Technical Note

Arthroscopic Repair of Posterosuperior Rotator Cuff Tears Using a Modified Mason-Allen Suture Technique With a Transosseous-Equivalent Construct: A Technical Note

Julian Hasler, M.D., Mustafa S. Rashid, M.D., Ph.D., Julia Mueller-Lebschi, M.D., Ulf Riede, M.D., and Matthias A. Zumstein, M.D.

Abstract: Iterative evolutions in arthroscopic rotator cuff repair aim to improve its biomechanical and biological properties. This technical note describes an arthroscopic rotator cuff repair technique that combines the advantages of a modified Mason-Allen suture technique with the advantages of an arthroscopic transosseous-equivalent construct. Two alternatives for creating this construct are described. The Mason-Allen stitch is easy to perform, is cost-effective, and increases tissue security without tendon strangulation. The arthroscopic transosseous-equivalent construct increases footprint contact pressure and coverage, aiding healing of the repaired rotator cuff.

Despite high patient satisfaction after rotator cuff repair, a large proportion of patients will experience retears.[1] Suture cut-through is among the most common modes of structural failure.[2] Historically, the gold-standard open techniques used transosseous bone tunnels, through which sutures were passed and tied, bringing the tendon to the footprint. These techniques provide significantly higher pullout strength and a large contact area with good pressure distribution between the tendon and the footprint.[3,4] The disadvantages of such techniques included substantial postoperative pain, scar formation, possible fractures of the tuberosity, and trauma to the deltoid muscle. Some of these disadvantages have been addressed with the development of modern arthroscopic rotator cuff repair techniques, which rely on suture anchors for rotator cuff fixation. A variety of arthroscopic fixation constructs have been proposed, including single-row, double-row, and transosseous-equivalent (TOE) repair. Biomechanically, the TOE construct has shown increased footprint compression pressure, less gap formation, and increased load to failure.[5-7] The TOE construct has become a common arthroscopic rotator cuff repair construct used by surgeons.[2]

Some tear patterns are best treated with a medialized single-row construct. Others require tying of the medial row to reduce the tendon to the footprint prior to securing the lateral row. Occasionally, an unlinked double-row construct is used, in which the tear reduction is complex and an “apex anchor” is needed. In these varying repair constructs, tendon cut-through may occur during knot tying. Surgeons have developed techniques to reduce the likelihood of its occurrence. Mason and Allen[8] first described their technique for apposing transversely cut tendon edges in 1941. Several modifications have been described since. Gerber et al.[4] investigated various constructs, concluding that the modified Mason-Allen configuration showed increased tissue-holding properties with less strangulation and pull-out of the sutures in the tendon. This article aims to describe a technique for arthroscopic rotator cuff repair that combines the advantages of a modified

From Shoulder, Elbow and Orthopaedic Sports Medicine, Orthopädie Sonnenhof, Bern, Switzerland (J.H., J.M-L., U.R., M.A.Z.); Department of Orthopaedic Surgery, University Hospital Basel and Bethesda Hospital, Basel, Switzerland (J.H.); Manchester University NHS Foundation Trust, Manchester, England (M.S.R.); Faculty of Medicine, University of Bern, Bern, Switzerland (M.A.Z.); and Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, NSW, Australia (M.A.Z.).

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Address correspondence to Matthias Zumstein, M.D., Shoulder, Elbow and Orthopaedic Sports Medicine, Orthopädie Sonnenhof, Salvisbergstrasse 4, 3006 Bern, Switzerland. E-mail: ses@sonnenhof.ch

