Single-Versus Double-Row Arthroscopic Rotator Cuff Repair in Massive Tears

Background: It is a challenge for orthopaedic surgeons to treat massive rotator cuff tears. The optimal management of massive rotator cuff tears remains controversial. Therefore, the goal of this study was to compare arthroscopic single- versus double-row rotator cuff repair with a larger sample size.

Material/Methods: Of the subjects with massive rotator cuff tears, 146 were treated using single-row repair, and 102 were treated using double-row repair. Pre- and postoperative functional outcomes and radiographic images were collected. The clinical outcomes were evaluated for a minimum of 2 years.

Results: No significant differences were shown between the groups in terms of functional outcomes. Regarding the integrity of the tendon, a lower rate of post-treatment retear was observed in patients who underwent double-row repair compared with single-row repair.

Conclusions: The results suggest that double-row repair is relatively superior in shoulder ROM and the strength of tendon compared with single-row repair. Future studies involving more patients in better-designed randomized controlled trials will be required.

MeSH Keywords: Arthroscopy • Outcome Assessment (Health Care) • Rotator Cuff

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**Background**

Arthroscopic techniques and instrumentation have developed rapidly and various techniques have been introduced for the treatment of rotator cuff tears. Due to decreased short-term pain and a somewhat cosmetic effect, arthroscopic repair is more popular than open repair [1–3].

Maintaining the integrity of the tendon is the primary goal of rotator cuff repair management strategies. Most studies have also shown improved clinical outcomes after repair, and small and medium-sized rotator cuff tears have been commendably performed with any repair management strategy in most cases. Recently, biomechanical studies have shown that the double-row repair procedure is superior for improving the pressurized contact area and the mean pressure between the tendon and footprint compared with the single-row repair procedure [4,5].

However, there is still controversy regarding the optimal management of massive rotator cuff tears (MRCTs) [6–8]. MRCTs are those in which the length of the greatest diameter of the tear measures more than 5 cm [9] or those that involve at least 2 tendons [10]. Charoussset et al. [11] reported better tendon healing rates with double-row repairs compared with single-row repairs but did not observe any significant difference in the clinical results. However, a recent comparative study [12] showed significantly greater functional outcomes in patients with large-to-massive tears that were treated with double-row repair compared with single-row repair. The sample size and duration of follow-up were the limitations of these studies. Due to these limitations, there may be a lack of strong evidence showing that either single- or double-row repair is superior.

Because of the controversy described above, we performed this study to address the question of whether double-row repair gives results that are superior to those obtained using single-row repair in terms of the integrity of the tendon and clinical outcomes for the treatment of MRCTs with a large sample size.

**Material and Methods**

This study was approved by our Institutional Review Board. From 2006 to 2012, 1137 patients underwent arthroscopic repair of rotator cuff tears. A total of 248 patients were included in the study. Single-row repair was performed in 146 patients, and double-row repair was used in 102 patients. The inclusion criteria were as follows: (1) a massive rotator cuff tear with preoperative magnetic resonance imaging (MRI) and arthroscopic evidence; (2) which persisted through non-operative treatment for more than 3 months with poor outcome; and (3) no previous history of fractures or operations on the affected shoulder. Patients were excluded if they had the following: (1) rotator cuff tears less than a diameter of 5 cm; (2) ipsilateral shoulder pathology; (3) glenohumeral osteoarthritis detected on radiographs; (4) a follow-up of less than 24 months; and (5) an inability to answer the questionnaires or undergo the rehabilitation treatment.

Clinical evaluations were conducted on all patients preoperatively and 2 years postoperatively. The data were collected by an orthopaedic surgeon using the VAS, range of motion (ROM), the Constant score, the American Shoulder and Elbow Surgeons (ASES) score, and the University of California, Los Angeles (UCLA) score. All patients underwent a radiographic evaluation consisting of anteroposterior (AP) views of the internal and external rotation and MRI images. All films were assessed by two specialists in musculoskeletal radiology. The size of the tear and fatty degeneration in the anteroposterior dimension were recorded. The postoperative images were used to divide the extent of rotator cuff injury into three classes: (1) full-thickness tear, (2) partial-thickness tear, and (3) cuff integrity.

All operations were carried out by a single experienced surgeon. The patients underwent general anaesthesia and were placed on the beach chair position. The arm was drawn at approximately 30–45° of abduction and 20° of forward flexion. Standard anterior and posterior portals were performed, and then a diagnostic arthroscopy was conducted to evaluate the quality of muscle tendon and arthrodial cartilage in shoulder.

In the single-row repairs method, anchors (Bio-Corkscrew, Arthrex, Naples, FL, USA) were placed along the lateral edge of the greater tuberosity within the footprint of the rotator cuff through the superior portal region. Sutures were then individually passed from the double-loaded anchors into the lateral edge of the tendon. If it was necessary to place a simple suture, a ten- to 15-mm bite of tissue was sutured using an antregrade suture passer or other instruments. After the sutures had been placed, they were sequentially tied with the help of a locking, sliding knot with backup half hitches.

