### Introduction

- Disorder of rotator cuff or associated issues is the most common problem of the shoulder.
- Prevalence of full-thickness rotator cuff tear varied widely (50%–60%).
- Over 270,000 rotator cuff repairs were performed in the US in 2006.
- Despite high satisfaction rates reported by patients with good-to-excellent clinical outcomes, many patients still experience functional limitations.
- Biomechanical studies have shown improved repair strength of rotator cuff anchorfootprint, decreased gap formation under cyclic loading, and increased load to failure with double-row (DR) repair compared to single-row (SR) repair.
- However, clinical evidence is needed to study the effect of repair technique on patients with a recurrent rotator cuff tear.
- Purpose: To study the effect of SR versus DR rotator cuff repair on functional outcomes in a prospective randomized design.

### Methods

- 49 patients were randomized and underwent pre-op baseline testing.
- Inclusion criteria: patient with full-thickness rotator cuff tear amenable to SR or DR repair, willingness to be randomized, ability to comply with standard PT.
- Exclusion criteria: tear size ≤1 mm, revision procedure, trochanteric changes in tendon, neurological involvement.
- The following outcome measures were collected at pre-operative testing and long-term follow-up:
  - Standard outcome scores: ASES score, Penn score, Simple Shoulder Test
  - Range of motion (ROM): forward flexion, abduction, external rotation (ER) at 0° and 90° abduction
  - Strength: full arm, empty arm, ER at 0° and 90° abduction at 10°
  - Clinical tests: Neer impingement, O'Brien test, external rotation drop arm, O'Brien active compression

- Surgical methods:
  - SR repair: modified MasonAllen stitch using 5-0 BioCorTech anchors and suture
  - DR repair: modified suture bridge technique using 5-0 BioCorTech anchors for medial row, 3.5 mm Pushback anchors for lateral row

- Intraoperative findings were recorded, including rotator cuff tear size, concomitant pathology and procedure, and number of anchors.

### Results

#### Table 1: Operative findings.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DR</th>
<th>SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Range</td>
<td>4-12</td>
<td>4-10</td>
</tr>
<tr>
<td>Root Sign</td>
<td>12/6</td>
<td>12/6</td>
</tr>
<tr>
<td>Lift Off</td>
<td>6/6</td>
<td>6/6</td>
</tr>
<tr>
<td>External Rotation</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Shoulder Lift</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td>ABD,internal rotation (ER)</td>
<td>8/8</td>
<td>8/8</td>
</tr>
<tr>
<td>ABD, external rotation (ER)</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>ABD, external rotation (ER)</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td>ABD, external rotation (ER)</td>
<td>1/1</td>
<td>1/1</td>
</tr>
</tbody>
</table>

#### Table 2: Special shoulder tests prior to and at final follow-up.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Single Row</th>
<th>Double Row</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASES score</td>
<td>82/100</td>
<td>87/100</td>
<td>0.09</td>
</tr>
<tr>
<td>Penn score</td>
<td>95/100</td>
<td>98/100</td>
<td>0.09</td>
</tr>
</tbody>
</table>

#### Table 1: Shoulder passive ROM tests.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Single Row</th>
<th>Double Row</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR</td>
<td>162° ± 10°</td>
<td>162° ± 10°</td>
<td>0.51</td>
</tr>
<tr>
<td>ER</td>
<td>65° ± 10°</td>
<td>65° ± 10°</td>
<td>0.36</td>
</tr>
<tr>
<td>ABD</td>
<td>90° ± 10°</td>
<td>95° ± 10°</td>
<td>0.08</td>
</tr>
<tr>
<td>ABD</td>
<td>80° ± 10°</td>
<td>85° ± 10°</td>
<td>0.09</td>
</tr>
</tbody>
</table>

#### Table 2: ASES Scores Treatment x Time

<table>
<thead>
<tr>
<th>Time</th>
<th>Single Row</th>
<th>Double Row</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mo</td>
<td>42/100</td>
<td>51/100</td>
<td>0.09</td>
</tr>
<tr>
<td>6 mo</td>
<td>71/100</td>
<td>76/100</td>
<td>0.09</td>
</tr>
<tr>
<td>12 mo</td>
<td>80/100</td>
<td>83/100</td>
<td>0.09</td>
</tr>
</tbody>
</table>

#### Figure 1: Functional outcome scores prior to and after surgery (A) ASES Scores Treatment x Time p<0.001, Treatment x Time x PostOp p<0.001. (B) Abduction strength effect of Time p=0.01, Treatment x PostOp p<0.001. (C) External rotation strength effect of Time p=0.01, Treatment x PostOp p<0.001. (D) ASES Scores Treatment x Time x PostOp p<0.001.