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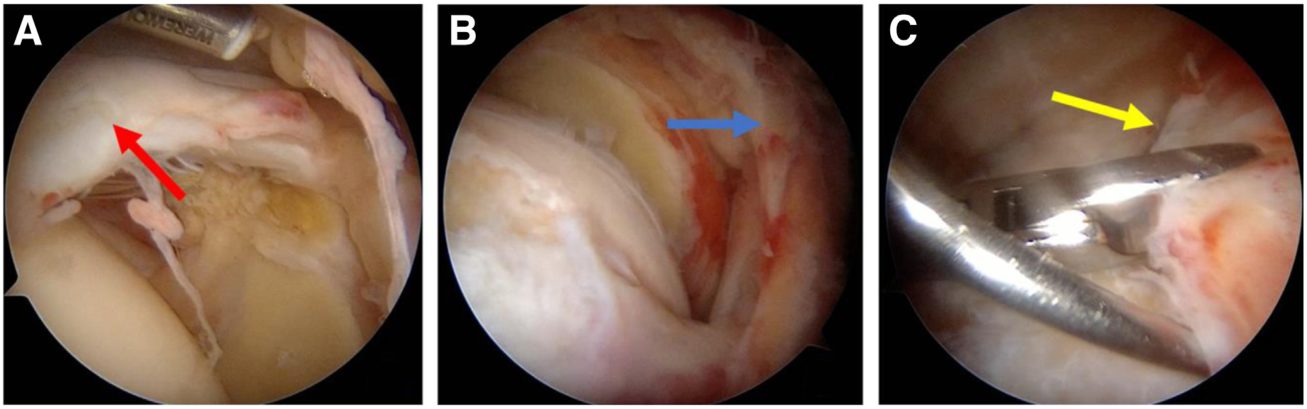

Fig 1. Left shoulder in 63-year-old male patient in beach-chair position. An intra-articular arthroscopic view from the lateral portal reveals a repairable posterosuperior rotator cuff tear involving the supraspinatus tendon (red arrow) (A) and infraspinatus tendon (blue arrow) (B), as well as a radial tear component (yellow arrow) between them (C).

Mason-Allen suture configuration with the advantages of a TOE construct.

Surgical Technique

Patient Positioning and Preparation

After administration of general anesthesia and an interscalene nerve block, the patient is placed in the beach-chair position. A hydraulic arm holder (Trimano Fortis Support Arm; Arthrex, Naples, FL) is applied to the operative shoulder.

Arthroscopic Portal Placement, Biceps Management, and Debridement

In general, 4 arthroscopic portals are used (typically posterior, lateral, anterolateral, and anteromedial portals). A 30° arthroscope is used throughout the procedure.

First, a posterior viewing portal is established inferomedial to the posterolateral corner of the acromion in line with the glenohumeral joint. Anteromedial and anterolateral portals are then placed under direct view from the posterior portal, after the ideal position is located with a needle. Tenotomy or tenodesis of the long head of the biceps is commonly performed. An additional lateral portal is then established, with subsequent subacromial bursectomy and resection of the remaining rotator interval using a shaver (Excalibur Shaver Blade, 5.5 mm; Arthrex) and a 90° tipped radiofrequency device (Werewolf Coblation System; Smith & Nephew, London, England). The torn rotator cuff is

