Double Row Repair: Is it Worth the Hassle?

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Abstract: In the operative management of rotator cuff disease, comparable functional results have been reported after open or mini-open repair and arthroscopic fixation. Surgical repair aims to re-establish an anatomical configuration of the tendon-bone construct for restoring its mechanical performance. Single row repair is the most commonly used technique, but recently some authors have proposed to re-establish the rotator cuff footprint with 2 rows of suture anchors (“double row” repair). In regard to imaging assessment, at time zero double row repair results being more anatomic and allows for structurally sound restoration of the rotator cuff footprint. However, this does not seem to translate into superior clinical outcomes for the double row repair when evaluating all different sizes of rotator cuff tears as a whole. The scientific basis for recommending single or double row repair as preferred treatment for patients with rotator cuff tear is questionable, as minimal differences have been measured on clinical and functional rating scales.

Keywords: rotator cuff tear, arthroscopic rotator cuff repair, suture anchor, double, row repair, single, row repair


BACKGROUND

Rotator cuff disease is a multi-factorial pathology responsible for pain and disability of the shoulder.1 Surgical repair is the gold standard in patients unresponsive to conservative management, resulting in good and excellent functional and clinical outcomes. In the last 2 decades,2,3 comparable functional results have been observed in patients undergoing open, mini-open, and arthroscopic repair.4–10 Nevertheless, higher occurrence of failure (repair) has been noted after arthroscopic repair than open surgery.11,12 Arthroscopic repair is associated with lower postoperative morbidity, less pain, less impairment of deltoid function, and better cosmetic appearance.13–16 On the other hand, structural failure, inadequate healing, and re-tears may be observed after arthroscopy.11,17–19

When failure occurs, tear grading, quality of the tendon, and knot loosening have to be assessed,20–22 considering that the failure is more frequent at the suture-tendon interface, where the mechanical pressure and biomechanical loads acting on the new construct are considerably increased.23 The Mason-Allen is the strongest suture configuration,24 whereas simple and mattress sutures alone may not be able to maintain the tendon-bone contact. Surgical repair aims to re-establish the anatomical continuity of the tendon-bone construct and restore the native mechanical properties. To obtain this, different configurations and types of sutures have been used and biomechanically tested.7 At present, single row is the most frequently used repair, with suture anchors disposed in 1 row over the humeral head, at the native site of insertion of the tendon.1,3,17,20,24–28 As single row repair may result in an inadequate contact between the tendon and the bone, healing may be incomplete11 and the mechanical stability of the construct may be compromised.20

To better re-establish the rotator cuff footprint, a 2-row configuration of the suture anchors (“double row” repair) has been introduced. Placing the anchors along the medial articular margin and the lateral aspect of the greater tuberosity, a larger area of insertion of the tissue over the greater tuberosity allows restoring the anatomic footprint of the rotator cuff.7,29–31 Even though this novel configuration may provide good clinical results, the real benefits related to the placement of a second row of anchors are still uncertain.

SURGICAL TECHNIQUE

In single row repairs, the anchors are disposed in a linear fashion, close to the lateral aspect of the footprint. In the “double row” configuration, 2 rows of suture anchors are placed over the articular cartilage margin of the anatomic neck (medial) and along the lateral edge of the tuberosity (lateral) to better restore the native rotator cuff footprint. Usually, a mattress configuration is used to tie the medial suture anchors, and a simple configuration is performed for the lateral anchors.7

Single Row Repair (Figs. 1, 2)

In the context of the single row repair, different techniques have been described:

(a) The single row anchor-simple (SRA-s) repair is 1 line simple stitch repair, achieved using 2 double-loaded suture anchors; (b) a single row anchor-mattress (SRA-m) provides a horizontal mattress stitch repair, performed using 1 line of 2 double-loaded suture anchors; (c) the single row arthroscopic Mason-Allen configuration (SRAma) is obtained by placing 1 line of 2 double-loaded suture anchors.

Double Row Repair (Figs. 3, 4)

A double row anchor-simple mattress (DRA-sm) is performed by lining up 4 suture anchors in 2 lines, to obtain a combined simple suture stitch (lateral/double-loaded) and...
horizontal mattress fashion stitches (medial/single-loaded) repair.

