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*Research Article*

# Partial and full-thickness rotator cuff tears in patients younger than 45 years

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ABSTRACT

***Objective:*** The aim of this study was to evaluate the results of the arthroscopic repair in patients with partial and full thickness rotator cuff tears and less than 45 years of age.

***Methods:*** Fifty patients (26 women and 24 men; mean age: 41.4±3.96 years; range: 31-45) with rotator cuff tear, and who were treated with the arthroscopic repair, were included in the study. Twenty patients had full thickness and 30 had partial-thickness tears. The final functional evaluation was conducted at a mean of 42.4 months (range, 24 to 95 months; SD:13.3). The American Shoulder and Elbow Surgeon (ASES) self-report score and the University of California at Los Angeles Shoulder Score (UCLA Shoulder Score) were used as validated scoring systems.

***Results:*** At the final follow-up, the mean ASES and UCLA scores improved significantly to 72.3 and 26.5, respectively, in the full-thickness group ($p<0.01$). The mean ASES and UCLA scores improved significantly to 70.7 and 25.3, respectively, in the bursal-side group ($p<0.01$). The mean ASES and UCLA scores improved significantly to 75.3 and 27.1, respectively, in the joint-side group ($p<0.01$). There were no significant differences between the groups according to the postoperative ASES score ($p>0.06$) and UCLA score ($p<0.37$).

***Conclusion:*** The arthroscopic repair of the joint-sided tears and bursal-sided tears has good functional outcomes as full thickness rotator cuff tears, and the surgical option should be considered in younger population if the conservative treatment fails.

***Level of Evidence:*** Level IV, Therapeutic study

## Introduction

The rotator cuff tears (RCT), whether full thickness or partial-thickness tears, are one of the most common shoulder pathologies causing pain and weakness (1). The histopathologic evidence proved that RCTs are frequently associated with degenerative etiology; however, rotator cuff injuries in younger patients are often related to trauma (2, 3). Minagawa et al. used ultrasonography to assess the integrity of the rotator cuffs and the prevalence of RCTs in general population, which was found to be 22.1%, while it was 0% in the 20s to 40s and 10.7% in the 50s (4). Gotoh et al. proved that the shoulder pain in the rotator cuff tear is independent of the depth or extent of the tear, and partial-thickness rotator cuff tears can sometimes be even more painful than the full-thickness tears, proportional to the degree of subacromial bursitis (5).

Three types of partial-thickness tears of the rotator cuff are entitled according to the region where the disruption occurs: 1) Joint-sided tears (JT) are confined to the glenohumeral joint, 2) Intratendinous tears (IT) are tears within the tendon, and 3) Bursal-sided tears (BT) are confined to the bursal side. The partial-thickness RCTs are almost always found in the supraspinatus tendon and may extend to the infraspinatus.

There are some prognostic factors for the healing of RCTs after surgery. Fermont et al. have noted that the younger age and higher bone mineral density are the positive prognostic factors in the rotator cuff healing (6). Meyer et al. investigated the reasons for failure of the rotator cuff repair and found that the osteoporotic bone, which is rarely seen in the younger population, can be one of the reasons of the failure (7). The vascular supply and tendon quality of the rotator cuffs are better in the younger patients (8). However, there is no study in the literature to support the assumption that the rotator cuff healing is better in the younger patients. In addition, most BTs and JTs respond poorly to the conservative treatment even in the young population (9). To our knowledge, there are few reports regarding the arthroscopic repair of the full thickness and partial-thickness RCTs in patients younger than 45 years in the literature (10-13). We reviewed the results following the arthroscopic repair of all the partial-thickness and full thickness RCTs in patients younger than 45 years. We hypothesized that good clinical and functional results can be obtained with

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the arthroscopic repair of both the full-thickness and partial-thickness RCTs in the younger population.

