Technical Note

Arthroscopic Single Lateral Row Repair Technique for Small Rotator Cuff Tears

Xunqi Cheow, MBBS, MRCS, and Denny Tjiauw Tjoen Lie, MBBS, MRCS, FRCS, FAMS

Abstract: Small symptomatic rotator cuff tears are a common problem seen by orthopaedic surgeons. Arthroscopic repair has been shown to have favorable outcomes for these lesions. There is as yet no consensus on the ideal technique for the arthroscopic repair of small rotator cuff tears. We present a single lateral row technique for the repair of such lesions, which we believe to be reproducible and effective, that achieves good approximation of the tear while reducing the chance of suture cutouts.

Rotator cuff tears is a common cause of shoulder pain and discomfort. Studies have suggested the prevalence of rotator cuff tears in the general population to be >20%,[1] and this has been shown to positively correlate with age.[2,3]

Rotator cuff tears can be classified according to the location size and extent of the tears.[4,5] Small tears can be treated nonsurgically[6,7] or surgically.[8,9] Most of the literature suggests similar outcomes between nonsurgical and surgical treatment in the short to medium term.[7,9,10] Moosmayer et al.[8] found in a randomized controlled trial that surgical repair of small and medium-sized rotator cuff tears had better outcomes at 10 years than treatment with physiotherapy.[8] However, tear enlargement may be a concern for patients who do not undergo surgical repair.[11,12] Arthroscopic repair of rotator cuff tears has increasingly become the surgical treatment of choice in recent times, largely replacing open or mini-open repairs.[13]

We present our preferred arthroscopic technique for repairing small rotator cuff tears, both full-thickness and partial-thickness tears, using a single loose suture and a single lateral row anchor. In all of these tears, the bony footprint of the tendon is small, not visible at all, or covered with remnant tendon; hence medial row anchors are not required. We believe that this technique is reproducible and effective and achieves good approximation of the tear while reducing the chance of suture cutouts. To our knowledge, this technique has not been published in the literature before.

Surgical Technique

Preoperative Planning

A thorough history and physical examination is performed. Ultrasound or magnetic resonance imaging (MRI) is performed to determine the presence, location, size, and extent of the tear.

Surgery is performed with the patient under general anesthesia. We prefer a beach chair position for the surgery. One may elect to use a pneumatic arm holder for the operated limb, but we find that to be unnecessary, as an assistant can manipulate the limb as required.

This technique requires 3 portals: a standard posterior viewing portal, an anterior working portal, and an anterolateral portal located at the edge of the acromion lateral to the long head of the biceps.

Surgical Steps

The Video shows the surgical steps in detail. A standard posterior viewing portal is created, and an anterior working portal is created with its position first determined with aid of a spinal needle. A routine diagnostic arthroscopy is performed to look for any intra-articular pathology that may not have been detected on imaging.

From the Department of Orthopaedic Surgery, Singapore General Hospital, Singapore.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received August 2, 2020; accepted October 29, 2020.

Address correspondence to Xunqi Cheow, Department of Orthopaedic Surgery, Singapore General Hospital, 20 College Road, Academia, Level 4, Singapore 169856. E-mail: cheowxunqi@gmail.com

2212-6287/201344

https://doi.org/10.1016/j.eats.2020.10.067

Identification, Debridement and Preparation of the Tear From the Glenohumeral Joint

From the glenohumeral joint with the camera from the posterior portal, the undersurface of the supraspinatus tendon is identified. Visualization is improved by bringing the arm to abduction and external rotation. Articular-sided and full-thickness tears may be obvious. For bursal-sided tears, reference is made to the preoperative MRI or ultrasound to geographically locate the tear; it usually is at the anterior edge of the supraspinatus tendon. A spinal needle is then inserted from the outside to locate the tear. It usually is from the anterolateral portal, at the edge of the acromion lateral to the long head of the biceps. A small skin incision is then made, and the muscle and fascial layers are dilated using a pair of forceps. The partial or small full-thickness tear is penetrated with the forceps and then dilated. Degenerated tendons easily fall away, whereas normal tendons offer firm resistance. The degenerated tendon, which is soft and shaved away easily, is shaved at the rim of the small tear. Radiofrequency at this stage is avoid to prevent charring of tissues. Any punctate bleeding from the tendon is a sign of healthy tendon.

