Joint Diseases and Related Surgery

Jt Dis Relat Surg
2025;36(3):696-701

ORIGINAL ARTICLE

Mid- to long-term results of modified tension band technique for small- and medium-sized rotator cuff tears

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ABSTRACT

Objectives: This study aims to evaluate the mid- to long-term outcomes of the tension-band suture technique for small- and medium-sized rotator cuff tears.

Patients and methods: Between January 2015 and January 2022, a total of 36 patients (21 males, 15 females; median age: 55 years; range, 35 to 65 years) with small- and medium-sized tears, classified according to Coefield, who were treated with the arthroscopic modified tension-band method were retrospectively analyzed. Functional outcomes were assessed using the American Shoulder and Elbow Surgeon (ASES) shoulder scores, and structural evaluations were conducted via ultrasound. Patient satisfaction was measured using the ASES Index score. Concomitant biceps pathology and the number of anchors used were also recorded.

Results: The overall median follow-up was 49.9 (range, 22 to 100) months. There was a significant postoperative improvement in functional outcomes, with the median preoperative ASES score of 18.5 (range, 8 to 32) improving to 89 (range, 68 to 100). However, patient satisfaction, as measured by the ASES Index score (median: 4.4), declined after 52 months. Retears occurred in six patients, primarily after 52 months, indicating long-term issues. No correlation was found between outcomes and patient age, biceps tendon pathology, or the number of anchors used.

Conclusion: Our study results highlight the arthroscopic modified tension-band technique as a viable option for small- to medium-sized rotator cuff tears, offering favorable functional outcomes, but raising concerns about long-term patient satisfaction.

Keywords: Long-term results, modified tension band technique, rotator cuff tears.

Arthroscopy-assisted treatment, described by Levy et al.[1] in the 1990s, has made rotator cuff tears one of the most intriguing conditions in shoulder surgery. When it comes to arthroscopic rotator cuff repairs, the repair methods, the superiority of different repair techniques, and the factors affecting clinical outcomes have been topics of discussion for many years.[2-5]

It has been shown that the structural characteristics of the torn tissue (such as fatty infiltration, sagittal plane length, delamination, etc.) affect the prognosis.[2-5] However, significantly, considerable research has focused on "double-row repair" which is assumed to impact the healing potential of the repair site. Although higher functional scores have been achieved with double-row repair for tears larger than 3 cm, this difference does not reach statistical significance.[6-8]

Completely covering the potential healing area is a key rationale behind the philosophy of double-row repair.[9] However, double-row repair is not the only option for fully covering the potential healing

Received: April 10, 2025
Accepted: June 14, 2025
Published online: July 21, 2025

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Citation: Demir T, Bekmezci T, Karaca H, Aykut S, Çepni SK. Mid- to long-term results of modified tension band technique for small- and medium-sized rotator cuff tears. Jt Dis Relat Surg 2025;36(3):696-701. doi: 10.52312/jdrs.2025.2321.

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area. The tension-band suture technique, initially described by Boileau et al.,[10] in which an inverted sutured mattress suture placed medially combined with laterally placed self-locking anchor, similarly aims to cover the entire potential healing area with the rotator cuff. In this repair model, the fixation of U-sutures passed through the tendon ends is achieved through a lateral row anchor configuration.

While lateral row fixation without creating a medial row is advantageous in terms of reducing the need for implants and the duration of the procedure, the long-term follow-up results remain unclear. In the present study, we aimed to evaluate the mid- and long-term follow-up results of patients in whom the tension-band fixation method was applied and to identify the factors affecting these outcomes.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Giresun Training and Research Hospital, Department of Orthopedics and Traumatology between January 2015 and January 2022. Initially, a total of 83 patients with rotator cuff tears who underwent arthroscopic rotator cuff surgery were screened. Among the patients with isolated full-thickness supraspinatus tendon tears treated with the arthroscopic tension band technique, those with tears less than 3 cm in the sagittal plane, without retraction to the level of the glenoid in the coronal plane, and classified as small- and medium-sized tears according to the Cofield classification[4] repaired arthroscopically by modified tension band technique were included in the study. All the patients had intact subscapularis tendons. Finally, a total of 36 patients (21 males, 15 females; median age: 55 years; range, 35 to 65 years) were recruited. Written informed consent was obtained from each patient. The study protocol was approved by the Giresun Training and Research Hospital Scientific Research Ethics Committee (Date: 31.07.2024, No: BAEK-89 31.07.2024). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical technique