## Materials and Methods

A total of 76 patients younger than 45 years, among 452 patients who were diagnosed with partial and full thickness RCTs between 2010 and 2016, were included in the study. Written informed consent was obtained from the patients They were all treated arthroscopically by a senior surgeon at the same institute after non-operative treatment of the partial or full thickness RCT had failed. The revision procedures, subscapularis tears, imcompatibility to rehabilitation, and follow-up period of less than 24 months were the exclusion criteria for the study. Eleven patients were unreachable to return to the follow-up.

This is a retrospective study in which the data was collected prospectively for every patient before the surgery, which is a routine procedure at our institute. All patients were examined to identify the weakness of the rotator cuff and positive impingement sign. After the physical examination, the imaging studies were performed and the glenohumeral and acromioclavicular joints were assessed on the radiographs. MRI was used to confirm the diagnosis of the full thickness or partial-thickness RCTs. However, the arthroscopic examination made the final diagnosis for the patients who had partial-thickness RCTs as it is not easy to distinguish BT, JT, or IT with MRI. The final diagnosis with concomitant pathologies were documented for each patient.

RCTs were categorized into full thickness and partial-thickness tears (BT, JT, and IT). The concomitant pathologies were labral lesions, superior labrum anterior to posterior (SLAP), biceps long head tendinopathy, acromioclavicular degeneration, and distal clavicle resection. The SLAP repair, biceps tenodesis, and tenotomy were performed for these concomitant pathologies. Thirty-nine of the patients (78%) had a traumatic incident as a cause of their shoulder pain, as we expected in the younger population. The clinical practice in our institute is to wait for 6 weeks after the trauma, following the patients with NSAIDs and rest for 2 weeks, which is followed by physical therapy for 4 weeks. Those who have improvement in pain are followed further until they recover completely. Those who do not satisfactorily improve are suggested surgical treatment. The American Shoulder and Elbow Surgeon's (ASES) self-report score and the University of California at Los Angeles Shoulder Score (UCLA Shoulder Score) were used as the validated scoring systems (14, 15).

### Surgical Technique

The lateral decubitis position under 5 lb longitudinal arm traction was preferred, and the senior author performed all the operations arthroscopically. The arthroscopic examination of the subacromial space and glenohumeral joint was made, and the pathologies were noted for each patient before the RCT repair. During glenohumeral joint arthroscopy, the bicep pathologies were treated with tenodesis or tenotomy. For tenodesis of the bicep tendon, just anterior of the supraspinatus attachment side on the tuberculum majus was prepared for a 5-mm diameter suture anchor. After the bicep tendon is fixed to the bone, tenotomy of the intraarticular part was resected with a punch. The SLAP lesions were repaired with 4.5-mm diameter anchor suture. Prior to the subacromial bursoscopy, a prolone suture is placed through a spinal needle and used as a marker during bursoscopy to localize JT.

After the glenohumeral pathologies were assessed and treated, the RCT type and behavior were defined from the subacromial spaces. Then, the full-thickness RCT was identified according to the size and shape (cresentric, U shape, L shape). BTs were available to examine from the subacromial space and the prolene suture marker, which was sent to the glenohumeral joint via the spinal needle, and was also checked to determine whether JTs showed continuity on the bursal side. The acromion and acromioclavicular joint were examined, and the subacromial decompression and acromioplasty were done after the repair of RCT to avoid the effect of bleeding if the coracoacromial ligament (CAL) degeneration existed. The acromioclavicular joint resection arthroplasty was also done if there were positive physical examination signs with the imaging studies.

In the treatment of the full-thickness RCT, the rotator cuff tendon was debrided with a shaver until a healthy edge was obtained and mobilized from its anterior and superior margins. The remaining cuff tissue and the other soft tissues were removed from the footprint of the cuff on the greater tuberosity. The double-row repair configuration was applied to place the rotator cuff to its footprint. The full-thickness RCTs of this young age group were all non-retracted and without fatty infiltration since the tears were rather fresher and the patients were rather more active in their daily life. There was no patient with arthrosis in the affected shoulder in the groups. JTs and BTs were classified according to the Ellman classification and grade 3 partial-thickness tears were repaired (16). The debridement was done for the other JTs and BTs, and these patients were not included in the study. JTs were converted to full thickness RCTs by debriding of the intact tendon insertions. Then, the double-row repair technique was applied to JTs. The modified lateral tension band technique was used for BTs. In this technique, free sutures were passed through the anterior and posterior side of the tear (Figure 1a). Then, the sutures

