

Retrospective Evaluation of Clinical and Radiological Results of Patients Treated With Arthroscopic Transosseous Repair for Rotator Cuff Tear

Review began 09/25/2024
Review ended 10/02/2024
Published 10/07/2024

© Copyright 2024
Aydin et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.71004

Mustafa Aydın ¹, Ahmet Firat ²

1. Orthopedics and Traumatology, Gülhane Training and Research Hospital, Ankara, TUR 2. Orthopedics and Traumatology, Etlik City Hospital, Ankara, TUR

Corresponding author: Mustafa Aydın, mustafaaydin5528@gmail.com

Abstract

Background: Surgical repair is recommended for symptomatic full-thickness rotator cuff tears to restore muscle function and alleviate pain. Advances in arthroscopic techniques and new implant designs have led to more reliable repair methods. The choice of technique is crucial for achieving favorable clinical outcomes.

Objectives: This study evaluates the short-term clinical and radiological outcomes of patients treated with the arthroscopic transosseous technique (ATO).

Methods: Data from 43 patients who underwent full-thickness rotator cuff (RC) repair using the arthroscopic transosseous technique between February 2014 and April 2016 were prospectively collected and retrospectively reviewed. Included patients had medium-sized (1-3 cm) full-thickness supraspinatus tears extending to the infraspinatus and underwent tenotomy or biceps tenodesis. Functional outcomes were assessed using the Visual Analog Scale (VAS), American Shoulder and Elbow Surgeons (ASES) score, and constant score at their final follow-up appointment.

Result: Radiological evaluation included postoperative MRI to assess re-tear development. The mean follow-up period was 26.52±8.14 months. Postoperative VAS, ASES, and constant scores significantly improved compared to preoperative values (3.14±1.20, 88.4±8.12, and 88.9±10.6, respectively).

Conclusion: The ATO technique provides strong mechanical and biological repair, yielding good functional outcomes for full-thickness rotator cuff tears (RCTs). It is an effective method for early recovery of shoulder joint range of motion (ROM) and pain reduction.

Categories: Orthopedics, Sports Medicine

Keywords: ato technique, chronic joint pain, cortical implant, ortho-biologics, rotator cuff tears

Introduction

The prevalence of rotator cuff tears (RCT) significantly increases with age and is a common cause of shoulder joint pain and restricted movement [1]. Surgical repair is preferred for symptomatic RCTs to reduce pain and restore muscle function. The technique used in the repair is critical for achieving satisfactory clinical outcomes [2,3].

Single-row (SR) repair methods have been reported to fail in restoring the rotator cuff (RC) attachment site, which is known as footprint, thus leading to high failure rates [4,5]. Advances in arthroscopic techniques and implant designs have introduced safer and more reliable fixation options like double row (DR) and arthroscopic transosseous equivalent (TOE) suture bridge techniques, as well as transosseous techniques (ATO) with or without implants. These developments aim to increase contact area at the footprint, provide stable repair under tensile loads, and improve bone-tendon healing and functional outcomes.

The most common postoperative complication is re-tearing due to insufficient repair [6]. Failures in RCT repair are often caused by knot failure, suture loosening, implant pullout, and anchor fixation loss [7]. Reports indicate that anchor fixation loss and implant pullout result in 10% to 80% of revision RC repair surgeries [8]. Anchor fixation strength is influenced by bone density, anchor design, and repair technique [9]. Transosseous sutures have been reported to provide greater contact area than anchor repairs [10]. The aim of the study is to evaluate the short-term clinical and radiological outcomes of patients who underwent RCT repair with the ATO technique retrospectively.

Materials And Methods

How to cite this article

Aydın M, Firat A (October 07, 2024) Retrospective Evaluation of Clinical and Radiological Results of Patients Treated With Arthroscopic Transosseous Repair for Rotator Cuff Tear. Cureus 16(10): e71004. DOI 10.7759/cureus.71004

Ethical approval and informed consent were obtained from all patients. Data from 43 patients who underwent full-thickness RCT repair using the ATO technique between February 2014 and April 2016 were prospectively collected and retrospectively reviewed. All patients were operated on by a single experienced arthroscopic surgeon.