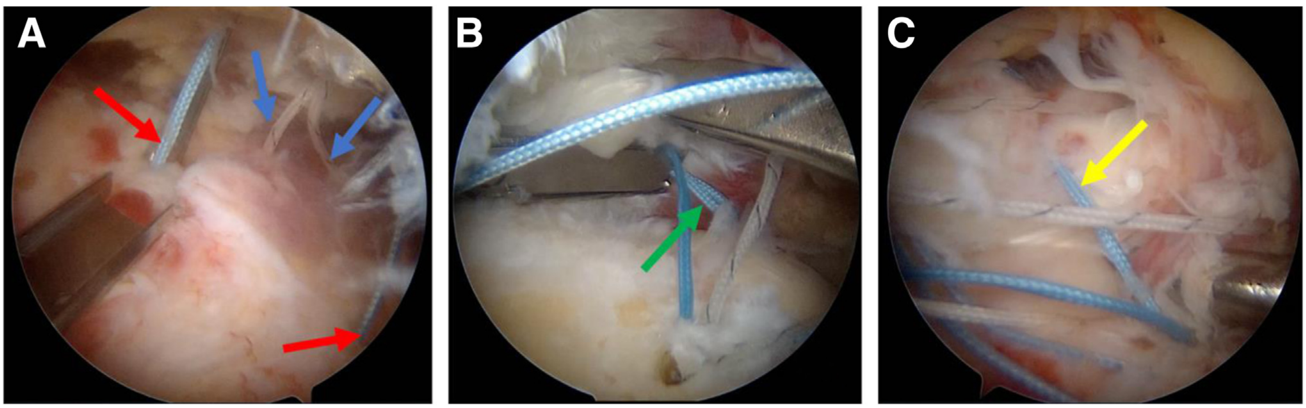

Fig 2. Intra-articular arthroscopic view from lateral portal in left shoulder in 63-year-old male patient in beach-chair position. (A) The white sutures (blue arrows) are passed centrally and slightly more medially through the tendon in a horizontal mattress fashion. The blue suture pair (red arrows) is split, with 1 limb being passed anteriorly and the other being passed posteriorly to the central (white) suture pair. (B) The posterior blue suture (green arrow) is passed more anterior and lateral to its corresponding suture limb in a bursal-to-articular direction. (C) To create a modified Mason-Allen stitch (yellow arrow), the suture is retrieved again from the articular side and passed in an articular-to-bursal direction just medial and posterior to the point where it first passed the tendon.

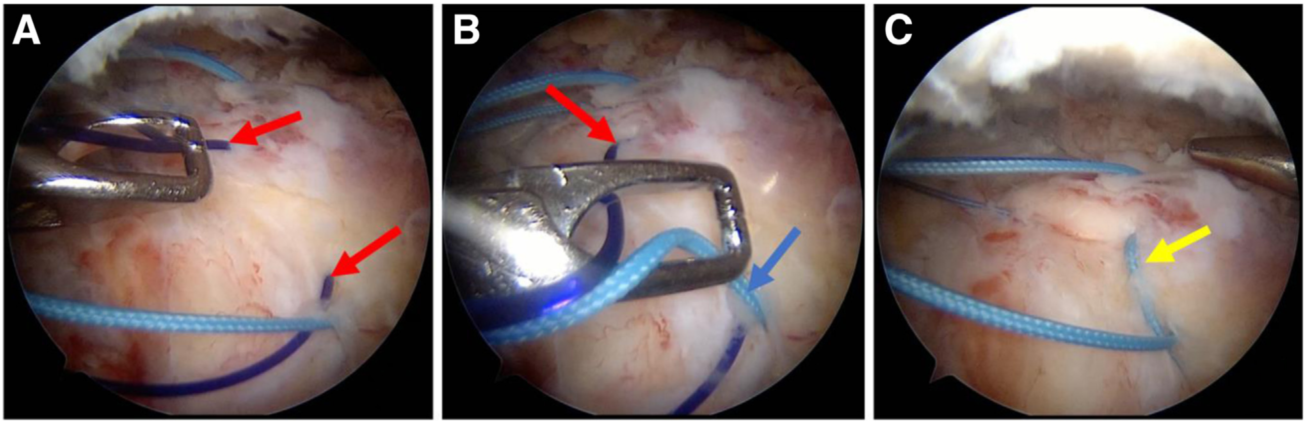

Fig 3. Intra-articular arthroscopic view from lateral portal in left shoulder in 63-year-old male patient in beach-chair position. An alternative method to create a Mason-Allen stitch configuration is shown, in which a polydioxanone (PDS) suture (red arrows) is passed through the tendon at the place where the modified Mason-Allen stitch is desired (A). The posterior blue suture (blue arrow) is then shuttled through the tendon using the anterior limb of the PDS suture (red arrow) (B), thereby creating a similar Mason-Allen stitch configuration (yellow arrow) (C).

debrided and mobilized. The footprint is prepared to create a bleeding bony bed (Fig 1).