All patients were operated by single surgeon in the beach chair position under general anesthesia. The glenohumeral joint and subacromial space were evaluated sequentially using standard anterior-posterior-lateral portals. Pathologies of the superior labrum and biceps tendon were assessed. Superior labrum anterior posterior (SLAP) lesions were repaired arthroscopically or biceps tenotomy was performed. Subacromial bursectomy was carried out. Subsequently, the torn supraspinatus tendon and the footprint on the greater tuberosity were debrided to prepare for repair. No. 2 high-strength free U stitches were passed through the tendon using a suture passer. Two U stitches were used for small tears, and four U stitches for medium-sized tears. The suture limbs were passed through knotless 5-mm anchors and hammered into the lateral row, known as the lateral side of the greater tuberosity (Figure 1). One anchor was used for small tears, and two anchors for medium tears.

Postoperative rehabilitation

Patients using an arm sling for the first six weeks were rehabilitated to achieve passive range of motion early in the recovery period. From the sixth week onwards, exercises focused on achieving active range of motion and muscle strengthening were performed.

Patients' age, sex, size of the sagittal plane tear, accompanying biceps pathology, and treatments related to these pathologies were examined. Additionally, data on the number of anchors used for the tear and follow-up duration were collected. At the final follow-up assessments, ultrasound was used to evaluate the quality of repair and assess the tear.

For functional assessment, the American Shoulder and Elbow Scores (ASES) were measured

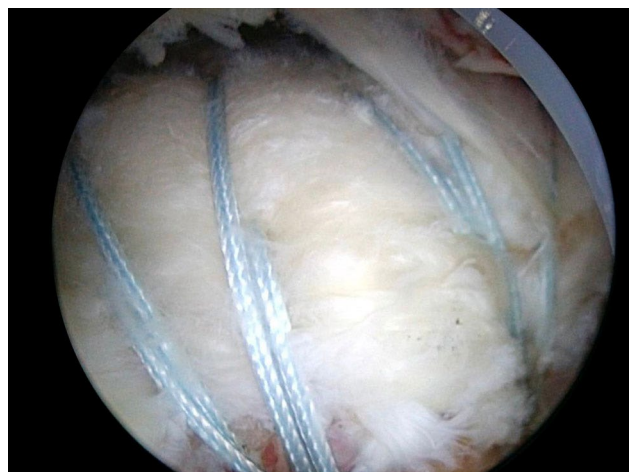


FIGURE 1. Lateral portal view of the repaired medium-sized supraspinatus tendon tear in the right shoulder. Two reinforced U-shaped sutures were passed through both the anterior and posterior parts of the tendon tear, and the suture ends were fixed to the lateral aspect of the greater tubercle with one anchor each, creating a tension band configuration.

TABLE I
Patient demographic data and retear incidence (n=36)

	n	%	Median	Min-Max
Sex				
Female	15	41.6		
Male	21	58.4		
Age at the time of surgery (year)			55	35-65
Follow-up period (month)			49.9	22-100
Tendon tears size				
Medium	21	58.4		
Small	15	41.6		
Ultrasonography control examinations				
Partial tears	4	11		
Full-thickness tears	2	5		

both preoperatively and at final evaluations postoperatively. To objectively assess the benefit patients derived from surgery, a parameter called the Index score was used. The Index score measurement was obtained using the equation: (postoperative ASES - preoperative ASES)/preoperative ASES.

Statistical analysis

Statistical analysis was performed using the MedCalc version 23 software (MedCalc Software Ltd., Belgium). Descriptive data were expressed in median (min-max) or number and frequency, where applicable. Data normality was checked using the Kolmogorov-Smirnov test. The Wilcoxon test was used to demonstrate statistical changes between pre- and postoperative ASES scores. To determine correlations between factors which could influence postoperative ASES scores and Index score measurements, the Spearman's rank correlation test was used. A p value of <0.05 was considered statistically significant.

