Technical Note

A Knotless Single-Row Suture Bridge Technique to Repair a Partial Articular Supraspinatus Tendon Avulsion-Type Rotator Cuff Tear: Surgical Technique

Laurens J. H. Allaart, M.D., Tilman Hees, M.D., Thibault Lafosse, M.D., and Geert Alexander Buijze, M.D., Ph.D.

Abstract: With improving surgical and technological solutions for repairing rotator cuff tears, there has been increased interest in treatment of partial rotator cuff tears. The most prevalent type of partial tear is the PASTA (partial articular supraspinatus tendon avulsion) lesion. There is an ongoing debate on the best surgical technique to repair a PASTA lesion, which has led to the development of many different arthroscopic techniques. This Technical Note provides a cost-effective and reproducible technique of a transtendinous single-row bridge repair of PASTA lesions, using two 1.8 FiberTak Knotless Soft Anchors.

With improving surgical and technological solutions for repairing rotator cuff tears, there has been increased interest in the treatment of partial rotator cuff tears. Previously, partial rotator cuff tears were difficult to diagnose, but recent studies show an incidence of up to 32% in the general population using magnetic resonance imaging.[1] The most prevalent type of partial tear is the PASTA (partial articular supraspinatus tendon avulsion) lesion.[2] Despite the absence of general consensus on the best treatment technique, it is commonly accepted that partial tears should extend to more than 50% of the thickness of the tendon before surgical repair is considered.[3]

Moreover, if case surgical repair is considered, there is an ongoing debate on the best surgical technique. This has led to the development of many different arthroscopic techniques, all of which have their own pros and cons. In general, these repair techniques may be divided into 2 groups: one group that proposes completion of the partial tear into a full-thickness rotator cuff tear followed by a traditional rotator cuff repair, and another group that suggests preservation of the intact tendon fibers and placing transtendinous anchors.

The most recent systematic reviews have not been able to prove superiority for either one of the groups, as they show comparable results on retear rate, tear progression, and functional shoulder scores.[4-6] This Technical Note provides a cost-effective and reproducible technique of a single-row bridge repair of PASTA lesions.

Surgical Technique (With Video Illustration)

In this paragraph, we provide a detailed step-by-step description on how to perform our single-row bridge repair of PASTA lesions. We have summarized all steps into a short technical video (Video 1).

Positioning of the Patient

The patient is placed in the beach-chair position. The patient's right arm is fixated in traction and remains in one position during the procedure.

From the Alps Surgery institute, Hand, Upper Limb, Peripheral Nerve, Brachial Plexus and Microsurgery Unit, Clinique Générale Annecy, Annecy, France (L.J.H.A., T.H., T.L., G.A.B.); Department of Human Movement Sciences, Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam Movement Sciences, Amsterdam, The Netherlands (L.J.H.A.); Department of Orthopedic Surgery, Martin-Luther-Hospital, Sportclinic, Berlin, Germany (T.H.); Department of Orthopedic Surgery, Amsterdam Movement Sciences, Amsterdam UMC, location AMC, University of Amsterdam, Amsterdam, The Netherlands (G.A.B.); and Department of Orthopedic Surgery, Montpellier University Medical Center, Lapeyronie Hospital, University of Montpellier, Montpellier, France (G.A.B.).

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Address correspondence to Laurens J. H. Allaart, M.D., Alps Surgery Institute, Hand, Upper Limb, Peripheral Nerve, Brachial Plexus and Microsurgery Unit, Clinique Générale Annecy, Annecy, France. E-mail: Laurensallaart@gmail.com

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Portals

For this repair, 5 portals standard portals marked A to E are used: a standard posterior portal A, a posterolateral portal B, 2 lateral portals C and D, one for each anchor, and an anterior portal E (Fig 1).

Equipment, Anchors, and Suture Management

Several common arthroscopy tools are required to perform this operation, including a motorized shaver blade, switching stick, suture retriever, and drill guide. Two 1.8 FiberTak Knotless Soft Anchors (Arthrex, Naples, FL) are used (Fig 2). The anchor consists of a hollow, looped sleeve with one suture attached to it and another suture passed through the sleeve. The attached suture is used for the repair; from hereon, it will be referred to as repair suture. It is striped blue and white. There is a laser mark at 10 cm from the tip of the long end of the repair suture. The other suture will be called the passing suture and is not attached to the anchor. Both ends of the passing suture have a black-and-white pattern. It is passed through the anchor and will only be used to guide the repair suture through the anchor. The passing suture has a looped end and a pulling end.