Tendon Fixation

The lateral portal is used as a viewing portal, and a cannula (Twist-In Cannula; Arthrex) is placed in the anterolateral portal. Depending on the tear size, 1 to 3 all-suture anchors (Y-Knot RC; ConMed Linvatec, Largo, FL) are placed adjacent to the articular margin. If needed, an additional accessory portal can be placed for adequate anchor placement. Sutures are then sequentially retrieved through the cannula and passed in an articular-to-bursal direction through the tendon, 10 to 12 mm medial to the rotator cuff tear edge, using a suture passer (Expressew AutoCapture; Johnson & Johnson, Solothurn, Switzerland). It is important to ensure that one corresponding suture pair (white sutures) is passed slightly more medially and centrally through the tendon in a horizontal mattress fashion, whereas the second suture pair (blue sutures) is split, with 1 limb being passed anteriorly and the other being passed posteriorly from the central (white) suture pair, with a distance of about 2 to 3 cm between the 2 suture limbs (Fig 2A). To create the modified Mason-Allen construct, the most posterior (blue) suture is again retrieved through the cannula and passed in a bursal-to-articular direction through the tendon slightly anterior and lateral to the corresponding anterior (blue) suture limb (Fig 2B). The passed suture limb is then retrieved from the articular side of the tendon through the cannula and is passed through the tendon in an articular-to-bursal direction just medial and posterior to the point where the suture was first passed (Fig 2C).

Alternatively, by use of a curved suture passer (Spectrum; ConMed, Utica, NY), a monofilament shuttling suture (e.g., No. 2 polydioxanone) is passed through the tendon where the modified Mason-Allen stitch is desired (Fig 3A). The posterior (blue) suture is then shuttled through the tendon using the anterior limb of the polydioxanone suture (Fig 2B), thereby creating a similar Mason-Allen stitch configuration (Fig 3B).

In larger tears, 1 modified Mason-Allen stitch and 1 horizontal mattress stitch are performed for each

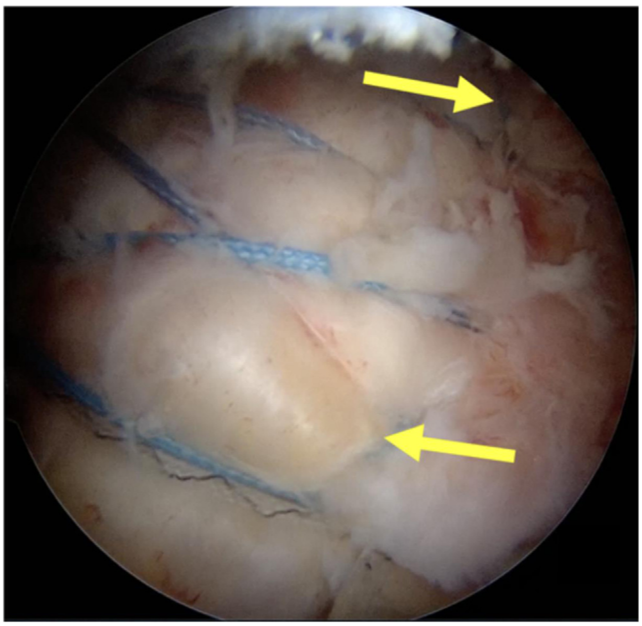

Fig 4. Intra-articular arthroscopic view from lateral portal in left shoulder in 63-year-old male patient in beach-chair position. To finish the reconstruction, the white sutures are tied in a horizontal mattress fashion and used together with the untied Mason-Allen sutures (yellow arrows) for the transosseous-equivalent repair, with the lateral anchor placed 2 cm below the superolateral aspect of the greater tubercle.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
A modified Mason-Allen stitch has high tissue-holding properties without additional tendon strangulation, which is especially useful in large, degenerative tears.	Meticulous suture management is mandatory when using multiple modified Mason-Allen stitches to avoid problems when tying the medial row and securing the lateral row.
A modified Mason-Allen stitch configuration can safely be performed by using a suture passer upside-down and then back in the original direction from bottom to top through the tendon.	Care should be taken when using the suture passer upside-down. The suture passer should be deployed under direct vision to avoid damage to the humeral head cartilage.
In posterior tears, the modified Mason-Allen stitch can easily be performed by inserting a PDS shuttling suture at the desired position using a curved suture passer.	

