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Functional and Radiological Out Comes of Patients With Full-Thickness Rotator Cuff Tears Repaired By arthroscopic Knotted-Suture Bridge Double Row Method

Erkan Akgun[1], Huseyin Emre Tepedelenlioglu[1], Demet Pepele Kurdal[2], Cihan Adanas[3], Ahmet Onur Akpolat[2]

[1] Etlik City Hospital , Orthopaedics Surgery and Traumatology Department, Ankara, Turkey.
[2] University of Health Sciences, Fatih Sultan Mehmet Training and Research Hospital, Orthopaedics Surgery and Traumatology Department, İstanbul, Turkey.
[3] Van University School of Medicine, Orthopaedics Surgery and Traumatology Department, Van, Turkey.

Abstract

Introduction: To evaluate the functional and radiological results of double-row arthroscopic rotator cuff repairs performed by the Knotted Suture Bridging method.

Materials and Methods: The study included 36 patients. Before surgery, tear type, tear size, and muscle atrophy were examined by ultrasound (USG) and magnetic resonance imaging (MRI) in all patients. In the clinical evaluation, the preoperative and postoperative 2nd year results of the patients were compared by Visual Analogue Scale (VAS), scoring the University of California, Los Angeles (UCLA) and the shoulder index scoring of the American Shoulder and Elbow Surgeons (ASES). Sugaya MRI recovery analysis was used to evaluate the structural healing of the tendon.

Results: A significant decrease was found in the patients' VAS scores in the postoperative period. While the preoperative UCLA (0-35) score was 19.1, the median value in the second postoperative year was 29.7. ($p<0.001$). The median preoperative ASES index (0-100) was 46.7 before and 85 after surgery. ($p<0.001$) Both scores show a significant improvement in patients in the second postoperative year. MRI imaging showed good rotator cuff healing in 29 patients (Sugaya type 1-2), Sugaya type 3 in 2 patients, type 4 lesions in 2 patients, and type 5 in 3 patients.

Conclusion: Double-row arthroscopic rotator cuff repairs performed by the Knotted Suture Bridging method in medium and large rotator cuff tears are highly effective in the tendon's functional and adhesive healing.

Keywords: Rotator cuff; Arthroscopic repair; Suture bridge; Knot-suture.

Introduction

Rotator cuff tendon tears are an important cause of shoulder morbidity that is increasingly encountered in orthopaedic clinics with the increase in the elderly population and advances in imaging methods. Tears are seen in 30% of patients over the age of 60 and 62% of patients over the age of 80. (1). Rotator cuff tendon tears cover a comprehensive spectrum, initiates with subacromial impingement, especially in advanced age, and progresses to partial or full-thickness tears and, if not appropriately treated, can evolve into severe articular arthrosis, such as rotator cuff. arthropathy (2). While follow-up is sufficient in asymptomatic patients, physical therapy protocols focusing on shoulder and scapular muscles constitute the first-line treatment in newly diagnosed symptomatic patients. Studies show that physical rehabilitation provides symptomatic improvement in small and medium-sized rotator cuff tears, similar to surgical treatment. (3-5). Although symptoms are significantly improved with non-surgical treatments, surgical repair is

* Corresponding Author: Ahmet Onur Akpolat Fatih Sultan Mehmet Training and Research Hospital, Orthopaedics and Traumatology Clinic, 34856 Ataşehir/İstanbul, Turkey **E-mail address**: onurakpolat@hotmail.com **Orcid:** Erkan Akgün 0000-0002-1700-1777, Ahmet Onur Akpolat 0000-0001-7773-5476, Cihan Adanas 0000-0002-3652-6077, Demet Pepele Kurdal 0000-0003-2669-3020, Huseyin Emre Tepedelenlioglu 0000-0002-3946-8554