In the double row anchor-arthroscopic Mason-Allen mattress (DRA-amam), an arthroscopic Mason-Allen (lateral/double-loaded) and horizontal mattress stitches (medial/single-loaded) repair are combined, and 4 suture anchors are disposed in 2 lines.\textsuperscript{17,32}

Concerning the suture bridges technique, medial anchors are fixed laterally, and the suture is bridged over the tendon. This type of the suture distributes the pressure on the footprint, improves the tendon-bone contact area and the force of the repair, and provides a low-profile repair.\textsuperscript{33,34}

The Roman Bridge is a transosseous-equivalent arthroscopic repair, which optimizes the benefits of the double pulley and suture bridge configurations, increasing the rotator cuff tendon-footprint contact area with a medial row anchor system.\textsuperscript{6,32}
BIOMECHANICAL RESULTS
Almost all biomechanical studies have shown better mechanical results after a double row than a single row or a transosseous repair. Compared with the single row repair, the double row improves mechanical stability, with 42% lesser gap formation, 46% greater stiffness, 48% greater ultimate load to failure.

Ma et al13 comparing 3 different configurations of stitch for single row and double row repair, found higher tensile loads (up to 287 ± 24 N) after double row fixation (P < 0.05).

Kim et al35 found a lower gap formation after a double row than a single row repair, at the first (1.67 ± 0.75 mm vs. 3.10 ± 1.67 mm) and last (3.58 ± 2.59 mm vs. 7.64 ± 3.74 mm) cycle of tensile test. Smith et al36 found that double row repair is significantly more resistant to gap formation under static loading (5.0 ± 1.2 mm vs. 3.8 ± 1.4 mm, P < 0.05) than single row repair. Increased strength (332 N vs. 244 N, P = 0.001) and stiffness (81 N/mm vs. 55 N/mm, P = 0.001),37 and higher resistance to elongation38 have been noted in shoulders undergoing double row repair (2 medial anchors with modified Mason-Allen technique and 2 lateral knotless anchors).

In a biomechanical study, Ahmad et al39 found a significantly lower (P = 0.0109) gap formation, especially in internal rotation, after double row repair than single row.

Double row fixation produces a higher resistance to cycles, higher tensile strength (P = 0.001), lower frequency of gap formation (P = 0.135), higher contact pressure (highest in DRA-amam), higher load to failure (397.7 ± 7.4 N, P < 0.001), and higher stiffness (162 ± 7.3 N/mm) than single row.17,32,40

In a biomechanical analysis of single row, transosseous, and double row fixation, Waltrip et al41 noted the highest number of cycles to failure after a double row fixation with medial anchors augmented using a transosseous lateral technique.

The transosseous equivalent technique exhibited no significantly different stiffness or gap formation compared with double row fixation,42 restored the footprint from 75% to 150%, produced a cyclic creep similar to intact cuffs, with an ultimate load to failure around 500 N.43

Considering the highest ultimate load between 350 and 400 N, transosseous equivalent repairs are considerably resistant to rotational and shear forces, and can restore the native footprint. Moreover, even though double row repair better restores the native footprint than the single row fixation, with a minimal gap formation, the clinical relevance arising from these findings is questionable.

Double row repair, covering 100% of the original footprint, restores the native cuff anatomy better than transosseous and single row44 and provides the largest repair area,28 and the greatest contact area (42% greater than transosseous technique P < 0.0001 and 60% greater than SR), with a contact pressure over the footprint inferior to that noted after transosseous repair.43 From these findings, double row and transosseous repair seem to provide the optimal conditions, which favor the bone tendon healing.45

Sano et al46 hypothesized that the high stress concentration at the anchor site may be responsible for re-tearing after single and double row repair.

On the contrary, Park et al47 found a greater contact and a higher distribution of the pressure acting on a defined footprint when performing a transosseous tunnel technique. Mazzocca et al48 showed a similar gap formation and comparable values of load to failure for single and double row fixation, regardless of the type of sutures, even though the double row configuration restores the footprint in a more anatomic fashion.

Concerning the evidence that single row repair provides better results than double row fixation, the biomechanical study by Barber et al49 demonstrated that a triple-load single row configuration is stronger compared with other fixation systems.

In addition, Zhang et al50 showed that a double row repair is significantly less strong (P < 0.05) than a trans-tendon single row fixation in terms of cycling loading, tensile testing to failure, gap formation, stiffness, failure load, and strain over the footprint area.

CLINICAL RESULTS (Tables 1, 2)
Aydin et al51 in a prospective cohort study on 68 patients (34 single row, 34 double row) found no significantly different constant scores between single row and double row groups at a minimum 1-year follow-up (postoperative constant score: 82.2 and 78.8, respectively).

These results were also confirmed by Burks et al52 in a randomized clinical study on 40 patients (20 single row, 20 double row).

Although Sugaya et al,57 Charousset et al,53 and Pennington et al56,58 detected different healing rates at imaging assessment, there were no significantly different clinical and functional outcomes.