The inclusion criteria for the study were determined as having a medium (1-3 cm) full-thickness supraspinatus tear extending to the infraspinatus or supraspinatus according to Cofield classification [11], having undergone RCT repair with ATO technique, including tenotomy or biceps tenodesis, and having attended postoperative check-ups regularly within the first year.

Patients who had subscapularis tear, Goutallier stage 3-4 fatty infiltration, frozen shoulder, humeral head osteonecrosis or osteomyelitis, shoulder joint arthritis, and those who had undergone arthroscopic repair of a superior labrum anterior-posterior (SLAP) lesion or any other surgery on the same shoulder previously were excluded from the study. Thirty-three patients were included in the study according to these criteria.

Surgical technique

All surgeries were performed under general anesthesia in the beach chair position. Diagnostic arthroscopy confirmed the joint. After bursectomy and acromioplasty, the footprint and tear edges were refreshed. A tunnel was drilled 18-20 mm distal to the lateral tubercle corner, aligned with the tear center (Figure 1).

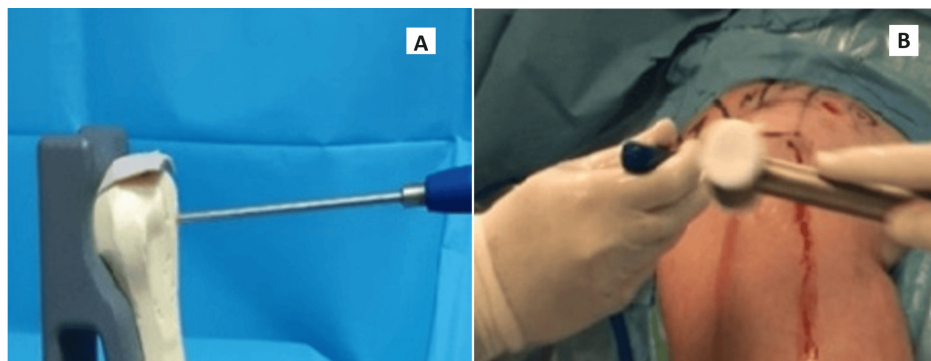


FIGURE 1: (A) Picture demonstrate opening an entry hole for a transosseous implant; (B) picture of opening an entry hole for a transosseous implant intraoperatively

A transosseous tunnel was created using a tool with a carrier suture, exiting near the cartilage border (Figure 2).

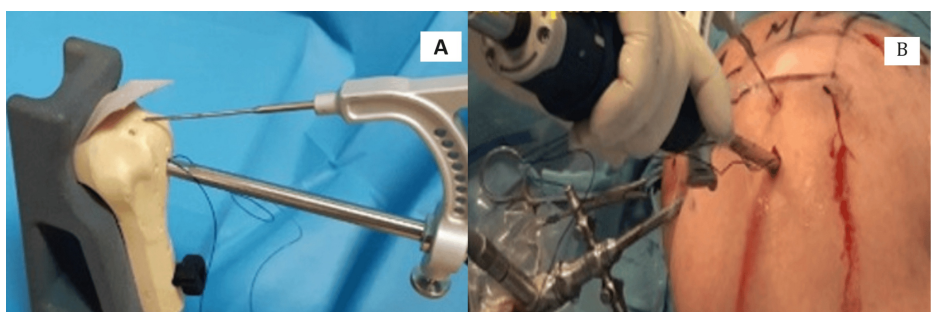


FIGURE 2: (A) Demonstrate of placement the transosseous suture passer with the targeter; (B) showing the placement of transosseous suture passer with the targeter intraoperatively

Two sutures were loaded onto a transosseous implant, passed through the tunnel with the carrier suture, then pulled through the anterior portal and fixed to the cortex. The sutures from the tunnel were passed through the rotator cuff and tied to create a medial row repair (Figure 3).