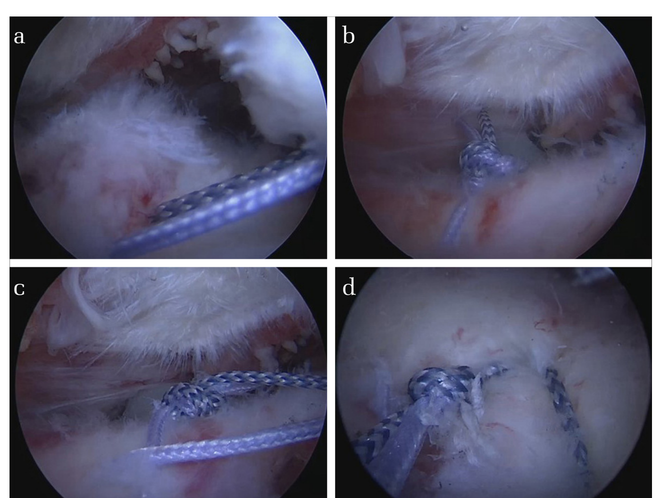


**Figure 1. a-d.** Modified lateral tension band technique (a, b, and c are from the posterior portal (d is from the lateral portal)

**HIGHLIGHTS**

- JTs were converted to full-thickness RCTs, then the double-row repair technique was applied.
- The modified lateral tension band technique (with one anchor) was used for BTs.
- It is important to restore the rotator cuff footprint for both full thickness and partial thickness RCTs. The modified lateral tension band technique (with one anchor) can restore the rotator cuff footprint in the arthroscopic repair of BTs.

**Table 1.** Demographic data of the patients

| Type of rotator cuff tear | | Full thickness | Joint-sided | Bursal-sided |
|---|---|---|---|---|
| Number of patients | | 20 | 21 | 9 |
| Age (years) (x±SD) | | 41.5±3.96 (range, 31-45) | 41.1±4.92 (range, 32-45) | 42.4±2.67 (range, 39-45) |
| Follow-up time (months) (x±SD) | | 41.7±10.3 (range, 29-78) | 42.6±16.3 (range, 28-95) | 43.5±13.1 (range, 24-74) |
| Sex (n [%]) | Male | 9 (45) | 12 (57.1) | 3 (33.3) |
| | Female | 11 (55) | 9 (42.9) | 6 (66.6) |
| Traumatic incident (n [%]) | Traumatic | 18 (90) | 19 (90.5) | 2 (22.2) |
| | Non-traumatic | 2 (10) | 2 (9.5) | 7 (77.8) |
| Concominant pathologies (n [%]) | SLAP repair | 4 (14.3) | 7 (28) | 0 |
| | Biceps Tenodesis/Tenotomy | 8 (28.6) | 3 (12) | 2 (16.7) |
| | Labral repair | 1 (3.6) | 0 | 0 |
| | Distal clavicle resection | 0 | 0 | 1 (8.3) |
| | Acromioplasty | 15 (53.5) | 15 (60) | 9 (75) |

SD: standard deviation

were knotted outside of the joint and pulled in the subacromial region (Figure 1b). After that, the other untouched ends were passed behind the knot and through the tendon again (Figure 1c). Finally, a modified lateral tension band technique was applied with the help of one anchor (Figure 1d).

**Postoperative care**

The patients were discharged after their meeting with a physical therapist on the first day after surgery. Immobilization in a sling for 6 weeks was applied for all patients with total or partial-thickness RCT. The passive range of motion (ROM) and pendulum exercises were directed by a physical therapist. After the sling was discontinued at 6 weeks, the full range of motion exercises were begun. Light resistance exercises were started at 3 months. As the patients tolerated more, the resistance exercises continued and full activity including sports activities were allowed after 6 months.