For double-row repairs, anchors for the medial row were set at the lateral margin of the articular surface. A lateral row of anchors was then inserted in the lateral aspect of the footprint, slightly distal to the greater tuberosity. Both sutures were passed through the tendon and tied in a mattress fashion using a locking, sliding knot with back-up half-hitches. The same postoperative rehabilitation protocol was used in the two groups. An immobilizing abduction brace was applied and passive range of motion stretching exercises were carried out. Shortly thereafter, at postoperative week 6, active-assisted range of motion exercises were started. Light activities were allowed at 3 months after surgery. Sports exercises and heavy labor were permitted after 9 months.
All statistical analyses were performed using the SPSS version 15.0 software. The 2-tailed, unpaired *t* test was used to evaluate differences between two groups, and the 2-tailed, paired *t* test was used to detect changes in preoperative to postoperative outcome scores. Student’s *t* test was used to compare the differences for continuous data in terms of preoperative and postoperative VAS, UCLA score, Constant score, ASES index score, time of ability to activities, and ROM in both groups. Categorical data were analyzed with the chi-square test. The significance level was set at *P*<0.05.

### Results

The demographic data are presented in Table 1. The single-row repair technique was performed in 146 patients, and double-row repair was performed in 102 patients. In both groups, there were no significant differences in the pre-surgical values with regards to age, gender, affected shoulder, workers’ compensation, ROM and scales (VAS, UCLA, ASES and Constant).

All of the results at the final follow-up in both groups showed a significant improvement compared with the patients’ preoperative status. There were no significant differences between the groups at the final follow-up evaluation in terms of VAS (*P*=0.082), ASES index (*P*=0.779), Constant (*P*=0.899), and UCLA (*P*=0.895) (Table 2).

Comparing the ability to participate in activities, the single-row repair procedure showed superior results compared with the double-row repair technique in both daily and sports activities (*P*=0.019; *P*=0.006) (Table 2). Comparing the ROM (Table 2), there were no significant differences in forward flexion (162.5±8.6° in single-row group and 171.7±9.5° in double-row group; *P*=0.093) and external rotation (48.8±12.6° in single-row group and 53.4±11.2° in double-row group; *P*=0.171). However, the double-row repair technique showed a tendency towards better results in ROM compared with the single-row repair technique.

The retear rate of a repaired rotator cuff was 29% (43/146 shoulders) for single-row repair and 17% (17/102 shoulders) for double-row repair, and this difference was statistically significant (*P*<0.05) (Table 3). The 43 retears in the single-row repair group involved 35 partial-thickness tears and 8 full-thickness tears. The 17 retears in the double-row repair group involved 12 partial-thickness tears and 5 full-thickness tears.

### Table 1. Patient demographics and combined surgical procedures.

| Variable               | Single-row group | Double-row group | *P* value |
|------------------------|------------------|------------------|-----------|
| Sample size (n)        | 146              | 102              |           |
| Age (mean ±SD, years)  | 57.2±6.3         | 58.4±5.9         |           |
| Gender (f/m)           | 56/38            | 39/62            | .777      |
| Affected shoulder (l/r)| 46/43            | 32/36            | .566      |
| Mean area (mm²)        | 41.2±7.2         | 39.9±9.5         | .569      |
| Workers’ compensation (n) | 2               | 2               | .742      |

### Table 1. Patient demographics and combined surgical procedures.

| Variable               | Single-row group | Double-row group | *P* value |
|------------------------|------------------|------------------|-----------|
| Biceps tenotomy        | 5                | 4                | .877      |
| Biceps tenodesis       | 7                | 5                | .982      |
| Acromioplasty          | 8                | 6                | .944      |
| Distal clavicle resection | 1           | 0                | .394      |
| Preoperative VAS       | 6.7±1.7          | 6.4±1.9          | .292      |
| Preoperative constant  | 51.6±13.5        | 52.7±12.8        | .601      |
| Preoperative ASES      | 49.4±11.6        | 50.3±10.9        | .617      |
| Preoperative UCLA score| 18.8±4.8         | 19.4±5.1         | .445      |
| Range of motion        |                  |                  |           |
| Forward flexion (deg)  | 124.4±36.7       | 125.1±34.5       | .903      |
| External rotation (deg)| 36.2±16.8        | 35.9±14.2        | .807      |

f – female; m – male; l – left; r – right; VAS – Visual Analogue Score; ASES – American Shoulder and Elbow Surgeons; UCLA – University of California, Los Angeles.

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Discussion

The most important findings were the lower retear rate but later return to daily and sports activities in the double-row group compared with the single-row repair group, although no significant differences were found in the functional outcomes of the two groups.