Subacromial Space Preparation

The subacromial space is entered the usual way. Often the tear is not easily visualized in the subacromial space if the bursa is not adequately cleared. A guide is the anterolateral portal created earlier to locate the tear. The obturator is used to probe the tendon and hence locate the tear. The edges of the tear are shaved until firm, healthy-looking tendon is seen.

Anterior Suture (First Suture Bite)

A loose Orthocord® (DePuy Mitek, Neuchatel, Switzerland) suture is loaded onto a suture passer (Expressew® III; Depuy Mitek). The camera is kept at the posterior portal with the arm in slight external rotation. The Expressew III suture passer is inserted via the anterolateral portal, and its lower jaw is inserted into the tear at ~45° anteromedial to the mediolateral axis of the tear. The suture bite is made as deep and anterior as possible (length of the suture passer, ≥16 mm). Care is taken to avoid the biceps tendon just anterior to the tear and keep the lower jaw close to the undersurface of the tendon. The suture is then retrieved, passed to the anterior portal, and clipped with an artery forceps. The other end of the loose suture is also clipped in the middle with an artery forceps to maintain the loop (Figure 1).

Looped Middle Suture (Second Suture Bite)

The other end of the suture is then loaded to the suture passer, and the suture is passed in the middle of the tear, or along the mediolateral axis of the tear at the center. The bite is made small, about half the length of the suture passer (~8 to 10 mm). It is retrieved from the same anterolateral portal as the rest of the suture with an artery clipped in the middle loop. If a cannula is not used, it is important to ensure that these sutures are in the same soft tissue portal. All 3 sutures limbs may be retrieved through the anterolateral portal with a retriever, to be safe. On the outside of the shoulder joint, the suture limb is passed into the loop (Figure 2). Both ends of the suture (the looped suture from the anterolateral portal and the anterior suture from the anterior portal) are pulled; the tear will close when the anterior suture is pulled tight (Figure 3).

Posterior Suture (Third Suture Bite)

The end of the suture that was looped is then passed posterior to the tear. This can be done either antegrade or retrograde. Antegrade passing uses the suture passer angled at 45° posteromedial to the mediolateral axis of the tear (Figure 4). The angle of approach may be difficult even after bringing the arm to internal rotation, and the bite is limited to the length of the suture passer. A recommended method is retrograde passing using a

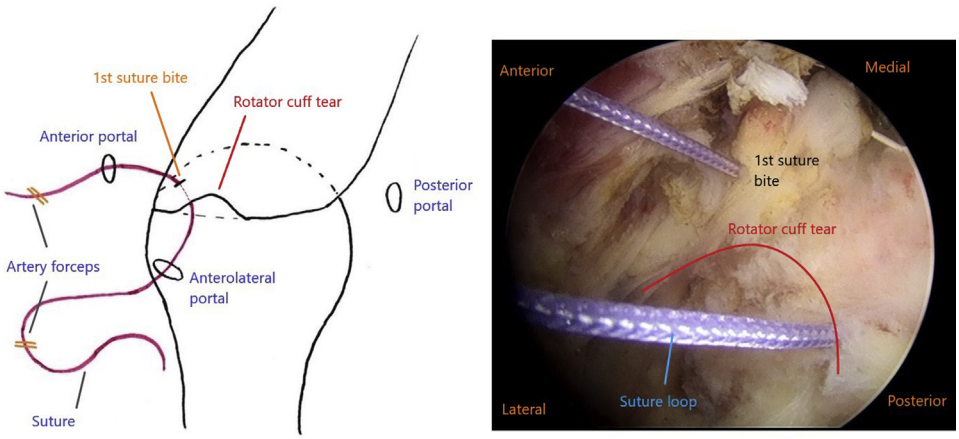


Figure 1. Right: Arthroscopic view of the right shoulder through a standard posterior viewing portal, showing a loose suture passed into the torn edge of the rotator cuff tear at ~45° anteromedial to the mediolateral axis of the tear (first suture bite) via the anterolateral portal, and retrieved through the anterior portal. Both limbs of the suture are clipped with an artery forceps. Left: Schematic diagram illustrating the above.