In order to place the anchor, a tunnel has to be made in the humeral head. After placing the anchor, a bundle of 3 sutures remains, consisting of one repair suture and both ends of the passing suture.

Technical Procedure

Step 1: Preparation for the Repair

The glenohumeral joint is primarily visualized through a standard posterior portal (A). A switching stick and shaver are inserted through a standard anterior portal (E) (Fig 3). Either the switching stick or a probe is used as a tendon retractor to visualize the size and location of the tear as well as to evaluate the quality of the biceps tendon (Fig 4). Subsequently, fraying of the articular tendon surface around the tear is removed using a motorized shaver blade and the footprint is prepared until bleeding of the subcortical bone occurs (Fig 5). Through a posterolateral portal (B), approximately 2 to 3 cm lateral of the posterior portal, the bursal side of the rotator cuff is visualized, and a subacromial decompression can be performed with an electrocautery or motorized shaver blade through portal (D) (Fig 6). If the bursal side of the rotator cuff is already well visible and free of bursa, this step can be skipped.

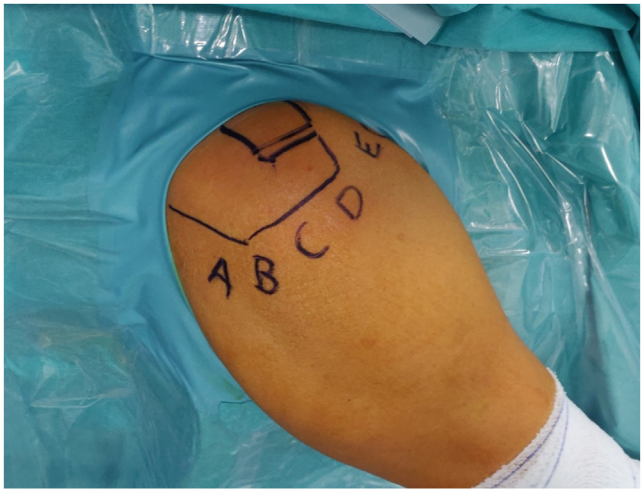

Fig 1. External overview of the right shoulder and the patient in the beach-chair position, where locations for portals are marked A until E as used for this repair (Standard posterior [A], posterolateral [B], 2 lateral portals, one for each anchor [C and D], and an anterior portal [E]).

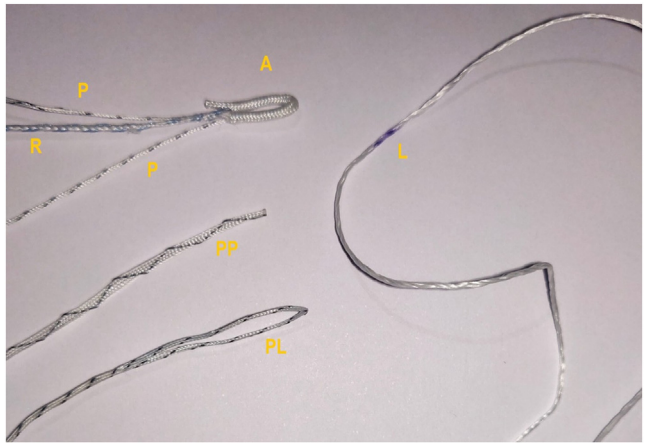

Fig 2. Close-up image of the 1.8 FiberTak Knotless Soft Anchor (Arthrex) that is used for this technique. (A, anchor; L, laser mark 10 cm of the end of the repair suture; P, passing suture [both sides]; PP, pulling end of passing suture; PL, looped end of passing suture; R, repair suture.)