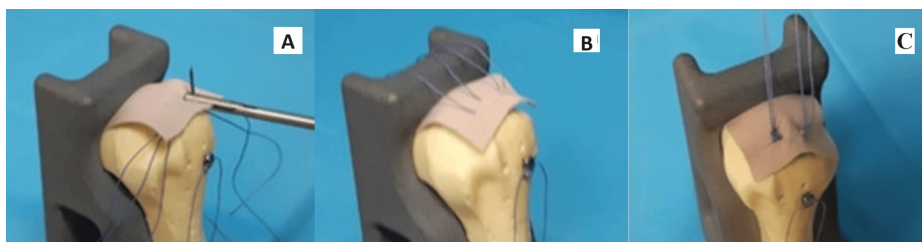


FIGURE 3: (A) and (B) Passing the sutures through the rotator cuff; (C) tying them in the medial order

Each suture's end was passed through a hole behind the implant and tied to complete the lateral row repair and suture bridge (Figure 4). The coracoacromial ligament was preserved in all patients.

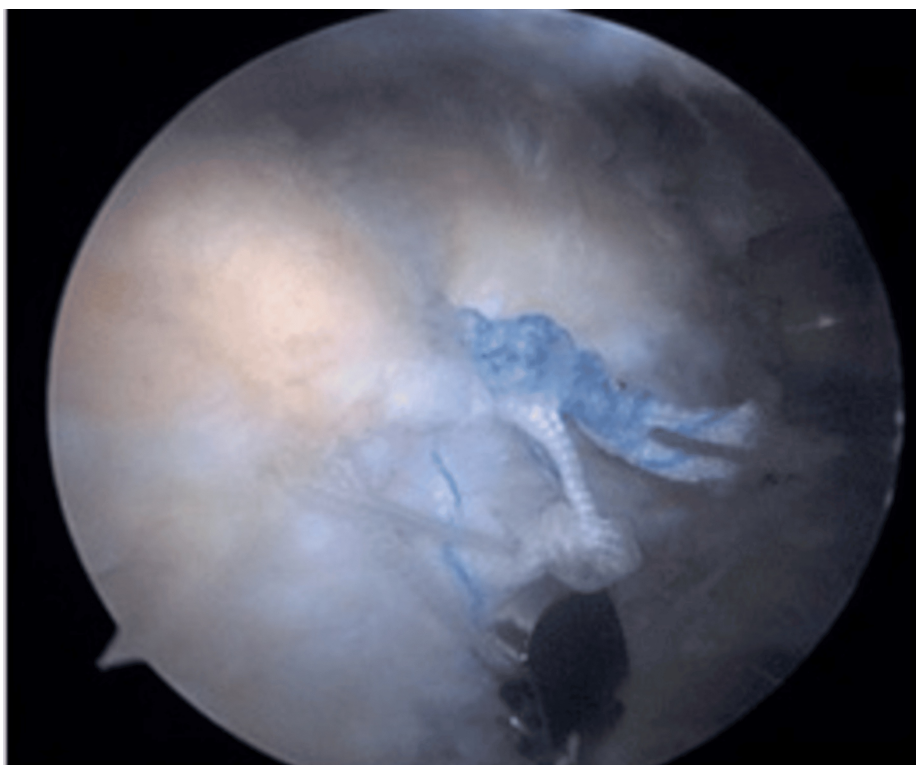


FIGURE 4: Each suture's end was passed through a hole behind the implant and tied to complete the lateral row repair and suture bridge

All patients followed a standard rehabilitation program.

Outcome evaluation

Clinical evaluations were performed by an experienced shoulder surgeon. Preoperative and postoperative shoulder X-rays and MRIs were reviewed for tear presence, involved tendons, retraction amount, and fatty degeneration grade (Figure 5).



FIGURE 5: Postoperative antero-posterior shoulder radiograph

The shoulder range of motion (ROM) was preoperatively measured with a goniometer. Forward elevation, abduction, internal rotation, and external rotation were assessed at the final follow-up. Tear type was classified according to Ellman and Gartsman [12], and tear size was measured intraoperatively and classified by Bayne and Bateman [13] as small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (>5 cm).

Clinical outcomes were assessed using Visual Analog Scale (VAS), American Shoulder and Elbow Surgeons (ASES), and Constant shoulder scores preoperatively and at the final follow-up. An experienced musculoskeletal radiologist performed a radiological evaluation, assessing anchor position on standard AP shoulder X-rays and re-tear presence on final follow-up MRIs. According to Sugaya et al. [14], re-tear was considered repair failure and staged.