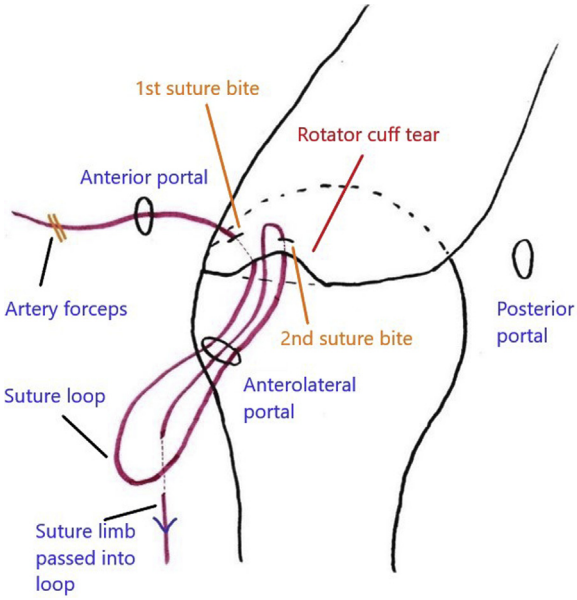


Figure 2. Schematic diagram illustrating the second suture bite being taken in the middle of the rotator cuff tear along its mediolateral axis, via the anterolateral working portal. The suture is then retrieved back through the anterolateral portal and passed into the resultant suture loop. The viewing portal here is the standard posterior portal.

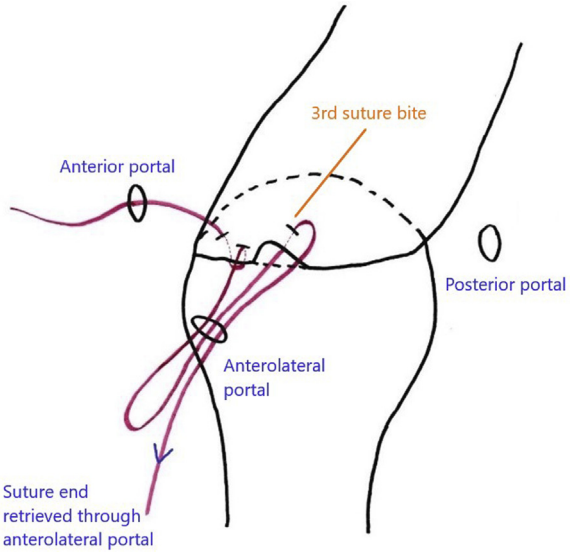


Figure 4. Schematic diagram illustrating the third suture bite being taken at an angle of 4° posteromedial to the mediolateral axis of the tear, via the anterolateral working portal. The suture is then pulled back through the anterolateral portal. The viewing portal here is the standard posterior portal.

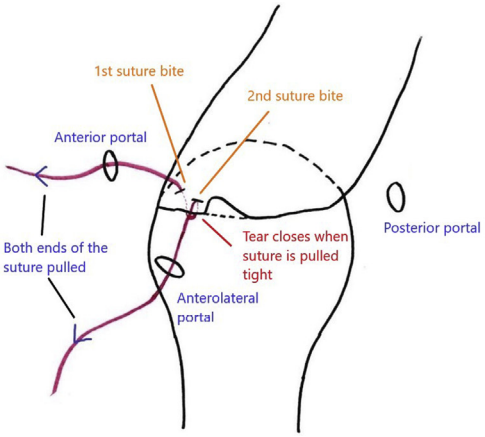
bird-beak retriever. The camera is shifted to the anterolateral portal, directly looking at the tear. The bird-beak retriever is inserted from the posterior portal and pierces the tendon far posterior from the tear (usually at the infraspinatus, ≥20 to 25 mm posterior to the tear) to retrieve the suture. The suture is then retrieved from the anterior portal, where the anterior suture is parked, and the camera is transferred back to the posterior portal.