Step 2: Transtendinous Anterior Anchor Placement

After satisfactory debridement, the tear is visualized intra-articularly through the posterior portal (A). The most anterior end of the tear is located using a spinal needle (Fig 7). In order to ensure maximal compression of the tear on its footprint, it is essential to place the anterior anchor close to or just outside of the anterior limit. The location of this spinal needle is used for the lateral portal (D). The direction of the spinal needle is used for inserting a standard straight drill guide (Fig 8). A hole is drilled in the humeral head just posterior of the prepared footprint. A soft 1.8 FiberTak Anchor is placed in the hole. By pulling on both ends of the passing suture at once, the soft anchor locks inside the humeral head.

Step 3: Transtendinous Posterior Anchor Placement

This process is then repeated at the most posterior limit of the tear. The posterior limit of the tear is located

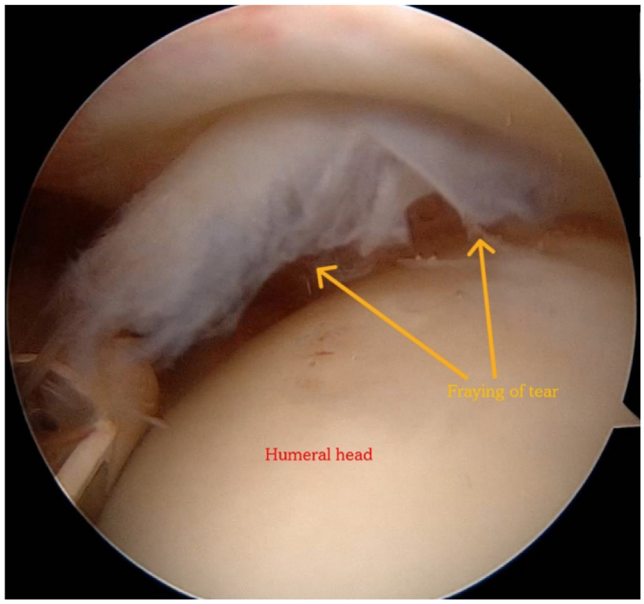

Fig 3. With the patient placed in the beach-chair position, the intra-articular space of the right shoulder of the patient is visualized through the standard posterior portal (A), in order to inspect the size and location of the tear. In the bottom of the figure the humeral head is visible (marked in red), and above it the fraying of the torn tendon fibers are marked with yellow, indicating the location of the tear.

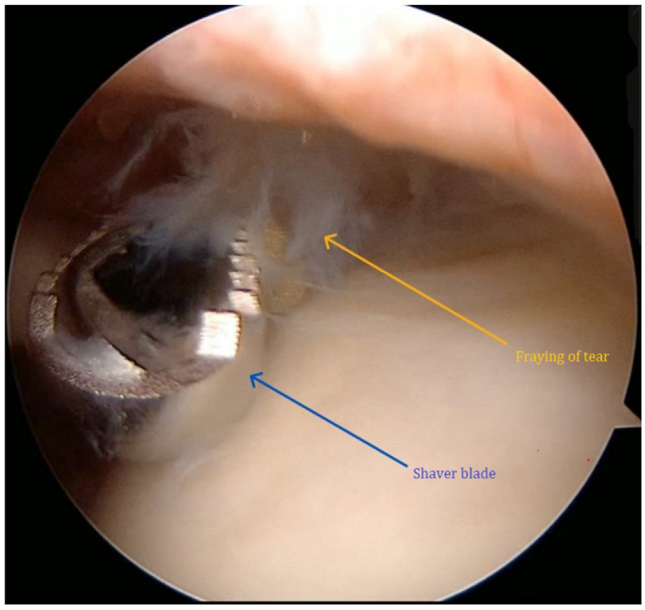

Fig 5. With the patient placed in the beach-chair position and viewing the intra-articular surface of the infraspinatus and supraspinatus of the right shoulder through the standard posterior portal (A), the fraying of the articular tendon surface around the tear (yellow arrow) is removed using a motorized shaver blade (blue arrow) in order to obtain a better view of the actual size of the tear.

