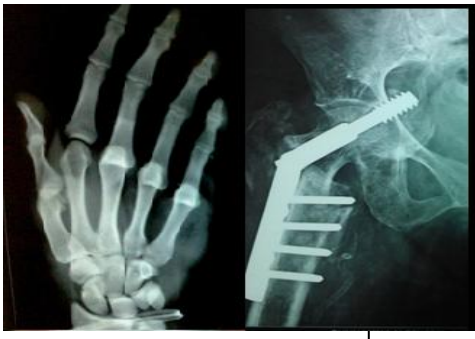

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Clinical outcomes of single versus double row, transosseous equivalent arthroscopic rotator cuff repair

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Abstract
Rotator cuff tears are common and are expected to present with increasing frequency as the population ages. Various techniques in surgical repair have been described to improve clinical outcomes. A arthroscopic transosseous-equivalent double row repair is believed to be superior, with improved tendon to bone contact area and reduced gap formation. In our series of 143 patients, with 76 undergoing single row repair, and 67 double row repairs by a single surgeon, we describe the observed clinical improvements and complication rates. Though surgical times were not significantly different, no significant advantage from double row repairs were observed with regards to clinical outcome measures.

Keywords: arthroscopic transosseous, clinical outcomes, musculoskeletal structure

Introduction
The shoulder is a complex musculoskeletal structure [1]. Despite the exceptional range of motion, only a few millimeters of humeral head translation occurs during movement in the glenohumeral joint [2]. A functional rotator cuff contributes to the stability of this joint [1, 3, 4].
The incidence of shoulder complaints is high, with approximately 13.7 million doctor visits in 2003 alone [3]. Some injuries are a result of excessive, repetitive overhead motion such as swimming, tennis, pitching and weightlifting [3]. However, many occur with daily activities - household chores such as cleaning the windows and hanging curtains have been associated with shoulder injuries, especially so in the elderly [3]. Even in normal cadavers, rotator cuff tears were found in 30% to 50% of specimens, suggesting that they may be part of the normal aging process [4, 5]. With an aging population, the number of patient visits for degenerative rotator cuff pathologies is expected to rise [6]. Regardless of the etiology, proper management of the rotator cuff disease is crucial for both physical function and wellbeing of the patient. In the patient group that undergoes surgical repair, we question the superiority of a dual-row repair technique, if it translates to better clinical outcomes and reduced re-tear rates.
With a three-space digitizer, Dugas *et al.* examined 20 normal cadaveric shoulders. He reported the mean minimum transverse diameter across the cuff insertion to be 14.7mm and the total area of supraspinatus attachment on the greater tuberosity was approximately 350mm [7]. Oguma *et al.* showed that the potential for woven bone formation to anchor collagen fibers at the bone-tendon interface increases as the available contact area for the fibrovascular tissue interface increases [15]. Thus, creating a similar area during surgical repair is essential as this insertion point undergoes large stresses [10, 11]. The belief is that a dual-row repair technique achieves this, hence better healing and reduced gap formation [14].
This has been supported by *in vitro* studies [7, 8]. Waltrip*et al* [21] reported that double row repair was superior to single row with regards to initial fixation strength in a cadaver study. Meier and Meier [22] in their cadaveric study, reports that double row repair restores the supraspinatus footprint closer to its original level than does the single row repair. Brady *et al* [23] in a clinical study demonstrated increased coverage in double row compared to single row. This was quantified by measuring coverage before and after tying of the lateral row, whereby single row repair was achieved prior to lateral anchorage. It was found that single row repair left on average, 52.7% of the original rotator cuff footprint uncovered, while double row technique achieved complete coverage [43].

This significant advantage has not been observed in clinical studies. We recognize that functional improvement after surgical repair is not as predictable as pain relief, and depends on many other factors [7, 8, 12, 13].

Design and Methods

We studied a total of 143 patients, recruited from 2004 to 2008. All were diagnosed with isolated supraspinatus tendon tears of up to 4cm. The pre-operative diagnoses were made via ultrasound or MRI, and were correlated with intra-operative findings. All had surgical repair performed arthroscopically by a single surgeon. The first 76 patients had repair performed via the single row technique while 67 patients after had double row repair performed. Patients with previous surgery to the ipsilateral shoulder and multiple rotator cuff pathologies were excluded from the study. This was not a double-blinded study and patients were not randomized nor selected based on tear size, pathology or characteristics.

Surgical method

Patients were positioned in a beach chair with back of bed flexed about 70º. Shoulders were examined under anaesthesia for range of motion (ROM). A posterior portal was established for the initial assessment of the joint. An anterior portal through the rotator interval was established as the working portal for intra-articular debridement. Up to four portals were required for rotator cuff repair: posterior and posterolateral portals were used mainly for the standard 30º angled 4-mm arthroscope (the viewing portals), while anterosuperior and lateral portals were used for the instruments (the working portals). All patients had subacromial decompression with acromioplasty performed. After adequate visualization, preparation, and release of the tendon, tear edges were fashioned and opposed to simulate repair and for assessment of eventual outcome.