RESULTS

The overall median follow-up was 49.9 (range, 22 to 100) months. According to Cofield classification, 21 patients had medium sized (1-3 cm) supraspinatus tendon tears and 15 patients had small (>1 cm) supraspinatus tendon tears. Medium-sized tears were repaired with two polyetheretherketone (PEEK) knotless anchors, and small tears with one such anchor. Twelve (33.3%) patients had no biceps pathology. Nine (25%) patients underwent arthroscopic SLAP repair for type 2 SLAP lesions, and 15 (41.6%) patients underwent tenotomy due to biceps tendon degeneration. Ultrasound control examinations revealed partial tears in four (11%) patients and full-thickness small tears in two (5%) patients (Table I).

The median pre- and postoperative ASES scores were 18.5 (range, 8 to 32) and 89 (range, 68 to 100), respectively. There was a statistically significant difference between the two measurements (p=0.0005) (Figure 2). The median Index score was 4.4 (range, 1.4 to 9.3).

No correlation was found between age, follow-up duration, biceps tendon issues, or the number of anchors and the final ASES score. The Index score, however, was correlated only with the follow-up duration (p=0.004) (Table II). Fifteen patients had a median follow-up duration of 22 to 49 months, while 21 patients had a follow-up duration of 52 to 100 months. While examining the relationship

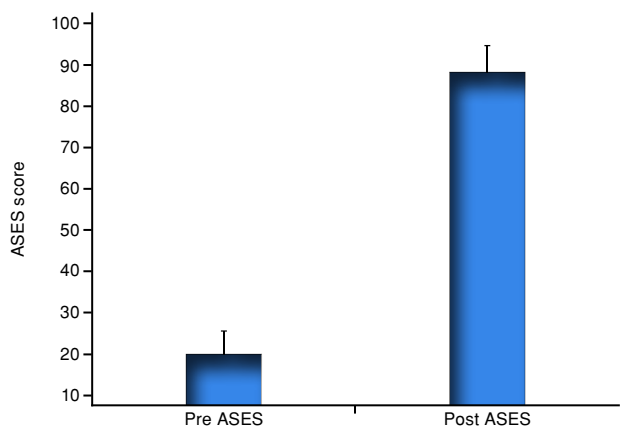


FIGURE 2. Median preoperative and postoperative ASES scores.
ASES: American Shoulder and Elbow Surgeons.

TABLE II
Correlation between postoperative ASES score and Index ASES score values with the patient's age, the number of anchors used, biceps pathology, and follow-up duration

Spearman rank test	Postoperative ASES score	Index ASES score
Age	0.8449	0.6806
Anchor	0.8193	0.4914
Biceps pathology	0.4670	0.9268
Follow	0.2029	0.0040

ASES: American Shoulder and Elbow Surgeons; Only follow up time and index score were correlated.

between the Index score and follow-up durations, no correlation was observed, when follow-up durations of 52 months and over were excluded from the series (p=0.1881). However, when each case with a follow-up duration over 52 months was included in the series and the test was repeated, the correlation was observed and persisted.

Among the four partial tears detected during follow-up ultrasound examinations, all were small tears fixed with a single anchor, and three of these tears occurred in patients with follow-up durations of 52 months or over (52, 63, and 67 months, respectively). One partial tear was included in the study with a 49-month follow-up and was a small tear fixed with a single anchor.

Two full-thickness tears were detected during ultrasound examinations at 86 and 100 months. These cases were medium-sized tears fixed with double anchors.

DISCUSSION

In the present study, we evaluated the mid- and long-term follow-up results of patients in whom the tension-band fixation method was applied and identified the factors affecting these outcomes. The main finding of this study was that, although functional outcomes of patients with small- to medium-sized tears repaired arthroscopically using the lateral single-row modified tension band technique did not deteriorate over time, patient satisfaction decreased. The ASES index score declined after 52 months postoperatively. Long-term outcomes showed no relationship with age, biceps tendon issues, or the number of anchors used. One retear was detected by ultrasound at 49 months, while three partial and two full-thickness retears occurred after 52 months.

Small- and medium-sized tears were repaired using the single-row lateral modified tension band technique according to the Cofield classification, as large tears have shown low healing potential and high retear rates with this method.[11] Boileau et al.[10] reported that only 71% of tendons healed in 65 patients. Although age was a key factor, healing was notably poor in large and retracted tears, with retear rates up to 100%. Another Boileau study with 117 patients showed that tear size and delamination reduced healing rates from 81 to 39%.[5] Bae et al.[12] also treated 31 small and medium tears with this technique and reported a 6% retear rate. However, in large tears, the rate increased up to 69%. These findings confirm the feasibility of the technique for small and medium tears.[5,10,12] In our study, the retear rate was 16% (4 partial, 2 full), possibly due to the longer follow-up period a median of 49 months compared to 29 in previous studies.