Statistical analysis

Data were analyzed using SPSS 22.0 (IBM Corp., Armonk, NY). Normal distribution suitability was tested with the Kolmogorov-Smirnov test. Pearson correlation, Kruskal-Wallis, Mann-Whitney U, Pearson chi-square, and Fisher's exact tests were used for various comparisons. Paired samples and Wilcoxon tests evaluated changes over time. A power analysis of 95% was determined, with a significance level set at $p < 0.05$.

Results

In our study, 33 patients who underwent arthroscopic transosseous surgery with 1-3 cm long tears were evaluated. The mean follow-up period was 26.52 ± 8.14 months. The mean age of patients was 56.0 ± 6.4 years (min: 42, max: 68). 27 patients (81.8%) were female. 32 (97%) of the patients had the right hand dominantly together, and 24 (72.7%) had lesions on the right side. Additional comorbidities were detected in 19 (57.6%) patients, and demographic data are presented in Table 1.

	Mean ± SD/n(%)
Age	56.0±6.4
Gender, n (%)	
Female	27 (81.8)
Mean	6 (18.2)
Dominant hand, n (%)	
Right	32 (97)
Left	1 (3)
Laterality, n (%)	
Right	24 (72.7)
Left	9 (27.3)
Duration of follow-up (month)	26.52±8.14
Comorbidities, n (%)	
Present	19 (57.6)
Absent	14 (42.4)
Comorbidity subgroups, n (%)	
Hypertension	9 (27.3)
Diabetes mellitus	7 (21.2)
Thyroid diseases	6 (18.2)
Hyperlipidemia	5 (15.2)
Malignity (breast)	1 (3)

TABLE 1: Demographic data

SD: standard deviation.

The mean tear size was assessed as 22.4±5.9 mm from preoperative MRI data. In addition, the tear shape was determined by examining the surgery reports in the patient files; 19 patients (57.6%) had a crescent-shaped tear, 8 (24.2%) had a U-shaped tear, and 6 (18.2%) had an L-shaped tear (Table 2). Infrapinatus tears were absent in 23 patients (69.7%) and present in 10 (30.3%). Two patients had type 2 SLAP lesions and underwent biceps tenodesis (Table 2).

	Mean \pm SD/n (%)
Tear size	22.4 \pm 5.9
Tear type, n (%)	
Crescent	19 (57.6%)
U-shaped	6 (18.2%)
L-shaped	8 (24.2%)
Infraspinatus tear, n (%)	
Absent	23 (69.7%)
Present	10 (30.3%)
Type 2 SLAP n (%)	
Present	2 (6%)
Biceps tenodesis, n (%)	
Present	2 (6%)

TABLE 2: Tear size, type, additional pathologies, and procedures performed

SD: standard deviation

Our study compared preoperative and postoperative shoulder ROM, pain measurement (VAS), and Constant ASES scores. Significant improvement in active ROM was observed postoperatively ($p < 0.001$), and VAS (3.14 ± 1.20), ASES (88.4 ± 8.12), and Constant (88.9 ± 10.6) scores showed significant differences postoperatively ($p < 0.05$) (Table 3).

	Preoperative mean \pm SD	Postoperative mean \pm SD	p-value
Abduction	84.9 \pm 11.1	160.8 \pm 9.4	<0.05
Forward elevation	83.6 \pm 12.8	159.1 \pm 11.7	<0.05
Internal rotation	49.9 \pm 3.9	65.3 \pm 5.0	<0.05
External rotation	67.1 \pm 5.2	83.3 \pm 7.7	<0.05
VAS	8.17 \pm 1.41	3.14 \pm 1.20	<0.05
ASES	46.8 \pm 15.2	88.4 \pm 8.12	<0.05
Constant	32.1 \pm 6.4	88.9 \pm 10.6	<0.05

TABLE 3: Abduction, forward elevation, internal rotation, external rotation, VAS, ASES, and Constant scores preoperatively and postoperatively

VAS: Visual Analogue Scale; ASES: American Shoulder and Elbow Surgeons; SD: standard deviation. *P-values < 0.05 were considered statistically significant.