Securing the Tear With a Lateral Row Anchor

The 2 limbs of the loose suture are then retrieved from the anterolateral portal (Figure 5) and secured to a lateral row anchor (Versalok® suture anchor; DePuy Mitek). The tighter the anterior suture is pulled, the more compressed the tear will be. The tighter the posterior suture is pulled, the more approximated the anterior and posterior edges of the tear will become. The end result is thus a wide (~20- to 30-mm) V-shaped suture configuration tied to a single lateral row anchor, in the middle of which the tear is localized by the suture loop, usually buried in. The anterior suture compresses the tear, and the posterior suture approximates and closes the tear.

Rehabilitation

Postoperatively, the shoulder is immobilized in a universal arm sling for 4 weeks. The patient is referred



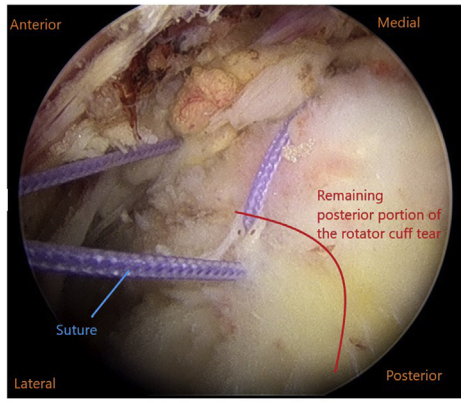


Figure 3. Right: Arthroscopic view of the right shoulder through a standard posterior viewing portal, showing the anterior portion of the rotator cuff tear being closed as a result of pulling on both limbs of the suture. Only the posterior portion of the rotator cuff tear remains unrepaired at this time. Left: Schematic diagram illustrating the above.

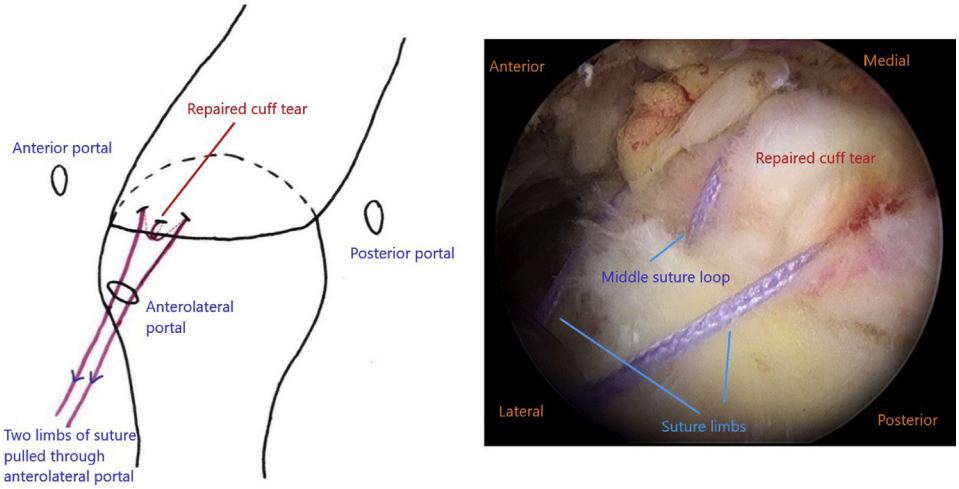


Figure 5. Right: Arthroscopic view of the right shoulder through a standard posterior viewing portal, showing the completed repair of the rotator cuff tear. The end result is a wide, V-shaped suture configuration, with both ends of the suture secured to a single lateral row anchor. Left: Schematic diagram illustrating the 2 limbs of the suture being pulled through the anterolateral portal, which will then be secured to a single lateral row anchor.

to the physiotherapist, and passive range of motion exercises are commenced 1 week postoperatively. Active range of motion is commenced only from 6 weeks postoperatively, and progressive strengthening exercises are subsequently started.

Discussion

Small rotator cuff tears are a common problem seen by orthopaedic surgeons. There is as yet no consensus on the ideal technique for the arthroscopic repair of such lesions.

The choice between initial treatment with physiotherapy or surgery should be discussed thoroughly with the patient. Physiotherapy has been proven in various studies to be successful in the treatment of rotator cuff tears.[6,7] Although various studies have found physiotherapy and surgery to have comparable outcomes in the short to medium term,[7,9,10] a study by Moosmayer et al.[8] demonstrated in a long-term prospective randomized trial that at 10 years, surgical repair results in better outcomes than physiotherapy with the option of secondary surgical repair, and this must be discussed with the patient.