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required for tendon restoration (6,7). Surgical treatments are more considered in cases of pain that persists for 4-6 months despite non-surgical treatments. (8). Different methods, including open repair, mini-open repair, and arthroscopic repair, have been used for a long time in the surgery of rotator cuff tears. Advances in surgical techniques have made arthroscopic repairs the gold standard treatment method. (9,10). Many arthroscopic repair methods have been described. Among these, single-row repairs, knotless-suture bridge double row, and knotted-suture bridge double row methods are the most commonly used surgical techniques (11-13). Regardless of the technique, the objective of rotator cuff rupture surgery is to provide stable fixation until the tendon heals, leaving no gap on the contact surface of the torn tendon rather than its anatomical adhesion, and to obtain this fixation at the appropriate tension. Failure in these stages causes repair failure and early rerupture (14,15). In this study, we examined the biological status of the knotted-suture bridge repair, one of the arthroscopic double-row techniques that has become popular in recent years, both functionally and in MRI imaging.

Materials and Methods

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, the approval date of the ethics committee is 09/08/2023, and the decision number is AESH-EKI-2023-333 (University of Health Sciences). The study included the results of 36 patients who had full-thickness medium-large rotator cuff tears and underwent double-row repair with the arthroscopic Knotted-Suture Bridge method between February 2017 and June 2019. Inclusion criteria for the study were determined as follows: being unable to perform daily activities, having a full passive joint range of motion, and having a rotator cuff tear, having a full-thickness medium-large (between 1cm and 5cm) rotator cuff tear proven by MRI. (Patte's stage 1-2 and Goutallier grade 1-2-3) and being over 18 years of age . Rupture in the subscapularis tendon, osteoarthritis in the affected joint, accompanying rheumatic diseases or long-term cortisone use, tear larger than 5 cm or smaller than 1 cm, Goutallier grade 4 fat atrophy and massive irreparable rotator cuff tear (Patte's stage 3 and tear larger than 5 cm) and patients with frozen shoulders were excluded from the study. All patients underwent detailed examinations before surgery. Routine shoulder radiographs, USG, and MRI imaging were performed in all patients; we suspected a rotator cuff tear, and a full-thickness rotator cuff tear between 10 mm and 50 mm was detected in all patients. Patte's and Goutallier's staging was performed by an experienced orthopedic surgeon by examining MRI sequences for tendon retraction and fat infiltration. Again, muscle atrophy was detected using MRI sections. In clinical evaluation, the results of the patients before surgery and at the average of the 2nd year after surgery were compared by using the Visual Analogue Scale (VAS), University of California, Los Angeles (UCLA) scoring and the American Shoulder and Elbow Surgeons (ASES) shoulder index scoring. Sugaya MRI recovery analysis was used to evaluate the structural recovery in the tendon. MRI images were requested at an average of 2 years in asymptomatic patients and earlier in symptomatic patients. Sugaya type 1 and type 2 were evaluated as successful recovery.

Surgical technique: All patients were treated by a single surgeon in the beach-chair position under general anesthesia. The nerve block was not applied to any of our patients. To control bleeding during the surgery, controlled hypotension was requested in consultation with the anesthesiologist, and adrenaline was added to the irrigation fluid. Bleeding control was achieved by keeping the arthroscopic pump at a pressure range of 70-90 mm-Hg. Four standard portals were used: anterior, posterior, accessory posterolateral and lateral portals. The glenohumeral joint was examined in all patients. Necessary interventions (tenotomy, tenodesis) were performed for biceps and labral pathologies. After glenohumeral joint examination, bursa debridement was performed by switching through the subacromial space, and limited acromioplasty was performed by loosening the coracoacromial ligament as a standard procedure. The anatomical attachment points of the rotator cuff were revitalized with shaver and burr, and this surgical procedure was combined with the microfracture method, making the tendon suitable for regeneration (Figure 1).