PDS, polydioxanone.

medial-row anchor. The central (white) suture pairs are then tied, thereby bringing the tendon back to the footprint, whereas the modified Mason-Allen stitch is not tied to avoid tendon strangulation. The passed suture limbs are then used to create a TOE construct, using the same number of knotless anchors (ReelX STT; Stryker, Kalamazoo, MI) as used for the medial row. For the lateral fixation, the anchors are placed as far anterior and posterior as possible, 2 cm distal to the lateral edge of the footprint insertion, to achieve adequate footprint coverage (Fig 4).

The operative technique is demonstrated in Video 1. Pearls and pitfalls of the procedure are listed in Table 1.

Discussion

The described technique aims to combine traditional and contemporary techniques. The clinical problem attempted to be solved involves optimizing suture security within the degenerative rotator cuff tendon. Mason and Allen[8] described their repair construct in 1941, using a twisted silk suture to repair the extensor carpi radialis tendon in dogs. Since the initial description of the Mason-Allen construct, surgeons have modified this construct for utility in various tendon repairs. The weakest link in most rotator cuff repairs is usually the suture-tendon interface.[2] In a biomechanical analysis, Gerber et al.[4] compared various stitch constructs, showing superior ultimate tensile strength and reduced gap formation with a modified Mason-Allen configuration. The mode of failure for the modified Mason-Allen stitch was suture failure, as opposed to suture slippage or cut-through for other constructs. Hence, the superior cut-through properties of the modified Mason-Allen stitch configuration are desirable.

Contemporary arthroscopic rotator cuff repair techniques aim to match the tear pattern to the optimal construct type. The most common repair type involves variations on a double-row construct, providing better footprint compression and coverage.[3] Several studies have shown improved biomechanical characteristics, such as increased load to failure, less gap formation, and improved footprint contact pressure, with TOE repair as compared with traditional single- and double-row repair techniques.[5-7] Our technique combines the superior tendon cut-through properties of the modified Mason-Allen stitch with the superior footprint compression properties of TOE constructs, while maintaining the advantages of an arthroscopic approach. Potential disadvantages of double-row constructs include tendon strangulation and structural medial (type 2) failure.[9] A modified Mason-Allen stitch configuration reduces tissue strangulation and improves tissue-holding properties[4]; moreover, a similar suture technique has recently been proved to improve clinical outcomes and decrease retear rates in arthroscopic rotator cuff repair.[10]

There are some risks associated with our technique. The suture passer, which uses a nitinol needle to pass the captured suture through the rotator cuff, is designed for use in an antegrade fashion (from articular-to-bursal side). To create the modified Mason-Allen stitch configuration, the same suture passer is used in an inverse orientation. Care must be taken to ensure that the needle does not injure the humeral head cartilage via passage under direct visualization. Another risk is suture entanglement, especially with larger tear sizes that may require multiple medial-row anchors. Care must be taken to manage the sutures before and after passage through the rotator cuff. Cannulas may help reduce soft-tissue bridges when passing the suture passer with captured suture in and out of the shoulder.

This technical note combines a technique that has stood the test of time, the modified Mason-Allen stitch, and a 21st century arthroscopic technique, TOE double-row suture anchor repair. This technique does not require any additional implants, making it a cost-effective adjunct to contemporary fixation methods. By using this technique, surgeons may be able to further enhance their ability to bring the torn tendon to the footprint securely to allow for successful healing.

Disclosures

All authors (J.H., M.S.R., J.M-L., U.R., M.A.Z.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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