In single row repairs (see diagram 1) tear edges were opposed and anchored with up to 2Healix® suture anchors. Double row repairs (see diagram 2) in essence have two anchoring points, after initial repair with the medial row anchor(s), the sutures were then tightened and anchored laterally with Versalok®. Depending on the size of tear, a "1:1" configuration (1 Healix® and 1 Versalok®) or a "2:2" configuration was performed. The arm was immobilized in a sling following routine portal closure.

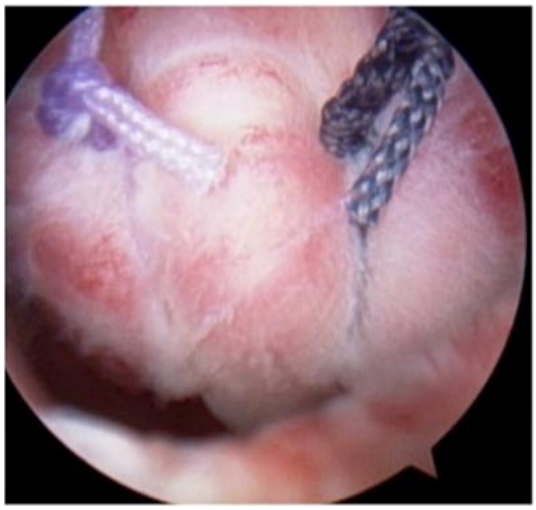


Diagram 1: Single Row

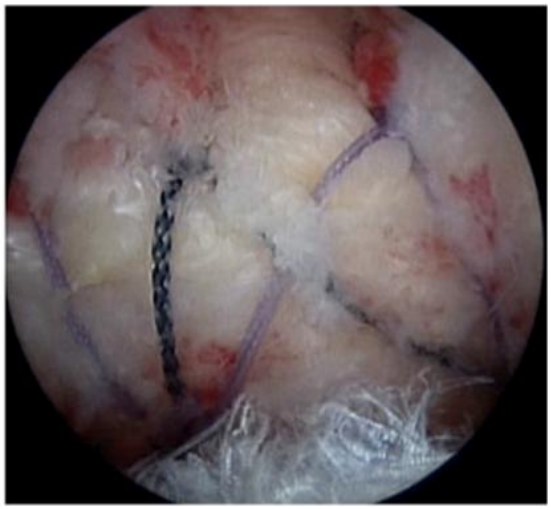


Diagram 2: Double Row

Immediate post-operatively, patients were allowed to perform passive ROM exercises, including pendulum exercises, passive forward flexion, and external rotation. No active motion was allowed until 6 weeks post-operatively. Active-assisted motion was initiated at six weeks postoperatively. They were then advised on muscle strengthening exercises and routine follow up assessments in the outpatient clinic.

Clinical evaluation

The patients were evaluated pre-operatively, 3 months, 6 months, and 24 months post-operatively. Clinical scoring systems used include Visual Analogue Scale (VAS) and University of California, Los Angeles Score (UCLA). Assessments and records of complications were also sought, such as infection, anchor pullout, re-tear of cuff, and need for revision surgery.

Scoring system

The UCLA score is a combination of subjective scoring and physical examination, and the variables are evaluated and weighted as follows: pain (28.6%), motion (14.3%), strength (14.3%), function (28.6%), and satisfaction (14.3%).

The Visual Analogue Scale (VAS) measures pain based on a continuum of values, as it cannot easily be directly measured. A horizontal line, 100 mm in length, anchored by word descriptors at each end is offered to the patient and advised to mark on the line the point that they feel represents their perception of their current state.

Demographics

Patient demographics between the two arms are clinically comparable and are summarized in *table 1*. The average age for single row (SR) arm is 59.5 +/- 11.4 years while that for double row (DR) is 59.1 +/- 9.6 years. A total of 45 males to 31 females in single row arm versus 34 males and 33 females in double row arm were studied. Duration of surgery between both arms was also comparable – 76.18 +/- 18.6 minutes for single row, while double row took 77.1 +/- 14.4 minutes on average. The mean tear size for single row was 1.37 +/- 0.65 cm and 1.77 +/- 0.85cm for double row group.

Pre-operative UCLA scores and VAS scores were also comparable between both arms. See Table 2. UCLA scores preoperatively for single row was 14.59 +/- 3.19 while double row was 13.41 +/- 2.97. VAS scores preoperatively for single row was 4.68 +/- 1.48 while double row was 4.33 +/- 1.14.