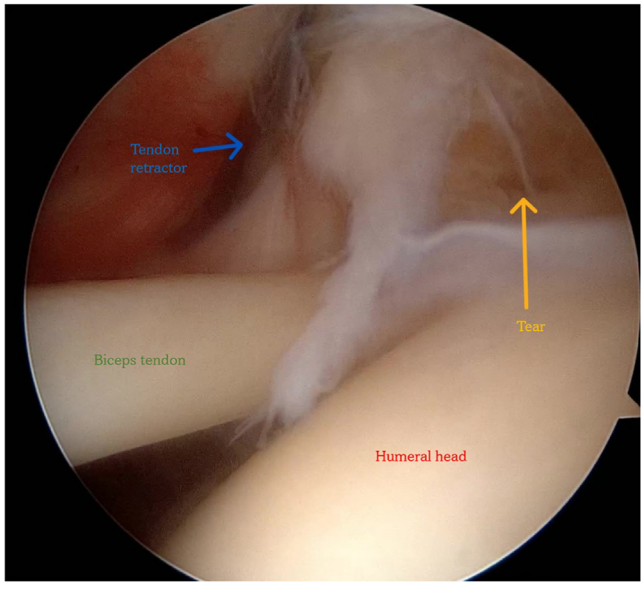

Fig 4. With the patient placed in the beach-chair position, the intra-articular space of the right shoulder of the patient is visualized through the standard posterior portal (A), in order to inspect the size and location of the tear. In the bottom of the figure the humeral head is visible (marked in red) and the biceps tendon (marked in green) is seen spanning the intra-articular space. A tendon retractor (blue arrow) is inserted through the anterior portal (E) and used to evaluate the quality of the supraspinatus tendon. By retracting the tendon, the size of the tear is visible (yellow arrow).

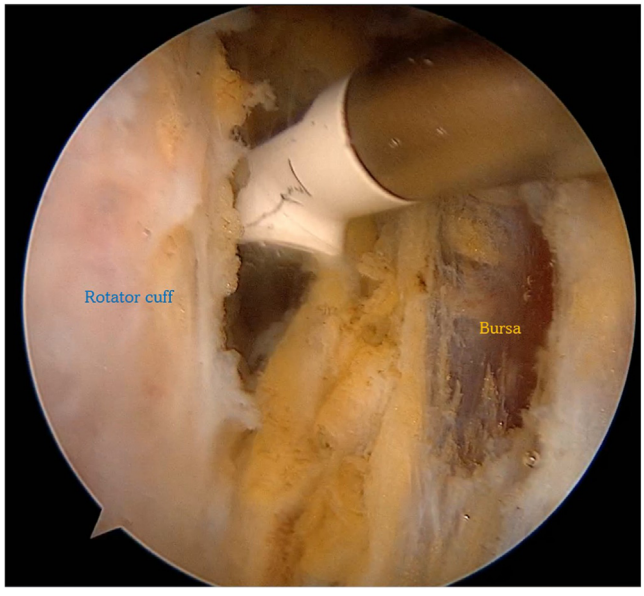

Fig 6. With the patient placed in the beach-chair position and the arthroscope inserted through the posterolateral portal (B), the bursal surface of the rotator cuff is visualized (marked in blue), and a subacromial decompression is performed with an electrocautery through portal (D). If the bursal side of the rotator cuff is already well visible, this step can be skipped.

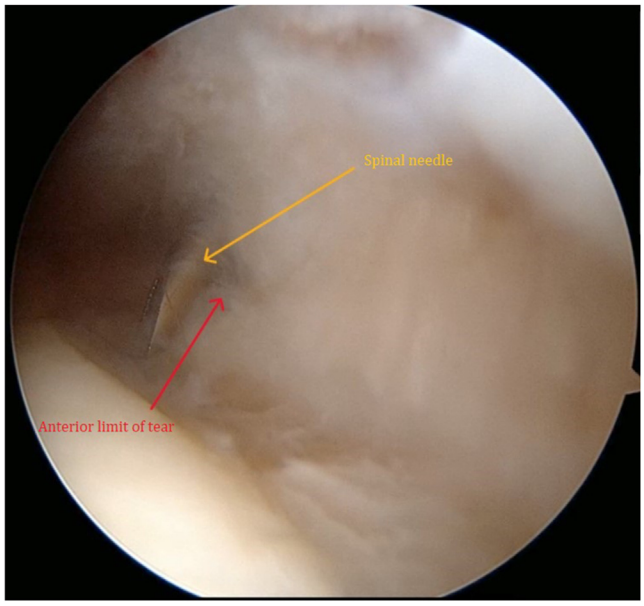

Fig 7. With the patient placed in the beach-chair position and viewing the intra-articular surface of the infraspinatus and supraspinatus of the right shoulder through the standard posterior portal (A), the most anterior edge of the tear (red arrow) can be delimited using a spinal needle (yellow arrow). In order to ensure maximal compression of the tear on its footprint, it is essential to place the anterior anchor close to or just outside of the anterior limit. This location will be used for lateral portal (D).