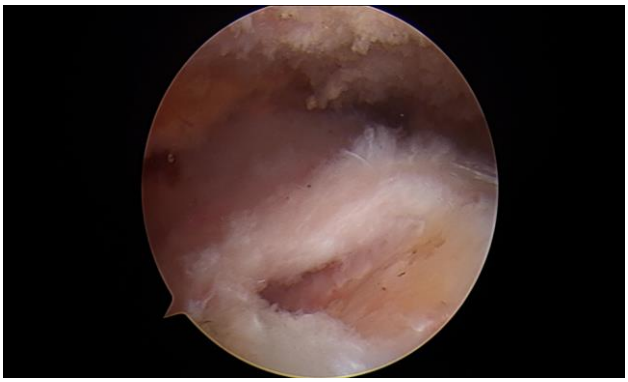

Figure 1: 59-year-old female patient. Preparation of the rotator cuff anatomical attachment site.

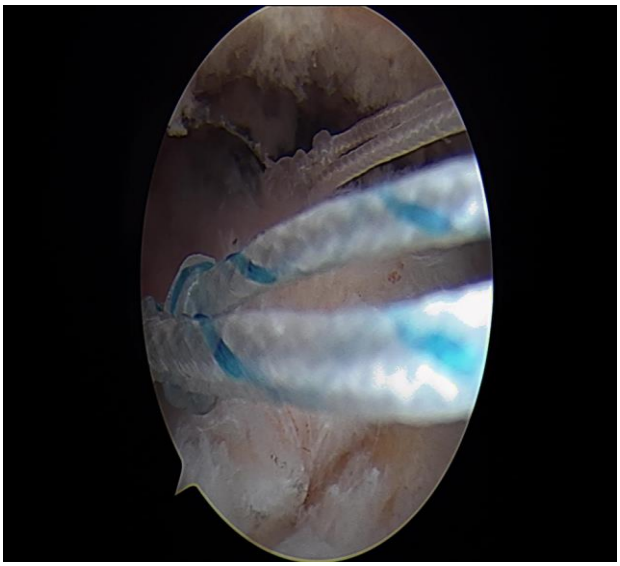

Figure 2: The patient's proximal row repair with two suture anchors

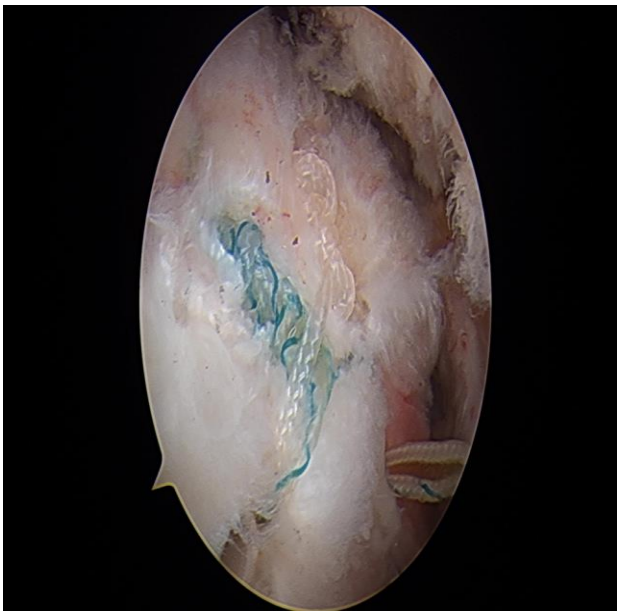

Figure 3: Arthroscopic view of the patient after knot-tying suture bridge double row repair.

Two suture anchors were placed 2 mm lateral to the humeral joint surface. With the help of Suture Lasso, 4 horizontal matrix sutures were passed just lateral to the musculocutaneous part of the tendon and the rotator cuff proximal row repair was performed with a sliding knot (Figure 2). Then, distal row repair and rotator cuff coverage were achieved using the suture bridge technique with two push lock anchors (Figure 3 and 4). Patients were given a standardized analgesia with a shoulder arm sling in the postoperative period. Passive range of motion exercises were given on the 7th postoperative day. In the 4th week, shoulder immobilization was terminated and active exercises were started. Rotator cuff strengthening exercises were started at the 10th week, and return to sports and heavy work was allowed at the 6th month.