Table 1: Patient demographics and peri-operative data

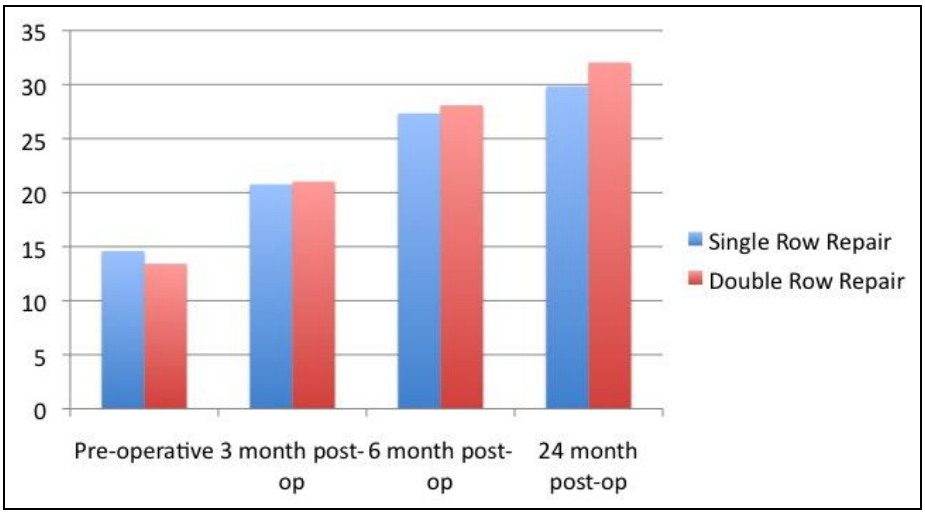
	Single Row (n = 76)	Double Row (n = 67)
Age (years)	59.5 (+/- 11.35)	59.1 (=/- 9.59)
Sex ratio (male : female)	45 : 31	34 : 33
Tear Size (cm)	1.37 (+/- 0.65)	1.77 (+/- 0.85)
Duration of Surgery (min)	76.18 (=/- 18.63)	77.07 (+/- 14.41)
Pre-op UCLA score	14.59 (+/- 3.19)	13.4 (=/- 2.97)
Pre-op VAS score	4.68 (+/- 1.48)	4.33 (+/- 1.14)

Results

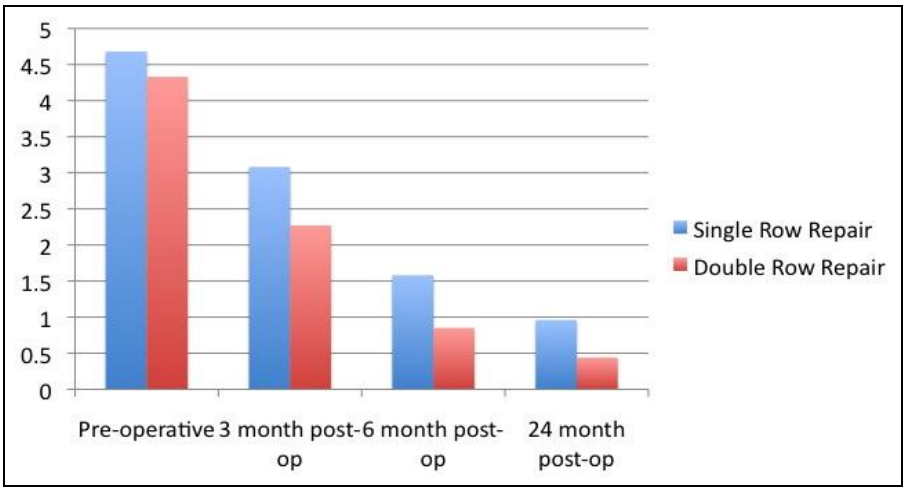
Patients were assessed at 3 months, 6 months, and 24 months postoperatively. See graph 1 and 2. Both arms showed significant improvement (p <0.01) in UCLA and VAS scores post-operatively. However, no significant improvements in scores were observed in double row repairs compared to single row repairs at both early post-operative period and 24 months post operatively.

UCLA scores in single row arm improved from 14.59 +/- 3.19 to 29.84 +/- 6.98 at 24 months post operatively. Double row scores improved from 13.41 +/- 2.97 to 32.05 +/- 5.26. (p<0.05). There was no statistical difference in UCLA scores for both arms at 24 months (p>0.65).*(Graph 1.*)

VAS scores in single row arm improved from 4.68 +/- 1.48 to 0.96 +/- 1.88 (p<0.05) at 24 months. Double row scores improved from 4.33 +/- 1.14 to 0.44 +/- 1.02 (p<0.05) at 24 months. However, no significant differences were noted between both arms at the end of evaluation. *(Graph 2.).*



Graph 1: UCLA scores



Graph 2: VAS scores

No reported cases of post-operative wound infection was noted in both arms by 24 months of follow up.