## Results

Fifty patients with a mean follow-up of 42.4 months (ranging from 24 to 95 months; SD: 13.3) and a mean age of 41.4 (ranging from 31 to 45; SD: 3.96) were reached. Twenty-six (52%) of the patients were females and 24 (48%) were males. There was a suddenly developed traumatic etiology in 39 patients (78%). There were 20 full thickness RCTs and 30 partial-thickness RCTs. Of the 30 partial-thickness tears, 21 (70%) were JTs and 9 (30%) were BTs. There were no significant differences between groups according to the age ($p>0.90$) and follow-up time ($p>0.60$).

Concominant pathologies were diagnosed with preoperative assessment (physical examination, X-ray, and MRI). These pathologies were also investigated with the arthroscopic examination of the shoulder. The demographic data and concominant pathologies for each group are shown in Table 1.

The overall mean preoperative ASES score was 23.8 (ranging from 8.3 to 36.6), postoperative ASES score was 72.2 (ranging from 11.6 to 88.3; $P < .01$), preoperative UCLA score was 12.7 (ranging from 9 to 22), and postoperative UCLA score was 26.1 (ranging from 8 to 35; $p<0.01$) across all groups.

The full thickness RCT group preoperative ASES score was 23.4 (ranging from 8.3 to 36.6), postoperative ASES score was 72.3 (ranging from 11.6 to 88.3; $p<0.01$), preoperative UCLA score was 12.9 (ranging from 9.0 to 22.0), and postoperative UCLA score was 26.5 (ranging from 8.0 to 35.0, $p<0.01$). The preoperative ASES score for the BT group was 23.4 (ranging from 11.6 to 36.0), postoperative ASES score was 70.7 (ranging from 60 to 81.6 $p<0.01$), preoperative UCLA score was 13.0 (ranging from 9.0 to 18.0), and postoperative UCLA score was 25.3 (ranging from 15.0 to 32.0; $p<0.01$). The preoperative ASES score for the JT group was 25.9 (ranging from 13.3 to 35), postoperative ASES score was 75.3 (ranging from 63.6 to 86.6; $p<0.01$), preoperative UCLA score was 12.0 (ranging from 10.0 to 15.0), and postoperative UCLA score was 27.1 (ranging from 22.0 to 33.0; $p<0.01$). There were no significant differences between groups according to the postoperative ASES ($p>0.06$) and UCLA scores ($p>0.37$).

The overall mean preoperative VAS pain was 7.9 (ranging from 5.0 to 10.0) and postoperative VAS pain was 3.1 (ranging from 1.0 to 10.0, $p<0.01$) across all groups. The full thickness RCT group preoperative VAS pain was 8.4 (ranging from 6.0 to 10.0) and postoperative VAS pain was 3.5 (ranging from 1.0 to 10.0, $p<0.01$). The preoperative VAS pain for the BT group was 7.6 (ranging from 5.0 to 10.0) and postoperative VAS pain was 3.2 (ranging from 2.0 to 5.0, $p<0.01$). The preoperative VAS pain for the JT group was 7.4 (ranging from 6.0 to 10), postoperative VAS pain was 2.3 (ranging from 1.0 to 4.0, $p<0.01$). There were no significant differences between groups according to the VAS scores ($p>0.24$).

There were no neurovasculer complications or wound infections within the patients. The closed shoulder manipulations were done under anaesthesia for two patients because of postoperative stiffness. No revision surgery was done for the rerupture of the rotator cuff.