Statistical analysis: Data were analysed using the Statistical Package for Social Sciences, version 25.0 (SPSS Inc., Armonk, NY). The normality of numerical data distribution was examined using the Shapiro-Wilk normality test. Continuous variables that do not show normal distribution are presented as median and interquartile range (IQR; 25th-75th percentile) or minimum-maximum, and qualitative data are expressed as frequency and percentage. Wilcoxon signed-rank test was used to compare repetitive variables that did not have parametric distribution. A marginal homogeneity test was applied in the analysis of dependent categorical variables. Spearman correlation analysis examined the correlation between the visual analogue and functional shoulder assessment scales. The confidence interval is 95%, and the accepted margin of error is 5%. A value of $P<0.05$ was considered statistically significant.

Figure 4: MRI section of the patient in the 2nd postoperative year. There is Sugaya type 1 recovery.

Table 1: Demographic and clinical features of the patients

	Median (min-max) or (N%)
Age	49.7 (32-69)
Gender	
Female	16 (44.4)
Male	20 (55.6)
Effected site	
Right	22 (61.1)
Left	14 (38.9)
Tear magnitude	23.1 (12-45)
Interval between diagnosis ad surgery (Months)	6.9 (4-14)
Patte's stage	
Stage 1	13 (36.1)
Stage 2	23 (63.9)
Goutallier's grade	
Grade 1	21 (58.3)
Grade 2	11 (30.6)
Grade 3	4 (11.1)

Table 2: Comparison of patients' preoperative and postoperative pain and functional shoulder assessment scales

	Preoperative	**Postoperative**	**z**	**P[?]**
VAS Score	5.5 (1.8)	1.0 (1.0)	-5.093	0.001
UCLA Score	19.1 (6.0)	29.7 (4.0)	-5.182	0.001
Staging according to UCLA Shoulder Scale				0.001
Excellent	-	7 (19.4)		
Good	-	5 (13.9)		
Fair	15 (41.7)	22 (61.1)		
Poor	21 (58.3)	2 (5.6)		
ASES Score	46.7 (38.0)	85.0 (8.0)	-5.167	0.001

[?] Wilcoxon signed-rank test; **VAS:** Visual analog scale, **UCLA:** University of California at Los Angeles, **ASES:** American Shoulder and Elbow Surgeons Shoulder Score

Results

The demographic and clinical characteristics of the patients are shown in Table 1. The median age of the patients is 49.7 years, and the males are more frequent than females. Right-side involvement is more common than left-side. The median tear size value was found to be 23.1 mm. The median value for the time between diagnosis and operation was 6.9 months. Patte's stage 2 was found in approximately 2/3 of the patients. According to Goutallier's stage, the rate of grades 1, 2, and 3 is 50.8%, 30.6%, and 11.1%, respectively. When the patients' preoperative and postoperative pain functional shoulder assessment scales were examined, a significant decrease in VAS scores and a significant increase in UCLA and ASES scores were found ($p<0.001$). According to the UCLA staging, 41.7% of the patients were evaluated as fair and 58.3% as poor in the preoperative period. In comparison, 19.4% were evaluated as excellent, 13.9% as good, 61.1% as fair in the postoperative period, and 5.6% were poor. A statistical difference was found between the preoperative and postoperative periods regarding UCLA staging ($p<0.001$), (Table 2). When the correlation between the evaluation scales in the preoperative period is examined, there was a moderate negative correlation between the VAS score and the UCLA and ASES scores (Rho=-.572, $p<0.001$; Rho=-.626, $p<0.011$, respectively), and a strong positive correlation between the UCLA score, VAS and ASES (Rho=. 862, $p<0.001$) was found. When the correlation between the evaluation scales in the postoperative period is examined, there was a moderate negative correlation between VAS and UCLA (Rho=-.661,

