperative or intraoperative factor being overwhelmingly predictive of it. Nevertheless, rotator cuff tear size (tear dimensions, tear size area, and tear thickness) showed stronger associations with retears at 6 months after surgery than did measures of tissue quality and concomitant shoulder injuries.
Comorbid Conditions

• **Smoking**
  – Registry data indicated significantly lower constant scores in smokers undergoing RTC repair
    • Kukkonen et al. Scand J Sci Med Sports

• **Osteoporosis**
  – Re-tear rates significantly increased in those with lower bone mineral density (even after controlling for age)
    • Chung et al. AJSM 2011
Effect of Smoking on Rotator Cuff Repairs
Mallon et al.  JSES 2004

**Table I** Mean (± SD) values before and after surgery comparing smokers and nonsmokers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Smokers</th>
<th>Nonsmokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCLA score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>15.92 ± 3.36</td>
<td>17.63 ± 4.15</td>
</tr>
<tr>
<td>Postoperative</td>
<td>25.03 ± 6.15</td>
<td>32.01 ± 3.76</td>
</tr>
<tr>
<td>Improvement*</td>
<td>9.12 ± 6.88</td>
<td>14.26 ± 5.59</td>
</tr>
<tr>
<td>Pain score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>7.60 ± 1.22</td>
<td>6.53 ± 1.59</td>
</tr>
<tr>
<td>Postoperative</td>
<td>4.24 ± 2.83</td>
<td>1.12 ± 1.69</td>
</tr>
<tr>
<td>Improvement*</td>
<td>3.36 ± 2.62</td>
<td>5.35 ± 1.94</td>
</tr>
</tbody>
</table>

*Difference of postoperative and preoperative scores.

**Table II** Frequency of smokers and nonsmokers in each category based on scoring of UCLA assessment

<table>
<thead>
<tr>
<th>Result</th>
<th>Smokers</th>
<th>Nonsmokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>14 (14.74)</td>
<td>66 (51.16)</td>
</tr>
<tr>
<td>Good</td>
<td>10 (10.84)</td>
<td>43 (33.33)</td>
</tr>
<tr>
<td>Fair</td>
<td>38 (40.00)</td>
<td>18 (13.95)</td>
</tr>
<tr>
<td>Poor</td>
<td>27 (28.42)</td>
<td>2 (1.55)</td>
</tr>
</tbody>
</table>

The Fisher exact test showed a significant difference for all categories between smokers and nonsmokers.

51% vs 15%
Comorbid Conditions

- Diabetes
  - Associated with increased re-tear rates
    - Chung et al. AJSM 2011
  - Non-randomized trial demonstrated diabetics with lower functional scores
    - Clement et al. JBJS-Br 2010
Preoperative Assessment and Setting Expectations

**IDEAL PATIENT:**
- < 65 years of age
- Non-smoker
- No diabetes
- Within 3 months of “re-injury”
- Minimal Fatty Infiltration
- ≤ 2 Tendon tear
- No Secondary Gain
Physical Exam

• Scars (open vs. arthroscopic)
• Atrophy
  – Deltoid
  – Supra/infraspinatus fossa
  – Both portend poor prognosis
    • Djurasovic et al. JBJS-Am 2001
• Infection (P. acnes)
  • Athwal et al. JSES 2007
Deltoid Deficiency
Physical Exam

• Range of motion (**Stiffness**)  
  – Active and passive  
  – Determinant of post-operative stiffness
• **AC joint** pain with cross body adduction
• **Biceps** testing/popeye deformity
• Strength testing  
  – Superior cuff  
  – External rotation lag  
  – Subscapularis
Horizontal Rotation

Internal Rotation

External Rotation
Physical Examination

- Inspection
- Palpation (AC, Biceps)
- AROM
- AAROM / Passive ROM
- Drop Arm / Lag signs
- ER Strength
- Hornblower’s
- Belly Press
- Biceps
Imaging

- Plain radiographs
  - AP (internal and external rotation), Grashey, axillary, scapular-Y

- Assess
  - Glenohumeral OA
  - Superior migration/cuff tear arthropathy
  - AC arthrosis
  - Previous hardware
Higher critical shoulder angle increases the risk of retear after rotator cuff repair

Grant H. Garcia, MD*, Joseph N. Liu, MD, Ryan M. Degen, MD, Christine C. Johnson, MD, Alexander Wong, BA, David M. Dines, MD, Lawrence V. Gulotta, MD, Joshua S. Dines, MD

**Table II** The full-thickness retear group had significantly higher critical shoulder angle (CSA) and glenoid inclination (GI) than the no retear group