- Functional outcome scores did not differ between SR and DR groups prior to surgery (p=0.19–0.91).
- All 4 outcome scores improved substantially at final follow-up (p<0.001), with similar improvements in SR versus DR groups (Figure 1A–C).
- At final follow-up, no difference was in the outcome scores between SR and DR groups (p=0.11–0.76).
- Shoulder strength improved dramatically for all 4 tests from pre-op to final follow-up (Figure 2A–D).
- Strength improvements were not different between single and double-row groups (p=0.23–0.77).
- Greater shoulder flexion ROM at follow-up was associated with better ASES (r=0.37, p=0.005) and Penn (r=0.40, p=0.005) scores.
- External rotation ROM at neutral follow-up was correlated with Penn score (r=0.35, p<0.05).
- All patients with SR group had excellent outcomes compared to the rest of patients on ASES (71/12 vs. 52/11, p<0.002) and Penn (79/15 vs. 91/15, p=0.001) scores.

#### Discussion

- Excellent outcomes in both SR and DR groups, with no difference in outcome scores between groups.
- No difference between SR and DR repairs confirmed findings of other prospective randomized trials.
- Patients after DR repair had less of IR ROM, which may be due to overconstrainting of anterior glenohumeral joint.
- Intraoperative finding of SLAP tear was associated with worse outcomes.

#### Conclusion

- Single-row repairs for full-thickness rotator cuff tear had excellent outcomes comparable to double-row repairs.

### References

- Allen stitch using 5-0 BioCorTech anchors and suture
- Modified suture bridge technique using 5-0 BioCorTech anchors for medial row, 3.5 mm Pushback anchors for lateral row
- Standard outcome scores: ASES score, Penn score, Simple Shoulder Test
- Range of motion (ROM): forward flexion, abduction, external rotation (ER) at 0° and 90° abduction
- Strength: full arm, empty arm, ER at 0° and 90° abduction at 10°
- Clinical tests: Neer impingement, O'Brien test, external rotation drop arm, O'Brien active compression
- Surgical methods:
- SR repair: modified MasonAllen stitch using 5-0 BioCorTech anchors and suture
- DR repair: modified suture bridge technique using 5-0 BioCorTech anchors for medial row, 3.5 mm Pushback anchors for lateral row
- Intraoperative findings were recorded, including rotator cuff tear size, concomitant pathology and procedure, and number of anchors.
- Statistics:
  - Mixed-model ANOVA (time x treatment) for effect of SR vs. DR on outcome scores, ROM, and strength
  - Independent t-tests or chi-square analysis for differences between SR vs. DR groups
  - Wilcoxon signed-rank tests for improvement in clinical shoulder tests
  - Power analysis: 30 patients per group needed to detect 10% difference in improvement in ASES scores between groups at a level of 0.05 with 80% power
- 36 patients were followed up at 26±18 ms after surgery (range 7-78 yr).
- Patients with SR repairs (4 women, 12 men) were older (55±18 yr vs. 51±18 yr, p=0.05) and heavier (BR 73.1±9.9 kg vs. 76.9±13.3 kg, p=0.05) than SR patients (9 women, 11 men), but not different in height (1.76±0.9 m vs. 1.76±1.1 m, p=0.08).
- Tear size and concomitant pathology did not differ between SR and DR groups, however number of anchors used for rotator cuff repair was significantly higher in DR compared to SR group (Table 1).
- All clinical tests, except the IR test-off, improved from pre-op to follow-up (Table 2).
- Prior to surgery, passive shoulder ROM was not different between the groups (Table 2).
- IR ROM significantly improved from pre-op to final follow-up (p<0.05) with no difference between SR and DR groups.
- Patients with SR repairs had loss of DR ROM at 0° abduction while patients with SR repairs improved slightly from pre-op to final follow-up (Time x treatment p<0.001). This effect was not apparent for ER ROM at 90° abduction (p=0.22).
- Prior to surgery, passive shoulder ROM was not different between the groups (Table 2).
- IR ROM significantly improved from pre-op to final follow-up (p<0.05) with no difference between SR and DR groups.
- Patients with SR repairs had loss of DR ROM at 0° abduction while patients with SR repairs improved slightly from pre-op to final follow-up (Time x treatment p<0.001). This effect was not apparent for ER ROM at 90° abduction (p=0.22).
- Prior to surgery, passive shoulder ROM was not different between the groups (Table 2).
- IR ROM significantly improved from pre-op to final follow-up (p<0.05) with no difference between SR and DR groups.
- Patients with SR repairs had loss of DR ROM at 0° abduction while patients with SR repairs improved slightly from pre-op to final follow-up (Time x treatment p<0.001). This effect was not apparent for ER ROM at 90° abduction (p=0.22).