Each arm had a single case of anchor pullout (Single row 1.3%, Double row 1.4%). Both cases were diagnosed within 12 weeks post-operatively, presenting with progressive pain and weakness. 6 re-tears were noted in single row arm (7.89%) while double row had 4 re-tears (5.97%). After 24 months, a total of 4 cases required revision surgery, with 2 cases in each arm (single row 2.6%, double row 2.9%). *Table 2.*

Table 2: Complication rates

	Single Row (*n* = 76)	Double Row (*n* = 67)
Infection	0	0
Anchor Pullout	1 (1.31%)	1 (1.49%)
Re-tear	6 (7.89%)	4 (5.97%)
Revision required	2 (2.62%)	2 (2.98%)

Discussion

Recurrent tears after rotator cuff repair is a common and has been reported in up to 40% of patients undergoing surgical repair [7-12]. Of interest, these were diagnosed via second-look arthroscopy after the initial repair surgery. With post-surgical ultrasonography, Galatz *et al* [13] reported astonishingly high recurrence rates, with 17 (94%) out of 18 cases having a re-tear, though it did not correlate with the clinical improvements observed. Sugaya *et al* [20] using magnetic resonance imaging reported that 43.6% of the rotator cuff repairs had sufficient thickness, 30.8% had insufficient thickness, and 25.6% had a re-tear in the single-row group, compared with 73.2%, 17.1%, and 9.8%, respectively, in the double-row group. Along with findings by Franschesci *et al* and Charousset *et al.* [16, 19], it is suggestive that clinical outcomes do not correlate with radiological findings of a re-tear post-operatively.

In this study, significant improvements in functional and pain scores were observed in both arms (SR and DR). We were not surprised, as previous studies have reported similar outcomes. Unfortunately, despite the reduction of a variable i.e. surgical expertise, we did not find significant improvements in patient outcome when comparing double row to single row repairs. This validates the findings of several authors. With the exception of Sugaya *et al.* [20] and Park *et al.* [23], who, after subdividing their patients by tear size, found improved outcomes and lower re-tear rates when large tears were repaired with double row technique, the majority of studies failed to show significant clinical advantage of double row repairs over single row.

Increased surgical time required for double row repair was a major initial deterrent. Franceschi *et al.* [16] reported on operative times required for the different procedures. Average time was 42 +/- 18.9 minutes for the single row and 65 +/- 23.4 minutes for the double row procedures. In his study, the time

Difference was significant. However, in our series and several others, no significant difference in operative time was noted. Hence, we feel that surgical duration should not serve to discourage employment of either technique.

Several potential bias were identified in these studies. They include type-II error in analysis secondary to insufficient power, to selection bias in studies that were not randomized or prospective.

The studies by Charousset *et al.* [19] and Grasso *et al.* [17] each involved multiple surgeons, which introduced the variable of skill level. In our study, a single surgeon performed all the surgeries. This reduces the variability of skill level. However, we recognize that this introduces yet another variable that of surgeon experience. The potential benefit of double row repair was thus confounded by improved surgeon's experience after performing a series of single row repairs.

We can expect predictable healing with either repair techniques, especially for small and medium sized tears. The potential benefit of double row repair may lie in improved outcomes with large and massive tears. Clinical studies, however, have not yet demonstrated a substantial improvement over single row repairs with regards to either the degree of structural healing or functional outcomes in ASES, UCLA and Constant scores.

Although double row repair may provide an improved mechanical environment for the healing tendon, several confounding variables have complicated attempts to establish a definitive relationship with improved rates of healing. Larger prospective randomized studies that include clinical assessments and that take tear size into account are necessary to determine the true efficacy of double row repair.

We have to recognize that despite the apparent superiority of structural outcomes in association with the double-row repair method, there are some potential drawbacks to employing this technique in all cases. First, in the studies reviewed, the required number of anchors ranged from one to two for single-row fixation, compared with two to four for double-row fixation, increasing the cost of the procedure [16-20]. Furthermore, the double-row fixation procedure is technically more difficult.

It was also suggested that multiple strands necessitated by the double-row repair could potentially interfere with the neovascularization process and thus inhibit healing, although none of the studies reported addressed this issue.

Despite the various biomechanical studies that demonstrate mechanical advantage of double row repairs, this has not been translated into superior clinical outcomes in our patient cohort. This finding is also supported by several other studies that have not shown improved clinical outcomes with double row repairs.

As no significant difference in clinical outcomes has been demonstrated between the two repair techniques except for, perhaps, large-to-massive rotator cuff repairs, a risk-reward analysis of patient age, functional demands, and other quality-of-life issues should be considered before deciding which surgical method to employ.

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