## Discussion

There are many reports in the literature about the success of the arthroscopic rotator cuff repair, regardless of age. Among the factors that affect the success of the rotator cuff repair, the most controversial ones in the literature are the age, size of the tear, and type of the tear. Rudzki et al. reported that the vascularity of the intact rotator cuff decreases with age in the *in vivo* assesment of the vascularity of the rotator cuff (8). Boileu et al. used the computerized tomography (CT) arthrogram and MRI to asses the tendon healing after the arthroscopic rotator cuff tear repair (17). They found lower healing rates in patients over 65 years of age and that the delamination of the subscapularis and/or infraspinatus also had a bad influence on the tendon healing. Cole et al. reported a minimum 2-year functional MRI outcome of 47 patients (49 shoulders) who underwent the arthroscopic repair (18). When we examined the results of this study in relation to age (12 shoulders ≤49 years, 19 shoulders between 50 and 59 years, 10 shoulders between 60 and 69 years, 8 shoulders ≥70 years), VAS and external rotation power in the patients younger than 50 years were better than the patients over 60 years of age. In the same study, it was shown that the ratios of the rupture increased in patients 70 years of age or older and in the tears extending to the infraspinatus. However, unlike these reports, the long-term functional outcomes of the open repair technique in the young patients were not satisfactory. Sperling et al. reported outcomes of 29 shoulders at the age of 50 or younger with minumum follow-up of 13 years (19). They found that 45% of the patients had unsatisfactory results, and the tear size did not significantly affect the functional outcomes. Hawkins et al. reported the outcomes of the open rotator cuff repair of 19 patients who were younger than 40, at an avarage follow-up of 5.7 years, retrospectively (20). Only 12 (63%) patients were able to do above shoulder activities and the satisfactory rate was 68%. Watson and Sonnabend (21) reported the outcomes of open repair results from their study and emphasized that the patients younger than 55 years of age had the worse results. These results were not compatible with ours and other reports on the arthroscopic repair of the rotator cuff tears in young patients in the literature (10-13).

There are only a few studies that report the results of the arthroscopic rotator cuff tears in young patients. Lin et al. reported the arthroscopic RCT repair results of the patients younger than 45 years (13). The mean postoperative ASES score was 84.6 and patient satisfaction was 96.2%. In this study, they excluded the partial-thickness RCTs. Burns et al. reported the arthroscopic repair of the RCTs of the patients younger than 50 years of age and they categorized the tears into groups according to the type and size (12). They used the UCLA score to evaluate the functional scores, and the results were good or excellent in 95% of the cases. In this study, JTs were categorized as one group and there were no significant differences between these groups, similar to the present study. However, BTs were not categorised as a group. Dwyer et al. compared the clinical results of the arthroscopic full thickness RCT repair between the patients younger than 55 years and older (10). They reported that the younger patients had similar functional outcomes as the older individuals. Krishnan et al. also reported the clinical results of the full thickness RCT in the patients younger than 40 years (11). The mean postoperative ASES score was 92, similar to the present study; the traumatic etiology was more common in the younger population. Unlike the other studies reporting the clinical results of the arthroscopic RCT repair in young patients, we have also reported the clinical results of the arthroscopic partial-thickness RCT repair.

The partial tears of the rotator cuff are clinically important as they may be the cause of the shoulder pain and dysfunction in the young population. Both JTs, BTs, and ITs occur as a result of several intrinsic and/or extrinsic mechanisms, as discussed in the literature. Nakajima et al. reported that the joint-layers and bursal-layers of the rotator cuff are histologically and biomechanically different in their cadaveric study (22). The joint-layers of the rotator cuff did not elongate with a tensile load and tear easily while the bursal-layers were able to elongate and were resistant to tear. Therefore, they concluded that the traumatic events cause JTs more than BTs. Kanatlı et al. reported that the subacromial impingement syndrome is a strong etiological factor of BTs, and the coracoacromial ligament degeneration is a predictive factor for the impingement syndrome (23). Fukuda et al. reported a series of 66 partial tears and that 92.3% of ITs and 63.6% of JTs had an etiology of episodic trauma (1). This ratio was 8.6% for BTs. JTs may also occur secondary to the internal impingement syndrome in young throwers. Walch et al. made an arthroscopic examination of the 17 athletes who had unexplained shoulder pain on throwing, and were found to have impingement between the posterosuperior border of the glenoid and the undersurface of the supraspinatus (24). JTs were confirmed in 8 of 17 patients. In the present study, the trauma was the most seen etiologic factor among the patients who had partial-thickness cuff tears, and similar to the literature, this led to the JTs to be seen more often than BTs. In addition, the partial tears are currently considered to be multifactorial and the findings related to primary causes (CAL degeneration, subacromial impingement, and internal impingement) have also been considered during the arthroscopic treatment.