In a retrospective study by Sugaya et al,57 the patients who had undergone single row and double row were similar for subjective functional outcomes, American Shoulder and Elbow Surgeons Score (ASES) and University of California at Los Angeles score (UCLA) scores, but the integrity of the cuff, as assessed by magnetic resonance imaging (MRI) was significantly better when performing the double row configuration.

On the other hand, although Charousset et al53 found no significantly different clinical results and tendon healing rates, but the double row resulted in a superior “anatomic” healing.

When comparing results in patients with tears from 2.5 to 3.5 cm, Pennington et al56 found comparable ASES (86.9 in single row and 91.6 in double row) and UCLA (29.6 in single row and 29.3 in double row) scores, but the imaging assessment showed a significantly improved healing for the double row group (P ≤ 0.03).

Indeed, Park et al55 observed that patients with large-to-massive tears (>3 cm) had significantly higher ASES (P = 0.01) and constant (P < 0.01) scores after a double row than a single row fixation.

Franceschi et al50 demonstrated that the double row technique better restores the anatomical rotator cuff footprint and gives a stronger construct compared with the single row, but these biomechanical superiority does not reflect a significant clinical improvement (UCLA score: 32.9 in single row and 33.3 in double row).

A recently prospective randomized clinical trial54 reporting on patients with medium-to-large rotator cuff tears showed no clinical difference between a double row repair performed using an additional medial suture anchor and a single row repair containing 2 lateral suture anchors.

DISCUSSION
Although the evidence suggests little difference between various modalities of repair of rotator cuff tears, the short
term benefits have contributed to the great popularity of arthroscopy in the management of such ailments. From the comparison between single and double row techniques, there is minimal difference in clinical and functional outcomes, and there is no scientific evidence to prefer the single or double row repair. Double row fixation

<table>
<thead>
<tr>
<th>Author</th>
<th>Tear Size</th>
<th>Tear Shape</th>
<th>Anchor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aydin et al⁵¹</td>
<td>All less than 3 cm (small medium tears)</td>
<td></td>
<td>Bio-anchors loaded with No. 2 Fiberwire sutures (SR); knotless anchors (Push Lock Anchor) DR</td>
</tr>
<tr>
<td>Burks et al⁵²</td>
<td>SR: 18 tears from 1-3 cm, 2 larger than 3 cm; DR: 15 tears from 1-3 cm, 3 larger than 3 cm</td>
<td>SR: 12 crescent lesions, 4 L-shaped lesions, 10 U-shaped lesions; DR: 14 crescent lesions, 6 L-shaped lesions, 6 U-shaped lesions</td>
<td>Bio FT anchors; 2.25 in SR and 3.2 in DR</td>
</tr>
<tr>
<td>Charousset et al⁵³</td>
<td>SR: 18 tears from 3-5 cm, 8 larger than 5 cm; DR: 21 tears from 3-5 cm, 5 larger than 5 cm</td>
<td>SR: 20 crescent lesions, 7 L-shaped lesions, 5 inverse L tear, 5 V-shaped, 0 U-shaped lesions; DR: 15 crescent lesions, 4 L-shaped lesions, 5 inverse L tear, 9 V-shaped, 2 U-shaped lesions</td>
<td>Panalok in SR; Panalok, Cuff Tack in DR</td>
</tr>
<tr>
<td>Franceschi et al⁵</td>
<td>SR: 18 tears from 3-5 cm, 8 larger than 5 cm; DR: 21 tears from 3-5 cm, 5 larger than 5 cm</td>
<td>SR: 20 crescent lesions, 7 L-shaped lesions, 5 inverse L tear, 5 V-shaped, 0 U-shaped lesions; DR: 15 crescent lesions, 4 L-shaped lesions, 5 inverse L tear, 9 V-shaped, 2 U-shaped lesions</td>
<td>Bio-corkscrew double loaded with No. 2 Fiberwire; 1.9 (range, 1-2) in SR and 2.3 (range, 2-4) in DR</td>
</tr>
<tr>
<td>Koh et al⁵⁴</td>
<td>All from 2-4 cm</td>
<td>U-shaped and crescent</td>
<td>First 11 cases in the SR group and 13 cases in the DR group; Corkscrew Suture Anchor Later cases: Bio-Corkscrew Suture Anchor</td>
</tr>
<tr>
<td>Park et al⁵⁵</td>
<td>SR: 25 tears less than 3 cm, 15 larger than 3 cm; DR: 21 tears less than 3 cm, 17 larger than 3 cm</td>
<td></td>
<td>DR: Twinfix Ti for medial row and Super Revo for lateral row; SR: anchor randomly selected between the 2 types</td>
</tr>
<tr>
<td>Pennington et al⁵⁶</td>
<td>All between 1.5 and 4.5 cm</td>
<td></td>
<td>SR: Bio-corkscrew double loaded with No. 2 Fiberwire; DR: Medial row: Bio-corkscrew single loaded with No. 2 Fiberwire; Lateral row: Push Lock bioabsorbable anchors 2.4 (range, 1-3) in SR and 3.2 (range, 2-5) in DR</td>
</tr>
<tr>
<td>Sugaya et al⁵⁷</td>
<td>SR: 6 tears less than 1 cm, 17 from 1-3 cm, 14 from 3-5 cm, 2 larger than 5 cm; DR: 10 tears less than 1 cm, 17 from 1-3 cm, 11 from 3-5 cm, 3 larger than 5 cm</td>
<td></td>
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</tbody>
</table>