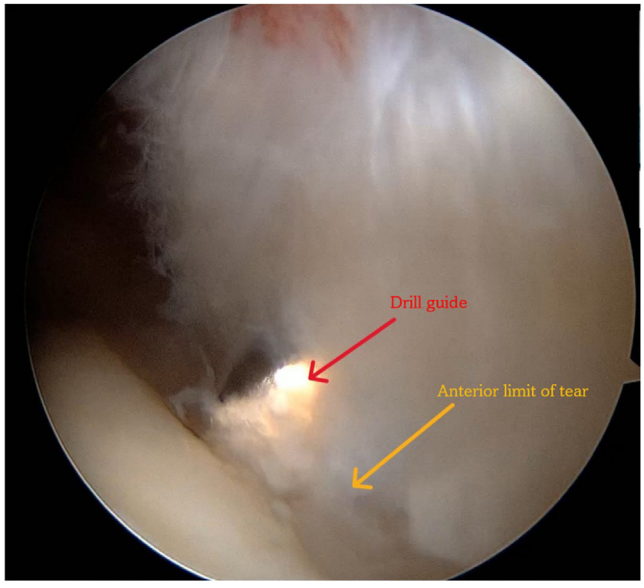

Fig 8. With the patient placed in the beach-chair position and viewing the intra-articular surface of the infraspinatus and supraspinatus of the right shoulder through the standard posterior portal (A), a drill guide (red arrow) is inserted through lateral portal (D) in order to drill a hole in the humeral head for the anterior anchor. By applying pressure on the drill guide, the tendon is temporarily pressed against the humeral head, however the anterior limit of the tear (yellow arrow) is still visible.

using a spinal needle (Fig 9). The location of this needle will be used as for the lateral portal (C). The drill guide is placed, a hole is drilled, and the anchor is locked in the humeral head as described in step 2.

Step 4: Retraction of the Right Sutures Through the Right Lateral Portal

The bursal side of the rotator cuff tear is visualized through the posterolateral portal (B). This allows both bundles of 3 sutures to be seen spanning the bursal space (Fig 10). A suture retriever is inserted through the lateral portal of the posterior anchor (C) and used to retrieve the repair suture of the anterior anchor (Fig 11). After retrieving the repair suture out of the shoulder by the opposite repair portal, the suture crosses the subacromial space diagonally. This is repeated to retrieve the posterior repair suture through the anterior repair portal (D) (Fig 12). Now both repair sutures can be seen spanning the bursal space diagonally (Fig 13).

Step 5: Single-Row Bridge Repair

The most crucial steps of this repair take place outside of the shoulder. The repair sutures have been crossed to the opposite portal, but they have yet to pass through the anchor (Fig 14). Sutures that are not currently used can be secured by holding them or with any suitable equipment The repair suture is passed through the looped end of the passing suture that is extending out of the same portal (Fig 15). The laser dot is lined up with the looped end of the passing suture (Fig 16). This ensures that the repair suture will have enough length to be passed through the anchor and back. By pulling the other end of the passing suture, the repair suture is guided through the anchor (Fig 17). After this step the passing suture can be discarded. This process is repeated for the second anchor (Fig 18).

Step 6: Tightening of the Repair

After successfully passing both repair sutures through the opposite anchors, the repair can be tightened by simultaneously pulling on both repair sutures (Fig 19). The structure of the suture wire allows the suture to pass through the anchor but prevents it from sliding back. The suture bridge is now compressing the tendon to its footprint (Fig 20). After cutting the remaining ends of the suture, the knotless repair is completed.