Preoperative fatty infiltration was grade 1 in 3 patients (9.1%) and grade 2 in 4 patients (12.1%), with postoperative grades of 9.1% for both. Two patients showed regression in fatty infiltration, though not statistically significant ($p > 0.05$). Seven patients (21.2%) showed repair failure on postoperative MRI (Sugaya III, IV, V). Re-tear patients had significantly higher mean age, larger tear size, and lower postoperative Constant scores ($p < 0.05$) (Table 4).

	Rerupture		p-value
	Absent (n:26) mean ± SD	Present (n:7) mean ± SD	
Age	54.6±6.1	61.1±4.5	0.012*
Postoperative Constant score	92.7±7.2	75±9.7	<0.05*
Tear size	20.9±5.7	28±1.9	0.002*

TABLE 4: Relationship between age, Constant scores, and tear size in rerupture

SD: standard deviation. *P-values < 0.05 were considered statistically significant.

One patient developed adhesive capsulitis as a complication, and one had radiological lateral cortex erosion without clinical symptoms due to the flexible implant structure.

Discussion

The main findings of this study are significant improvements in ROM and Constant shoulder scores and a significant reduction in pain scores following ATO repair. Postoperative pain was absent in 25 patients (75.8%) and mild in 8 (24.2%). Shoulder ROM significantly increased, with average abduction rising from 84.9° to 160.8°.

Many surgical methods for RCT treatment have been compared in the literature, with recent studies showing that transosseous and transosseous equivalent repairs provide the best pressure and strength at the footprint [15-18]. The increased contact area between the tendon and footprint enhances biological healing along with the mechanical strength of the repair. As the footprint surface area in contact with the tendon increases, a stronger healing response is achieved. It has been shown that transosseous sutures provide contact over a broader surface area compared to repair with anchors [10]. Our method combines several repair techniques, offering reliable transosseous fixation, medial and lateral row repair, and transosseous equivalent techniques through implant design, providing a broad contact area and stable repair.

In elderly osteoporotic patients, implant pullout and anchor fixation loss are common causes of RCT repair failure [7]. Revision RCT surgeries often address anchor fixation loss and implant pullout [8]. Anchor fixation strength depends on bone density [9]. Our method ensures solid fixation with a transosseous implant, preventing cortical deformation in osteoporotic bone. By positioning the lateral wings of the implant on the lateral part of the bone, the deformation of the cortex in the osteoporotic bone by the implant was prevented. Since the reliability of the RCT repair technique in osteoporotic bones directly affects postoperative rehabilitation, we were able to confidently implement rehabilitation programs for our patients.

However, our technique has some disadvantages. Sutures from the implant can create dog ears, reducing the tendon-bone contact area. Massive tears require two implants, increasing cost and surgical complexity. The most frequent complication is re-tearing due to insufficient repair [6,19]. Radiological studies report re-tear rates between 29% and 94%, with higher incidences in elderly and massive tear patients [20]. In our study, patients with preoperative grades 1 and 2 fatty degeneration had larger tear sizes and worse repair outcomes, suggesting poor tendon quality in larger tears. Age and RCT size increased re-tear risk, which is consistent with the literature. MRI showed re-tear in 7 of 33 patients (21.2%), with a higher mean age and larger tear size.

Flurin et al. [21] conducted a retrospective study of 576 cases, with a mean follow-up of 18.5 months, and found that patient age influences healing and functional outcomes. However, they concluded that age should not be considered a contraindication for arthroscopic repair. Our study supports their findings, with re-tear patients having a mean age of 61.1 and non-re-tear patients 54.6. Older age correlated with lower postoperative Constant scores. Study limitations include a small sample size, a lack of a comparison group, and a short follow-up period. ATO RCT repair is effective for full-thickness rotator cuff tears, with satisfactory pain alleviation and shoulder function outcomes, as reported by previous studies [22-24]. Our patients' functional scores at the final follow-up indicate high patient satisfaction with surgical treatment.