The patient should be made aware, however, that tear enlargement is a possible natural progression of the condition if surgical repair is not performed,[11,12] which would make subsequent repair more complicated and may result in poorer functional outcome.[14] Indeed, the technique described here is meant for the repair of small rotator cuff tears.

If physiotherapy is used as the initial treatment, the patient should be followed up over a period of 3 to 6 months to monitor progress. Surgical repair should be considered if the patient continues to be symptomatic.

Primary surgical repair results in good outcomes, with a mean Constant-Murley score of 76.8 to 81.9 1 year postoperatively, as reported by various studies,[7,9] with significant improvement from baseline. Moosmayer et al. reported a mean Constant-Murley score of 79.8 5 years postoperatively[10] and 80.5 10 years postoperatively.[8] More specifically, arthroscopic repair of partial-thickness rotator cuff tears has been shown to achieve favorable results in the short and medium term,[15-17] and these excellent outcomes appear to hold true in the long term.[18-20]

There is currently no consensus on the best repair technique for arthroscopic repair of partial-thickness rotator cuff tears. Some surgeons advocate completion of the tear with subsequent repair,[21] which may mean that otherwise good tendon is taken down, but may provide an optimal biological condition for healing. Other surgeons advocate the in situ transtendinous repair of the tendon,[16] which may mean that some degenerate tissues may be left in the repair, while preserving robust native tendon. Koh et al.[22] described a "small-window technique" for repairing partial thickness bursal-sided tears, in which a small window was created in the articular side of the rotator cuff tendon to permit the passage of a shaver and grasper, while preserving as much intact articular-sided tendon as possible.

There has been much discussion about the outcomes of tear completion and repair compared to transtendinous repair, with most studies reporting similarly good outcomes with no significant difference in outcomes between the 2 techniques.[23-26] Jordan et al.[27] published results of a systematic review of the outcomes of arthroscopic repair of partial-thickness articular-sided rotator cuff tears suggesting that transtendinous repairs are associated with more pain and worse function during the first 3 months postoperatively.

There is controversy regarding the retear rates after tear completion and repair versus in situ repair.

Table 1. Surgical pearls

Visualization of the supraspinatus tear through a posterior viewing portal can be improved by bringing the arm into abduction and external rotation.
Use an arthroscopic shaver to debride the degenerate tendon, instead of radiofrequency ablation, as the latter may char healthy tissues.
Adequately clear the bursa in the subacromial space to optimize visualization of the tear.
When passing the anterior suture, be careful to avoid the biceps tendon just anterior to the tear, and keep the lower jaw close to the undersurface of the tendon.
Use artery forceps to clip the suture end of the anterior suture after passing the anterior suture, as well as the suture loop before passing the middle suture, to prevent retraction of the respective sutures.
If arthroscopic cannulae are not used, care must be taken to ensure that all 3 suture limbs pass through the same soft tissue portal after passing the middle suture and retrieving it through the anterolateral portal. Use of a suture retriever to retrieve all 3 suture limbs is recommended.
Consider using a bird-beak retriever to pass the posterior suture in a retrograde fashion if anterograde passing is difficult, as may be the case even after internal rotation of the arm.

Katthagen et al.[24] concluded in a systematic review that there was no significant difference in retear rates between tear completion and repair versus in situ repair, whereas a meta-analysis by Sun et al.[26] found that in situ repairs had a higher retear rate.

Sethi et al.[28] performed a cadaveric study on 14 fresh-frozen cadaveric shoulders to determine the biomechanical performance of tear completion and repair versus in situ repair of partial articular-sided rotator cuff tears and found that in situ repair showed a lower strain and displacement on the bursal side of the cuff compared with tear completion and repair. This was similar to the findings of another cadaveric study, by Gonzalez-Lomas et al.,[29] which found that transtendinous repair with 2 suture anchors was biomechanically superior to tear completion and repair with a double-row repair technique for partial-thickness articular-sided rotator cuff tears.