Discussion

Both transtendinous repairs and conversion repairs appear to have certain advantages. The more traditional approach of conversion into a full rotator cuff tear and performing a standard repair is considered to be a technically easier intervention, as after completion of the tear it is in fact the same technique as a standard

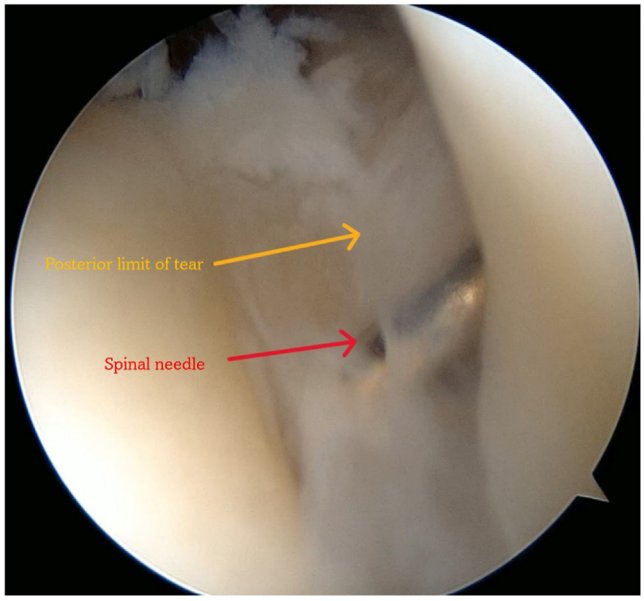

Fig 9. With the patient placed in the beach-chair position and viewing the intra-articular surface of the infraspinatus and supraspinatus of the right shoulder through the standard posterior portal (A), the most posterior edge of the tear (yellow arrow) can be delimited using a spinal needle (red arrow). In order to ensure maximal compression of the tear on its footprint, it is essential to place the posterior anchor close to or just outside of the posterior limit. This location will be used for lateral portal (C).

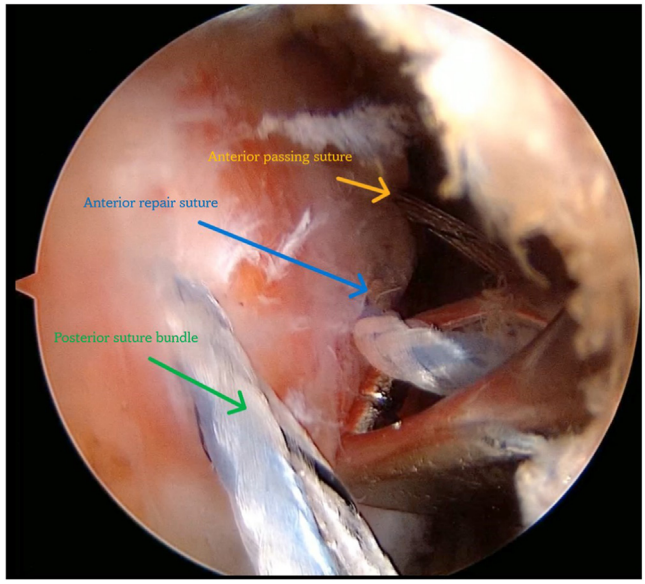

Fig 11. With the patient placed in the beach-chair position and viewing the bursal space of the right shoulder through the posterolateral portal (B), a suture grabber is inserted through lateral portal (C) and used to retract the anterior repair suture (blue arrow), currently exiting the shoulder through portal (D), out of portal (C). This step is essential in order to guide the repair suture through the opposite anchor. The anterior passing suture ends (yellow arrow) and the posterior bundle of sutures (green arrow) are left in place.