The arthroscopic treatment of the partial-thickness RCTs is controversial in the literature. Ellman (16) classified the partial tears based on the depth of the defect. If the thickness of the defect were less than 3 mm, grade 1; between 3 and 6 mm, grade 2; and more than 6 mm, grade 3. “A” added for the JTs and “B” for the BTs. Cordasco et al. presented the results of 162 patients who underwent the arthroscopic debridement and acromioplasty for grades 1, 2 (A, B) partial-thickness RCTs and rotator cuff without tear (25). They reported that there was no significant difference between the clinical outcomes of the patients with partial-thickness RCTs (grade 1 and 2) and the ones with healthy rotator cuff, although they considered primary repair for the grade 2B subgroup responsible for the statistically high failure rate. Many articles in the literature suggest rotator cuff repair when the tear contains more than 50% of the tendon thickness (26, 27). Yang et al. also recommended repair for > 50% thickness BTs in their biomechanical study (28). In the present study, grade 3A and grade 3B partial-thickness RCTs were arthroscopically repaired. However, we believe that the studies involving more patients should be performed on the repair indications of the grade 2 partial-thickness RCTs.

In the repair of full thickness RCTs, it has become important to restore the rotator cuff footprint. In a biomechanical study reported by Apreleva et al., the repair methods for the simulated RCTs on cadaver were compared with 3-dimensional (3D) area of the original rotator cuff insertion (29). The authors showed in this study that the rotator cuff repair with the single-row technique restored only 67% of the original footprint. Kim et al. stated that the footprint restoration provided by the double-row repair improved the initial strength and stiffness and decreased the gap formation as compared to the single row anchor repair in a biomechanical study on the cadavers (30). The other studies in the literature have also indicated that the double-row technique is more effective at restoring the footprint and healing the rotator cuff tears (31-34). Similar to the literature, the full thickness RCTs were repaired with the double-row technique in the present study. JTs were also converted to full thickness as it was reported that over 90% of the intact tendons show moderate histopathological degeneration after debridement (35). BTs are repaired with the modified lateral tension band technique. We modified the technique reported by Park et al., as described in the surgical technique section (36). We aimed to restore the footprint better as the knot pushes the tendon down medially while the untouched ends pulled laterally with the anchor.

This study, however, is subject to several limitations. Firstly, this study has a retrospective design and limited sample size for each group. The groups are heteregenous as they contain different tear types and repair methods. Also, the postoperative MRI data showing the results of these repair methods are not included in this study. However, despite these limitations, the results of this study provided preliminary information for both the full thickness and partial-thickness RCTs in younger ages.

In conclusion, this study assesed the treatment of patients younger than 45 years with full thickness and partial-thickness RCTs. In younger patients, the traumatic etiology is more commen for RCTs. The arthroscopic repair of JTs and BTs also has good functional outcomes as full thickness RCTs; the surgical option should be considered in younger population if the conservative treatment fails.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of Dr. Abdurrahman Yurtaslan Ankara Onkoloji Training and Research Hospital (2019-08/358).

**Informed Consent:** Written informed consent was obtained from the patients.

**Author Contributions:** Concept - U.K., A.Y.K.; Design - U.K.; Supervision - U.K.; Materials - A.Y.K., U.K., T.A.; Data Collection and/or Processing - M.Ç., A.Y.K., M.Ö., M.B.A.; Analysis and/or Interpretation - M.Ç., T.A.; Literature Search - A.Y.K, M.B.A., C.U.; Writing Manuscript – A.Y.K., M.Ç., C.U.; Critical Review - U.K., M.Ö.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

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