Massive rotator cuff tears present a particularly complex and difficult challenge for the orthopaedic surgeon. Several published studies on both open and arthroscopic approaches have reported improved results in shoulder function and pain relief with rotator cuff repair [9,11,13,14]. Arthroscopic rotator cuff repairs are becoming popular as a result of improvements in technology and the ability to achieve robust repairs in a minimally invasive fashion [15]. Compared with repairs of smaller tears, the operative repair of massive tears is technically more difficult and is associated with a higher recurrence rate [16–20]. Poor results for the treatment of MRCTs are primarily due to inelastic and poor tendon quality, scarring and adhesions to the retracted tendon, muscle atrophy, and fatty infiltration [21–25]. Many techniques have been introduced for the treatment of MRCTs [26–28]. However, so far, no articles have been published that definitely support the superior clinical outcomes of double-row fixation over single-row fixation. We conducted this study to confirm, in a large sample population, whether double-row repairs could yield better results compared with single-row repairs for the treatment of MRCTs.

Biomechanical studies have emphasized that the double-row repair technique yields results that are superior to the single-row repair technique [29–31]. However, clinical studies have not yet verified this idea [32–35]. The results of this study suggested that the functional outcomes both single- and double-row repairs are equal with respect to VAS, UCLA, ASES and Constant score. A previous study by Sugaya et al. [36] also showed no significant difference between the groups in terms of two postoperative scores. However, Sugaya et al. thought that the dual-row repairs excelled in terms of structural outcomes compared with the single-row technique. Carbonel et al. [26] reported that a significant improvement with the double-row technique was demonstrated in clinical evaluation and that the improvements were more significant in tears greater than 30-mm than in ten- to 30-mm tears. Charousset et al. [11] performed a non-randomized comparative study including 31 patients in the double-row group and 35 in the single-row group. There were no significant differences between the groups in the clinical outcomes measured by the Constant scale. However, in these studies, the limitation of the period of follow-up remains; therefore, long-term follow-up is required in future studies.

In the study by Carbonel et al. [26], the double-row technique showed superior results in ROM compared with the single-row technique. Franceschi et al. [32] published a series of 60 patients who underwent single- or double-row repair. With a mean period of 24 months of follow-up, MRI showed no significant

Table 2. Clinical outcomes at the final follow-up.

|                      | Single-row group | Double-row group | P value |
|----------------------|------------------|------------------|---------|
| Preoperative VAS     | 1.9±1.4          | 2.2±0.9          | .082    |
| Preoperative constant| 82.3±13.6        | 84.2±9.8         | .779    |
| Preoperative ASES    | 86.5±10.1        | 87.1±8.9         | .899    |
| Preoperative UCLA    | 30.6±5.8         | 31.4±4.6         | .895    |
| Time of daily activities (m) | 5.2±1.1       | 5.8±2.1          | .019    |
| Time of sports activities (m) | 9.3±1.8        | 10.2±2.4         | .006    |

Table 3. Retear rate of single-row and double-row repairs in each group.

|                      | Single-row group | Double-row group | P value |
|----------------------|------------------|------------------|---------|
| Intact               | 103              | 85               | .021    |
| Retear               | 43               | 17               |         |

VAS – Visual Analogue Score; ASES – American Shoulder and Elbow Surgeons; UCLA – University of California, Los Angeles; m – months; deg – degree.
difference in the postoperative ROM between the groups. In this study, the ROM results also exhibited no difference when comparing single-row repair with double-row repair. However, a tendency for a larger ROM was shown in the double-row repair group. Stiffness is the most common complication after rotator cuff repair [37,38]. However, a standard rehabilitation protocol for tendon healing, though it prevents shoulder stiffness, has not been definitively established. This is an issue that requires careful judgment because overly conservative measures tend to aggravate stiffness, whereas overly aggressive measures can result in recurrent tears [39].

A few studies have shown that the results are variable in massive tears, which have retear rates of 17% to 44% [40–42]. Several studies have reported superior tendon strength in patients who had undergone double-row repair [43,44]. However, because these studies represent a heterogeneous series of operative techniques and tear sizes, it is not possible to reach a consistent conclusion. The failure rate on MRI in this study was 24.4%, representing a total of 60 patients. Compared with single-row repair, double-row repair resulted in a stronger rotator cuff postoperation. These findings were in line with the results comparing the biomechanical properties of the two techniques. Therefore, we can conclude, with caution, that double-row repair could significantly decrease the retear rates compared with single-row repair.

Our study has some inherent limitations. First, this study was not designed as a randomized trial because these techniques were applied at different time points. Next, though we tried to include a large sample size, this study had low power for recognizing differences in the clinical scores between the repair procedures. Finally, because the choice of surgical procedure was made according to the surgeon’s preference at the time of surgery, some bias may have existed in the selection of the repair technique.

**Conclusions**

Single- and double-row repairs resulted in significant improvement in shoulder functions. No differences in functional outcomes were shown between the groups. Although single-row repair resulted in the ability of patients to take part in activities at a shorter time after the procedure, the results with regards to ROM and the strength of tendon appeared superior following double-row repair. To better evaluate the outcomes of the two treatment strategies, a well-designed randomized controlled trial is warranted.

**Competing interests**

The authors declare that they have no competing interests.

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