Interestingly, there have been studies on live animals that seem to show that tear completion and repair of partial-thickness rotator cuff tears provide better healing compared with in situ repair, in rabbits[30] and in rats.[31]

We believe that the technique described here represents a reproducible and effective method in addressing small rotator cuff tears in which the bony footprint of the tendon is small, not visible at all, or covered with remnant tendon, and hence medial row anchors are not required. The use of a single lateral row repair technique often requires a mattress suture configuration, which can sometimes cause suture cutouts in degenerated tendons. The uniqueness of our technique lies in the loop created in the middle suture, which we believe redirects the forces to lower the chances of cutouts. Furthermore, with the presence of the loop in the middle suture, pulling on the anterior suture thus compresses the repair, and subsequent pulling on the posterior suture lateralizes the tendon.

Potential disadvantages of this technique include those that apply to any repair of rotator cuff tears, including infection and implant failure. Poor tendon quality may result in suture tear-through, and hence it is essential to debride degenerated tendon with a shaver until healthy tendon with punctate bleeding is seen. In Table 1, we highlight several surgical pearls to help the surgeon in performing this technique.

References

1. Minagawa H, Yamamoto N, Abe H, et al. Prevalence of symptomatic and asymptomatic rotator cuff tears in the general population: From mass-screening in one village. *J Orthop* 2013;10:8-12.
2. Sher JS, Uribe JW, Posada A, Murphy BJ, Zlatkin MB. Abnormal findings on magnetic resonance images of asymptomatic shoulders. *J Bone Joint Surg Am* 1995;77:10-15.
3. Milgrom C, Schaffler M, Gilbert S, Van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. The effect of age, hand dominance and gender. *J Bone Joint Surg Br* 1995;77:296-298.
4. Millstein ES, Snyder SJ. Arthroscopic Management of partial, full-thickness, and complex rotator cuff tears: Indications, techniques, and complications. *Arthroscopy* 2003;19:189-199 (suppl 1).
5. Ellman H. Diagnosis and treatment of incomplete rotator cuff tears. *Clin Orthop Relat Res* 1990;(254):64-74.
6. Björnsson Hallgren HC, Adolfsson LE, Johansson K, Öberg B, Peterson A, Holmgren TM. Specific exercises for subacromial pain: Good results maintained for 5 years. *Acta Orthop* 2017;88:600-605.
7. Ranebo MC, Björnsson Hallgren HC, Holmgren T, Adolfsson LE. Surgery and physiotherapy were both successful in the treatment of small, acute, traumatic rotator cuff tears: A prospective randomized trial. *J Shoulder Elbow Surg* 2020:459-470.
8. Moosmayer S, Lund G, Seljom US, et al. At a 10-year follow-up, tendon repair is superior to physiotherapy in the treatment of small and medium-sized rotator cuff tears. *J Bone Joint Surg Am* 2019;101:1050-1060.
9. Lambers Heerspink FO, van Raay JJ, Koorevaar RC, et al. Comparing surgical repair with conservative treatment for degenerative rotator cuff tears: A randomized controlled trial. *J Shoulder Elbow Surg* 2015;24:1274-1281.
10. Moosmayer S, Lund G, Seljom US, et al. Tendon repair compared with physiotherapy in the treatment of rotator cuff tears. *J Bone Joint Surg Am* 2014;96:1504-1514.
11. Keener JD, Galatz LM, Teefey SA, et al. A prospective evaluation of survivorship of asymptomatic degenerative rotator cuff tears. *J Bone Joint Surg Am* 2015;97:89-98.
12. Ranebo MC, Björnsson Hallgren HC, Norlin R, Adolfsson LE. Clinical and structural outcome 22 years after acromioplasty without tendon repair in patients with subacromial pain and cuff tears. *J Shoulder Elbow Surg* 2017;26:1262-1270.