Table 3: Correlation analysis of shoulder evaluation scales

Preoperative stage		**VAS**	**UCLA**	**ASES**
VAS	Rho	1.000	-.572**	-.626**
	p	.	0.001	0.001
UCLA	Rho	-.572**	1.000	.862**
	p	0.001	.	0.001
ASES	Rho	-.626**	.862**	1.000
	p	0.001	0.001	.
Postoperative stage		**VAS**	**UCLA**	**ASES**
VAS	Rho	1.000	-.661**	-.795**
	p	.	0.001	0.001
UCLA	Rho	-.661**	1.000	.900**
	p	0.001	.	0.001
ASES	Rho	-.795**	.900**	1.000
	p	0.001	0.001	.

****** Spearman correlation analysis;(sigma two-tailed).
VAS: *Visual analog scale,* ***UCLA:*** *University of California at Los Angeles,* ***ASES:*** *American Shoulder and Elbow Surgeons Shoulder Score*

p<0.001), a strong negative correlation between VAS score and ASES (Rho=-.795, p<0.001), and a strong positive correlation between UCLA score and ASES score (Rho=.862, p<0.001) was found (Table 3). At the end of 2 years, MRI images of 31 asymptomatic patients showed good rotator cuff healing (Sugaya type 1-2) in 29 patients. Although 1 patient had a Sugaya type 3 lesion and 1 patient had a type 4 lesion, additional surgery was not required because these patients were asymptomatic. MRI imaging was performed earlier in 5 patients whose symptoms continued after surgery. Sugaya type 3 lesion was detected in one patient, Sugaya type 4 in one patient and Sugaya type 5 lesion in 3 patients. Additional surgery was recommended for all of these patients. 1 patient did not accept surgery. 4 patients underwent double-row repair with the arthroscopic knotted suture bridge method. 1 patient had tendon repair. Superior capsular reconstruction surgery was also performed on one of our patients. No wound healing problems or infection were observed in any of the patients.

Discussion

This study examined the functional results and radiological recovery of patients with full-thickness, medium-large rotator cuff tears who underwent double-row repair with the arthroscopic Knotted Suture Bridge method. The Knotted-Sutured Bridge double-row repair technique positively affects both mechanical and biological healing stimuli. It is known that it does this by increasing the tendon-footprint attachment surface, reducing the gap between the tendon and the fixed bone, thus preventing intra-articular fluid leakage, and by more withstanding the rotational movements of the humerus and distributing the tensile force evenly (16). Again, in our patients, with the confidence of the double-row repair method, passive pendulums are applied on the first postoperative day. Exercises were started and active exercises were started in the 4th postoperative week. By starting the movement, possible joint movement restrictions are prevented and are thought to contribute to preventing early re-ruptures. No shoulder stiffness problem was encountered in any of our patients. In our study, when the UCLA and ASES values of the patients in the second postoperative year are compared with the preoperative values, there is a significant functional improvement. An average improvement of 10 points in UCLA scoring and 40 points in ASES scoring was observed before and after surgery. The most crucial gain of our study is that this improvement is not only in functional results, but is also proven biologically by MRI imaging. Successful recovery (Sugaya Type 1-2) was detected in MRI imaging in 29 of the patients (80.6%). With the development of arthroscopic equipment and repair techniques, anatomical repair methods have become more widely used. Many biomechanical studies have shown that double-row repair methods are superior to single-row repair methods (17-19). Kim et al. In their study on cadaver models, they