The technique, described by Boileau et al.,[10] uses a single-row knotless anchor lateral to the greater tuberosity. Thus, results can be compared with conventional single-row repairs. Lapner et al.[13] reported a 23% retear rate after two years. Hueberer et al.[14] reported a 75% rate at 10 years, with 50% total and 25% partial tears. This suggests that retear rates in long-term follow-ups are usually higher than in our series. Conventional single-row repairs rely on single-point fixation, which limits tendon-bone contact. Additionally, inverted mattress sutures used in the tension band technique are mechanically stronger than simple sutures. Boileau et al.[10] emphasized the technique's advantages in providing a good adhesion bed and compressing the tendon effectively. The fact that all our cases were small- to medium-sized tears may also explain the relatively lower retear rates.

Review of the literature reveals controversial findings on whether retears affect functional outcomes. Some studies suggest functional decline over time with retears. Lapner et al.[13] reported

deterioration after two years. Jeong et al.[15] and Yau[16] found that retears begin affecting function in the long term, particularly by year five. Our results show that retears can occur even later (after 49 months), likely due to lower tension during repair. Tear size still remains a known risk factor for retears.[17]

Furthermore, several studies have demonstrated that the functional outcomes of rotator cuff tears are independent of the number of anchors used.[17] While single-row repairs typically require one to four anchors, double-row repairs may require two to seven anchors.[8] When focusing exclusively on small- to medium-sized tears, the number of anchors required for single-row repairs ranges from one to three, depending on the tear size, whereas double-row repairs necessitate two to five anchors. In our series, one anchor was used for small tears and only two anchors for medium-sized tears.[18] This indicates that the modified tension band technique is usually more economical than the double-row repair technique. Considering our long-term results, it can be evaluated as cost-effective. Furthermore, the presence of biceps pathologies and the necessity for additional surgical interventions did not significantly impact the overall outcomes, consistent with previous research findings.[19,20]

Although functional outcomes remained stable, patient satisfaction (ASES index score) declined over time, particularly after month 52. The ASES index reflects improvement relative to preoperative scores. Over time, patients may lose awareness of these gains. While not statistically significant, late retears may contribute. Thus, the ASES index may serve as a long-term marker of loss of improvement or retear development. While only one retear was detected by ultrasound at 49 months, the others (three partial, two full-thickness) were found after 52 months.

Nonetheless, there are several limitations to this study. First, the single-center, retrospective nature limits the ability to control for confounding variables and biases, increasing the likelihood of incomplete or inconsistent data which can impact the reliability of the findings and their generalizability to the broader population. Second, the lack of control groups of standard single row and double row repairs restricts the ability to compare the outcomes of the modified tension band technique with other surgical methods or approaches. Furthermore, this absence poses challenges in accurately assessing the cost-effectiveness of the technique, as comparisons with alternative treatments cannot be made. Specifically, a critical aspect of evaluating cost-effectiveness involves comparing the number of anchors used in this study with those used in other studies within the literature.

Another significant limitation may be the reliance on a single postoperative ultrasound examination; however, the use of ultrasonography in diagnosing rotator cuff pathologies is quite common. Although there are questions regarding its accuracy in detecting partial tears, studies conducted between 2016 and 2020 have reported a substantial increase in detection rates, demonstrating high sensitivity and specificity for both partial and full-thickness tears.[21] Gilat et al.[22] reported extremely high specificity and sensitivity rates in detecting retears during follow-up after rotator cuff tear surgeries. Therefore, and considering that ultrasound is easily tolerated by patients, readily accessible, and cost-effective, only ultrasound was employed in the follow-up assessments.

In conclusion, the modified tension band technique yields favorable long-term functional outcomes for small- to medium-sized rotator cuff tears (Cofield classification). However, despite stable function, patient satisfaction tends to decrease over time. Based on these findings, we suggest that for further research to address the gap between functional outcomes and patient satisfaction.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Conceptualization, methodology: T.B., T.D.; Validation and formal analysis, investigation, writing-original draft preparation: T.D., T.B., H.K., S.A., S.K.C.; Data curation: T.D., T.B., H.K.; Writing-review and editing: T.D., H.K.; Visualization: T.B.; Supervision: T.D. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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