**TABLE 2. Patient Features and Type of Studies**

<table>
<thead>
<tr>
<th>Type of Study</th>
<th>Mean Follow-up (mo)</th>
<th>Preoperative Symptoms (mo)</th>
<th>Mean Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aydin et al⁵¹</td>
<td>Prospective cohort study</td>
<td>36 (24-40)</td>
<td>59 (40-60) in SR; 57 (36-67) in DR</td>
</tr>
<tr>
<td>Burks et al⁵²</td>
<td>Randomized clinical study</td>
<td>12</td>
<td>16.8 (1-144)</td>
</tr>
<tr>
<td>Charousset et al⁵³</td>
<td>Prospective cohort study</td>
<td>27.6 (SR), 28.7(DR)</td>
<td>11.9 (SR); 14.7 (DR)</td>
</tr>
<tr>
<td>Franceschi et al⁵</td>
<td>Randomized clinical study</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>Koh et al⁵⁴</td>
<td>Prospective randomized clinical trial</td>
<td>31.0 (24-44) in SR, 32.8 (24-42) in DR</td>
<td>17.4 mo (range, 6-84 mo) 61.3 (43-78)</td>
</tr>
<tr>
<td>Park et al⁵⁵</td>
<td>Prospective cohort study</td>
<td>25.1 (22-30)</td>
<td></td>
</tr>
<tr>
<td>Pennington et al⁵⁶</td>
<td>Case control study</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Sugaya et al⁵⁷</td>
<td>Case control study</td>
<td>41.3 (24-60) in SR, 28.2 (24-53) in DR</td>
<td>57.7 (34-72) in SR; 58.1 (36-73) in DR</td>
</tr>
</tbody>
</table>
is superior to single row repair in load to failure, cyclic displacement, and gap formation, \(^{35,39}\) but many downsides have been observed after double row fixation, \(^{50}\) including the high tension imparted on the tendon, \(^{61}\) which may result in overloading and failure of the fixation. Compared with single row, double row repairs completely reconstitute \(^48\) and cover the footprint area, \(^7,30,62\) better promote tendon healing and recovery of strength. \(^7,30,37\) The fact that imaging postoperative re-tear rates are higher after single row repairs reflects that re-establishing the footprint may play a key role in the anatomic healing process, \(^33,36,37\) without exerting relevant effects on clinical and functional outcomes of the operated patients. A recently published meta-analysis \(^63\) confirms that double row is superior to single row repair only for tendon healing and postoperative external rotation, but the impact on function, muscle strength, satisfaction, and loss of working days is not so different. Even though Pennington et al found an overall higher MRI healing rate in patients undergoing single row repair, double row fixation resulted in a significantly superior imaging healing in managing tears from 2.5 to 3.5 cm of size \(\left(P \leq 0.03\right)\). \(^{56,58}\) Although single and double row arthroscopic repair are comparable for postoperative ASES, UCLA, and constant scores, comparing subset of patients with large-to-massive tears \((>3\) cm), higher ASES \((P = 0.01)\), and constant \((P < 0.01)\) scores have been reported when performing a double row instead of a single row fixation. \(^{65}\)

On the basis of MRI findings, the double row repair is a more anatomic construct, which better restores the native structures of the rotator cuff footprint. However, this does not seem to translate into superior clinical outcomes, except for large-to-massive tears \((>3\) cm), in which the double row technique provides better clinical outcomes compared with the single row.

### CONCLUSIONS

For the time being, better mechanical properties at time zero are not indicative of better clinical outcomes. \(^{64,65}\) The double row repair requires more anchors, \(^66\) greater operating time, \(^66\) increased costs, \(^66\) and a demanding learning curve. On the other hand, the single row repair is simpler to be performed and is a suitable arthroscopic technique. \(^{66}\) Therefore, the circumstances in which the double row technique is truly indicated have to be better defined.

### REFERENCES