<table>
<thead>
<tr>
<th>Radiographic measurement</th>
<th>Degrees (group)</th>
<th>Degrees (group)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA</td>
<td>34.3 ± 3.3 (NT)</td>
<td>35.6 ± 3.2 (PT)</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>34.3 ± 3.3 (NT)</td>
<td>38.6 ± 3.5 (FT)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>35.6 ± 3.2 (PT)</td>
<td>38.6 ± 3.5 (FT)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>GI</td>
<td>12.3 ± 2.7 (NT)</td>
<td>14.8 ± 4.2 (PT)</td>
<td>.53</td>
</tr>
<tr>
<td></td>
<td>12.3 ± 2.7 (NT)</td>
<td>17.3 ± 2.7 (FT)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>14.8 ± 4.2 (PT)</td>
<td>17.3 ± 2.7 (FT)</td>
<td>.06</td>
</tr>
</tbody>
</table>
Failed Rotator Cuff Repair + PAIN
• Gold standard in evaluation of failed cuff
• Implant artifact may impair evaluation of structures
• Sensitivity high but specificity for detecting re-tears low
  – Motamedi et al. JSES 2002
• Assess tendon location/retraction
MRI

Step 1 – Coronal T2 (Camera in Front)

- Evaluate Supraspinatus/Infraspinatus – white fluid in black tendon suggests tear
MRI

Step 2 – Axial T2 (Camera on Top)

• Evaluate Subscapularis and Biceps Tendon
MRI

Step 3 – Sagittal T1 (Camera on the Side)
• Evaluate Muscle Quality – T1 – Fat is White = BAD
MRI

• Muscle quality important determinant of function after revision surgery
  • Gladstone et al. AJSM 2007
• Goutallier et al. CORR 1994 (CT Scan based)
  – Stage 0: Normal muscle
  – Stage 1: Some fatty streaks
  – Stage 2: Less than 50% fatty atrophy
  – Stage 3: 50% fatty atrophy
  – Stage 4: Greater than 50% fatty atrophy
MRI

- White Area = Fat
- Gray Area = Muscle Tissue

- Atrophy
- Normal Muscle
Massive Cuff Tear
Imaging Findings
Suggestive of Irreparability

- Medial/lateral tear size
- Retraction to glenoid rim
- Fatty infiltration
- Superior migration of humeral head

- Supraspinatus Fatty index > 3
- Coronal oblique tear distance > 31mm
- Sagittal oblique tear distance > 32 mm

*Dwyer et al., KSSTA, 2013*

*Yoo et al., Arthroscopy, 2009*
Fatty Infiltration

- Functional outcomes at final long term follow-up were significantly worse for patients with increased fatty degeneration
  - Goutallier et al. JSES 2009

- Tendon length
  - Tendon length and association with fatty infiltration examined
  - Tendon length >15mm associated with lower re-tear rates; less fatty infiltration improved results
  - Meyer et al. AJSM 2012
Set Expectations…

Pain relief: 85%
Patient Satisfaction: 85%

But…

One Tendon Tear
15 – 25% Re-tear rate

Two Tendon Tear
30 – 50% Re-tear rate

Three Tendon Tear
>50% Re-tear rate

Function = Tendon Healing
Integrity of Cuff Repairs
Harryman, et al JBJS 1991

5 year follow-up

- One tendon tears: 80% intact
- Two tendon tears: > 50% with defect
- Most comfortable / satisfied with result

*Intact cuff = better function*
Failed Rotator Cuff Repair
Recognize Tear Patterns

• Crescent
• “L” or “Reverse “L”
• U-Shaped

Curtis, Burbank, Tierney, Scheller, Curran
The insertional footprint of the rotator cuff: An anatomic study
Massive & Contracted Tears (Subscapularis, Supra, Infra)

*Keys to anatomic repair*

1. Begin with restoring subscapularis to lesser tuberosity
2. Infraspinatus to its anatomic position at the upper border of the bare area
3. Repair the supraspinatus according to tear pattern (crescent, L-shaped, or reverse L-shaped) with double row suture bridge

Transosseous Equivalent: 
SpeedBridge
Technical Factors

• Inadequate fixation
  – TOE technique shown to have superior contact pressure at footprint vs. DR
  – TOE also with 50% greater load to failure vs. DR
    • Park et al. JSES 2007
  – Animal study demonstrated improved biomechanical characteristics for TOE vs. DR vs. SR following repair and healing in rabbit model
    • Quiqley et al. JOR 2013
Other/Missed Diagnosis

- Biceps pathology
  - Chen et al. J Trauma 2005
- AC arthritis
- Suprascapular neuropathy
- Subscapularis tear
- Impingement
- Labral pathology
- Cervical disease
Ancillary procedures