13. Huang R, Wang S, Wang Y, Qin X, Sun Y. Systematic review of all-arthroscopic versus mini-open repair of rotator cuff tears: A meta-analysis. *Sci Rep* 2016;7:22857. 6.
14. Moosmayer S, Gärtner AV, Tariq R. The natural course of nonoperatively treated rotator cuff tears: an 8.8-year follow-up of tear anatomy and clinical outcome in 49 patients. *J Shoulder Elbow Surg* 2017;26:627-634.
15. Ranalletta M, Rossi LA, Bertona AB, et al. Arthroscopic transtendon repair of partial-thickness articular-side rotator cuff tears. *Arthroscopy* 2016;32:1523-1528.
16. Ranalletta M, Rossi LA, Atala NA, Altieri BAB, Maignon GD, Bongiovanni SL. Arthroscopic in situ repair of partial bursal rotator cuff tears without acromioplasty. Arthroscopy 2017;33:1294-1298. Erratum. *Arthroscopy* 2017;33:1911.
17. Kanatlı U, Ayanoğlu T, Ataoğlu MB, Özer M, Çetinkaya M, Eren TK. Midterm outcomes after arthroscopic repair of partial rotator cuff tears: A retrospective study of correlation between partial tear types and surgical technique. *Acta Orthop Traumatol Turc* 2020;54:196-201.
18. Vap AR, Mannava S, Katthagen JC, et al. Five-year outcomes after arthroscopic repair of partial-thickness supraspinatus tears. *Arthroscopy* 2018;34:75-81.
19. Plachel F, Korn G, Traweger A, Ortmaier R, Resch H, Moroder P. Long-term results after arthroscopic treatment of symptomatic Ellman grade 2 PASTA lesions. *J Shoulder Elbow Surg* 2019;28:1356-1362.
20. Rossi LA, Atala NA, Bertona A, et al. Long-term outcomes after in situ arthroscopic repair of partial rotator cuff tears. *Arthroscopy* 2019;35:698-702.
21. Kamath G, Galatz L, Keener J, Teefey S, Middleton W, Yamaguchi K. Tendon integrity and functional outcome after arthroscopic repair of high-grade partial-thickness supraspinatus tears. *J Bone Joint Surg Am* 2009;91:1055-1062.
22. Koh KH, Shon MS, Lim TK, Yoo JC. Clinical and magnetic resonance imaging results of arthroscopic full-layer repair of bursal-side partial-thickness rotator cuff tears. *Am J Sports Med* 2011;39:1660-1667.
23. Osti L, Buda M, Andreotti M, Osti R, Massari L, Maffulli N. Transtendon repair in partial articular supraspinatus tendon tear. *Br Med Bull* 2017;123:19-34.
24. Katthagen JC, Bucci G, Moatshe G, Tahal DS, Millett PJ. Improved outcomes with arthroscopic repair of partial-thickness rotator cuff tears: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2018;Jan;26:113-124.
25. Castricini R, La Camera F, De Gori M, et al. Functional outcomes and repair integrity after arthroscopic repair of partial articular supraspinatus tendon avulsion. *Arch Orthop Trauma Surg* 2019;Mar;139:369-375.
26. Sun L, Zhang Q, Ge H, Sun Y, Cheng B. Which is the best repair of articular-sided rotator cuff tears: A meta-analysis. *J Orthop Surg Res* 2015;10:84.
27. Jordan RW, Bentick K, Saithna A. Transtendinous repair of partial articular sided supraspinatus tears is associated with higher rates of stiffness and significantly inferior early functional scores than tear completion and repair: A systematic review. *Orthop Traumatol Surg Res* 2018;104:829-837.
28. Sethi PM, Rajaram A, Obopilwe E, Mazzocca AD. Partial articular-sided rotator cuff tears: In situ repair versus tear completion prior to repair. *Orthopedics* 2013;36:771-777.
29. Gonzalez-Lomas G, Kippe MA, Brown GD, et al. In situ transtendon repair outperforms tear completion and repair for partial articular-sided supraspinatus tendon tears. *J Shoulder Elbow Surg* 2008;17:722-728.
30. Pulatkan A, Anwar W, Ayık O, Bozdag E. Tear completion versus in situ repair for 50% partial-thickness bursal-side rotator cuff tears: A biomechanical and histological study in an animal model. *Am J Sports Med* 2020. 363546520909854.
31. Gereli A, Kocaoglu B, Ulku TK, et al. Completion repair exhibits increased healing characteristics compared with in situ repair of partial thickness bursal rotator cuff tears. *Knee Surg Sports Traumatol Arthrosc* 2018;26:2498-2504.