Conclusions

In the repair process, we applied transosseous fixation, medial and lateral row repair, and repaired threads to the tendon, ensuring a wide surface contact and mechanical stability. In this way, we provided easier rehabilitation to our patients. The ATO technique, which provides strong mechanical and biological repair, gave good functional results for full-thickness RCT repair and led to satisfactory healing and clinical results

with low complication rates in the short term. However, it is necessary to conduct studies with longer follow-up periods and large series.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Mustafa Aydın, Ahmet Firat

Acquisition, analysis, or interpretation of data: Mustafa Aydın, Ahmet Firat

Drafting of the manuscript: Mustafa Aydın, Ahmet Firat

Critical review of the manuscript for important intellectual content: Mustafa Aydın, Ahmet Firat

Supervision: Ahmet Firat

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Yıldırım Beyazıt University Clinical Research Ethics Committee issued approval 02/04/2018-63. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

This study was presented as an oral presentation at the 8th International Gevher Nesibe Health Sciences Conference, Istanbul, Turkey, 2021

References

1. Tempelhof S, Rupp S, Seil R: Age-related prevalence of rotator cuff tears in asymptomatic shoulders. *J Shoulder Elbow Surg.* 1999, 8:296-9. [10.1016/s1058-2746\(99\)90148-9](https://doi.org/10.1016/s1058-2746(99)90148-9)
2. Heuberer PR, Smolen D, Pauzenberger L, et al.: Longitudinal long-term magnetic resonance imaging and clinical follow-up after single-row arthroscopic rotator cuff repair: clinical superiority of structural tendon integrity. *Am J Sports Med.* 2017, 45:1283-8. [10.1177/0363546517689873](https://doi.org/10.1177/0363546517689873)
3. Vastamäki M, Lohman M, Borgmästars N: Rotator cuff integrity correlates with clinical and functional results at a minimum 16 years after open repair. *Clin Orthop Relat Res.* 2013, 471:554-61. [10.1007/s11999-012-2494-1](https://doi.org/10.1007/s11999-012-2494-1)
4. Baums MH, Spahn G, Steckel H, Fischer A, Schultz W, Klinger HM: Comparative evaluation of the tendon-bone interface contact pressure in different single- versus double-row suture anchor repair techniques. *Knee Surg Sports Traumatol Arthrosc.* 2009, 17:1466-72. [10.1007/s00167-009-0771-7](https://doi.org/10.1007/s00167-009-0771-7)
5. Kim DH, Elattrache NS, Tibone JE, Jun BJ, DeLaMora SN, Kvitne RS, Lee TQ: Biomechanical comparison of a single-row versus double-row suture anchor technique for rotator cuff repair. *Am J Sports Med.* 2006, 34:407-14. [10.1177/0363546505281238](https://doi.org/10.1177/0363546505281238)
6. Mansat P, Cofield RH, Kersten TE, Rowland CM: Complications of rotator cuff repair. *Orthop Clin North Am.* 1997, 28:205-13. [10.1016/s0030-5898\(05\)70280-7](https://doi.org/10.1016/s0030-5898(05)70280-7)
7. Cummins CA, Murrell GA: Mode of failure for rotator cuff repair with suture anchors identified at revision surgery. *J Shoulder Elbow Surg.* 2003, 12:128-33. [10.1067/mse.2003.21](https://doi.org/10.1067/mse.2003.21)
8. Djurasovic M, Marra G, Arroyo JS, Pollock RG, Flatow EL, Bigliani LU: Revision rotator cuff repair: factors influencing results. *J Bone Joint Surg Am.* 2001, 83:1849-55. [10.2106/00004623-200112000-00013](https://doi.org/10.2106/00004623-200112000-00013)
9. Pietschmann MF, Fröhlich V, Ficklscherer A, Gülecüyz MF, Wegener B, Jansson V, Müller PE: Suture anchor fixation strength in osteopenic versus non-osteopenic bone for rotator cuff repair. *Arch Orthop Trauma Surg.* 2009, 129:373-9. [10.1007/s00402-008-0689-4](https://doi.org/10.1007/s00402-008-0689-4)
10. Apreleva M, Ozbaydar M, Fitzgibbons PG, Warner JJ: Rotator cuff tears: the effect of the reconstruction method on three-dimensional repair site area. *Arthroscopy.* 2002, 18:519-26. [10.1053/jars.2002.32930](https://doi.org/10.1053/jars.2002.32930)
11. Cofield RH: Subscapular muscle transposition for repair of chronic rotator cuff tears. *Surg Gynecol Obstet.* 1982, 154:667-72.
12. Rotator cuff classifications. (1995). Accessed: October 7, 2024: <https://www.shoulderdoc.co.uk/article/1456>.
13. Plachel F, Traweger A, Vasvary I, Schanda JE, Resch H, Moroder P: Long-term results after arthroscopic transosseous rotator cuff repair. *J Shoulder Elbow Surg.* 2019, 28:706-14. [10.1016/j.jse.2018.09.003](https://doi.org/10.1016/j.jse.2018.09.003)
14. Sugaya H, Maeda K, Matsuki K, Moriishi J: Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation. *Arthroscopy.* 2005, 21:1307-16.