- Acromioplasty
- Distal Clavicle Resection
- Biceps Tenodesis
- Suprascapular Nerve decompression
The Role of Subacromial Decompression in Patients Undergoing Arthroscopic Repair of Full-Thickness Tears of the Rotator Cuff: A Systematic Review and Meta-analysis


*Arthroscopy. 2012 May;28(5):720-7.*

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Inclusion Criteria*</th>
<th>Details of Surgery</th>
<th>Sample Size (% Male)</th>
<th>Mean Age (yr)</th>
<th>Follow-Up Rate (%)</th>
<th>Follow-Up (Range) (mo)</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gartsman and O’Connor, 2004</td>
<td>Level I randomised</td>
<td>Isolated full-thickness repairable supraspinatus tears Type II acromion</td>
<td>Arthroscopic repair</td>
<td>93 (55)</td>
<td>59.7</td>
<td>100</td>
<td>15.6 (12.3-18.9)</td>
<td>ASES</td>
</tr>
<tr>
<td>Milano et al., 2007</td>
<td>Level I randomised</td>
<td>Full-thickness tear in ≥1 tendons Type II or III acromion</td>
<td>Arthroscopic repair</td>
<td>80 (55)</td>
<td>60.4</td>
<td>88.75</td>
<td>24</td>
<td>Constant DASH Work-DASH</td>
</tr>
<tr>
<td>Macdonald et al., 2011</td>
<td>Level I randomised</td>
<td>Full-thickness tear in ≥4 cm in ≥1 tendons Type I, II, or III acromion</td>
<td>Arthroscopic repair</td>
<td>86 (65)</td>
<td>56.8</td>
<td>79.1</td>
<td>24</td>
<td>WORC ASES</td>
</tr>
<tr>
<td>Tetteh et al., 2011</td>
<td>Level I randomised</td>
<td>Full-thickness tear of ≥1 tendons Type I, II, or III acromion Compensation patients not excluded</td>
<td>Arthroscopic repair</td>
<td>114 (66)</td>
<td>57.8</td>
<td>33.3</td>
<td>12</td>
<td>Constant ASES SST Visual analog scale for pain Range of motion</td>
</tr>
</tbody>
</table>

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; SST, Simple Shoulder Test. *Workers’ Compensation patients excluded in all trials except for that of Tetteh et al.
4 RCT including 1 abstract (Tetteh et al.)

**Constant Rate of Repeat Surgery**

**ASES**

**Arthroscopy. 2012 May;28(5):720-7.**
Fewer rotator cuff tears fifteen years after arthroscopic subacromial decompression

Hanna Björnsson, MD\textsuperscript{a,*}, Rolf Norlin, MD\textsuperscript{b}, Anders Knutsson, MD\textsuperscript{c}, Lars Adolfsson, MD\textsuperscript{a}

- Evaluated 70 patients 15 years post acromioplasty, mean age 60
- 82% intact, 14% partial tears, 4% full thickness tears
- Overall lower rate than expected age matched controls

Table I: Patient demographics in relation to rotator cuff status

<table>
<thead>
<tr>
<th>Rotator cuff status</th>
<th>No.</th>
<th>F</th>
<th>M</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>57</td>
<td>30</td>
<td>27</td>
<td>60</td>
<td>38-80</td>
</tr>
<tr>
<td>PTT</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>60</td>
<td>41-78</td>
</tr>
<tr>
<td>FITT</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>64</td>
<td>58-67</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>38</td>
<td>32</td>
<td>60</td>
<td>38-80</td>
</tr>
</tbody>
</table>

F, Female; FITT, full-thickness tear; M, male; PTT, Partial-thickness tear.

Clinical follow-up

- Intact rotator cuff (82%)
- Partial-thickness tear (14%)
- Full-thickness tear (4%)
Revision Versus Primary Arthroscopic Rotator Cuff Repair

A 2-Year Analysis of Outcomes in 360 Patients

Aminudin Shamsudin,* MD, MMed(Ortho), Patrick H. Lam,* PhD, Karin Peters,* MD, Imants Rubenis,* Lisa Hackett,* AMS, and George A.C. Murrell,*† MD, DPhil

Investigation performed at the Orthopaedic Research Institute, St George Hospital Campus, University of New South Wales, Sydney, New South Wales, Australia

Early results promising, but...

Twice as likely to re-tear at 2 year follow-up.

Re-tears correlated with worse results
Impossible to repair?
Side-to-Side Repair
Repaired! But, will it heal?
Biologic Augmentation?
TISSUE AUGMENTATION?

What is the role for:

- Patch reinforcement or extension?
- SCR?
Successful
(Failed) Rotator Cuff Surgery…

1. Preop Assessment / Expectations
2. Surgical Preparation of Repair
3. Surgical Technique
4. Ancillary Procedures
5. Postoperative Rehabilitation
Thank you!