suggested that double-row repair methods are superior to single-row repair methods, thanks to stronger initial fixation, wider footprint adhesion rate, and less gap formation between bone and tendon after repair (18). Again in their study on human cadaver models Ahmad et al. showed that the double-row repair method is more resistant to cyclic movements of the humerus and that the force is distributed more evenly during these movements, thus providing a strong fixation (20). However, this has not always been proven in clinical studies. We can explain the reason for this when we examine the literature as follows. In most studies, not optimizing the tear type and tear size seems to be an important factor. The most important problem here seems to be the size of the tear. No significant functional difference was found between single-row and double-row repairs, especially in full-thickness tears where the tear size was less than 3 cm (21-23). Aydin et al. performed single-row and double-row repairs on rotator cuff tears smaller than 3 cm. They showed that there was no significant difference in terms of functional results in patients with diabetes (20). However, some studies have shown that the results of double-row repair are superior to single-row repair in tears where the tear size is larger than 3 cm (24-25). Especially in the study conducted by Park et al. comparing single-row and double-row repair, it has been previously reported that The issue we mentioned has been emphasized. While there is no significant difference between the functional results of single-row and double-row repair in tears smaller than 3 cm, there appears to be a significant difference when the tear size is larger than 3 cm (26). Rhee et al. followed up 51 patients with rotator cuff tears, whom they treated with the double-row repair method using two different techniques (knotted and knotless), for an average of 21.5 months, and found the final UCLA score to be 31. They also detected 18% re-tear in the group they treated with the knotted-suture bridge method (27). Again, Miyazaki et al., in their series of 37 patients in whom they performed double-row repair, found the UCLA score to be 33.7 after an average follow-up of 30 months and detected 2.7% re-tear. (28). Some studies reported that rotator cuff tears were treated with the Knotted-Suture Bridge method in 59 patients. They found the latest mean ASES score to be 88.2 and detected 15.7% re-tear (29,30). Similar results were obtained in our study. The median UCLA score of our patients in the 2nd year was 29.7 and the ASES score was 85. Again, re-rupture was detected in 19.4% of our patients. The most important achievement of our study was the demonstration of biological recovery using MRI imaging while evaluating functional results. There are very few studies in the literature evaluating biological healing. Sugaya et al., who first introduced the concept of biological healing, divided MRI healing into 5 types. While Sugaya type 1 and type 2 were evaluated as successful biological recovery, Sugaya types 3-4 and 5 were evaluated as unsuccessful recovery. Accordingly, 81% of our patients had successful biological (Sugaya type 1-2) recovery, and 19.4% had unsuccessful biological (Sugaya type 3-4-5) recovery. Two patients were classified as type 3, two as type 4 and 3 as type 5. Surgery was recommended to symptomatic patients again; one patient with type 4 did not accept surgery, and tendon transfer was performed to a patient with type 5. Superior capsular reconstruction was performed in one patient with type 5, and arthroscopic Knotted-suture bridge double-row repair was performed in the others.

Study limitations: Although our study provided useful information, it also has some limitations. First, it is a retrospective review rather than a prospective randomized controlled study. Another limitation is the low number of patients and short follow-up period. The reason for this is that, in order to standardize the study, only patients with medium and large tears were included in the study and their treatments were performed by a single surgeon in a single center. Another limitation is that the results of applying a single type of repair technique cannot be compared with the control group. Therefore, in order to more clearly determine the effectiveness of the Knotted-Sutured Bridge double row technique in patients with medium-large full-thickness rotator cuff tears, more patients, for a longer period of time, and in comparison with the control group. We think that it should be examined and examined.

Conclusions

In conclusion, we believe that the arthroscopic double-row Knotted-Suture Bridge technique is a very effective treatment for medium and larg

rotator cuff tears, both functionally and in terms of anatomical and biological healing of the tendon, and provides excellent results in suitable patients.

Ethical approval: The University of Health Sciences Non-interventional Research Ethics Committee provided its approval to this study, which was carried out in accordance with the Helsinki Declaration (permission date/number: 2023/2023-333)

Conflict of interest: The authors declare that they have no conflict of interest for this study.

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Author contributions: EA, AOA conceived and designed the study. EA contributed to the data collection.CA, TT and DPK analyzed the data. EA and AOA wrote the manuscript. All authors read and approved the final manuscript and consented to publish this manuscript.

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Availability of data and materials: The datasets generated and/or analysed during the current study are available from the
corresponding author by reasonable request

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