- [10.1016/j.arthro.2005.08.011](https://doi.org/10.1016/j.arthro.2005.08.011)
15. Park MC, ElAttrache NS, Tibone JE, Ahmad CS, Jun BJ, Lee TQ: Part I: Footprint contact characteristics for a transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. *J Shoulder Elbow Surg.* 2007, 16:461-8. [10.1016/j.jse.2006.09.010](https://doi.org/10.1016/j.jse.2006.09.010)
 16. Park MC, Tibone JE, ElAttrache NS, Ahmad CS, Jun BJ, Lee TQ: Part II: Biomechanical assessment for a footprint-restoring transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. *J Shoulder Elbow Surg.* 2007, 16:469-76. [10.1016/j.jse.2006.09.011](https://doi.org/10.1016/j.jse.2006.09.011)
 17. Ahmad CS, Stewart AM, Izquierdo R, Bigliani LU: Tendon-bone interface motion in transosseous suture and suture anchor rotator cuff repair techniques. *Am J Sports Med.* 2005, 33:1667-71. [10.1177/0363546505278252](https://doi.org/10.1177/0363546505278252)
 18. Gazielly DF, Gleyze P, Montagnon C: Functional and anatomical results after rotator cuff repair. *Clin Orthop Relat Res.* 1994, 304:43-53.
 19. Park MC, Cadet ER, Levine WN, Bigliani LU, Ahmad CS: Tendon-to-bone pressure distributions at a repaired rotator cuff footprint using transosseous suture and suture anchor fixation techniques. *Am J Sports Med.* 2005, 33:1154-9. [10.1177/0363546504273053](https://doi.org/10.1177/0363546504273053)
 20. Galatz LM, Ball CM, Teefey SA, Middleton WD, Yamaguchi K: The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. *J Bone Joint Surg Am.* 2004, 86:219-24. [10.2106/00004623-200402000-00002](https://doi.org/10.2106/00004623-200402000-00002)
 21. Flurin PH, Landreau P, Gregory T, et al.: Arthroscopic repair of full-thickness cuff tears: a multicentric retrospective study of 576 cases with anatomical assessment. *Rev Chir Orthop Reparatrice Appar Mot.* 2005, 91:31-42. [10.1016/s0035-1040\(05\)84503-9](https://doi.org/10.1016/s0035-1040(05)84503-9)
 22. Gartsman GM, Brinker MR, Khan M: Early effectiveness of arthroscopic repair for full-thickness tears of the rotator cuff: an outcome analysis. *J Bone Joint Surg Am.* 1998, 80:33-40.
 23. Bishop J, Klepps S, Lo IK, Bird J, Gladstone JN, Flatow EL: Cuff integrity after arthroscopic versus open rotator cuff repair: a prospective study. *J Shoulder Elbow Surg.* 2006, 15:290-9. [10.1016/j.jse.2005.09.017](https://doi.org/10.1016/j.jse.2005.09.017)
 24. Burkhart SS, Danaceau SM, Pearce CE Jr: Arthroscopic rotator cuff repair: analysis of results by tear size and by repair technique-margin convergence versus direct tendon-to-bone repair. *Arthroscopy.* 2001, 17:905-12. [10.1053/jars.2001.26821](https://doi.org/10.1053/jars.2001.26821)