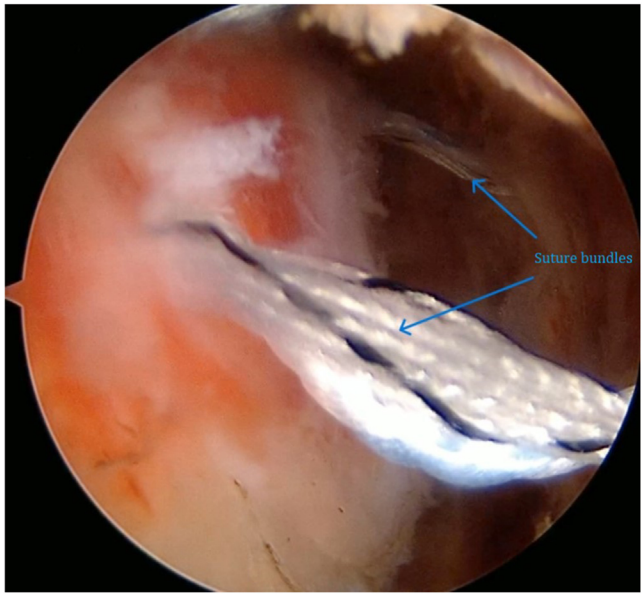

Fig 10. With the patient placed in the beach-chair position and viewing the bursal space of the right shoulder through the posterolateral portal (B), after placing both anchors, the 2 bundles of sutures (blue arrows) can be seen spanning the bursal space from the rotator cuff on the left toward the deltoid muscle on the right. This is where the PASTA bridge will be constructed.

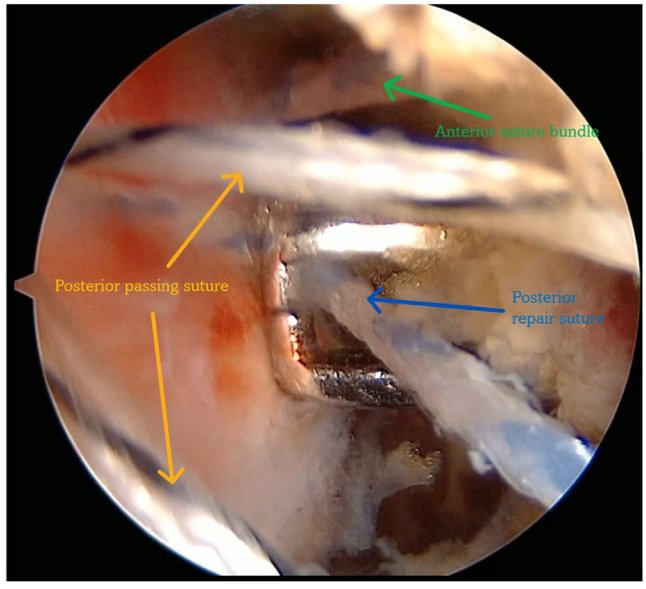

Fig 12. With the patient placed in the beach-chair position and viewing the bursal space of the right shoulder through the posterolateral portal (B), a suture grabber is inserted through lateral portal (D) and used to retract the posterior repair suture (blue arrow), currently exiting the shoulder through portal (C), out of portal (D). This step is essential in order to guide the repair suture through the opposite anchor. The posterior passing suture ends (yellow arrows) and the anterior bundle of sutures (green arrow) are left in place.

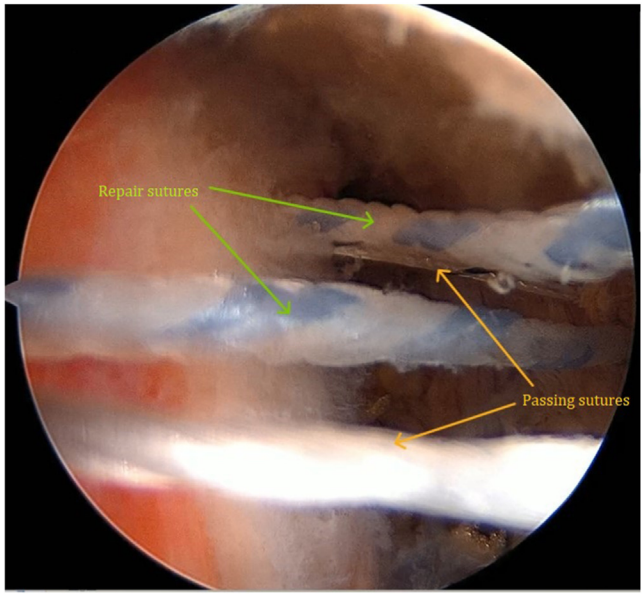

Fig 13. With the patient placed in the beach-chair position and viewing the bursal space of the right shoulder through the posterolateral portal, after retraction of the two repair sutures (green arrows) out through the opposite lateral repair portals, they can be seen spanning the bursal space crossed whereas the pulling sutures (yellow arrows) are spanning the bursal space straight. After this step, the next steps will be executed outside of the shoulder.

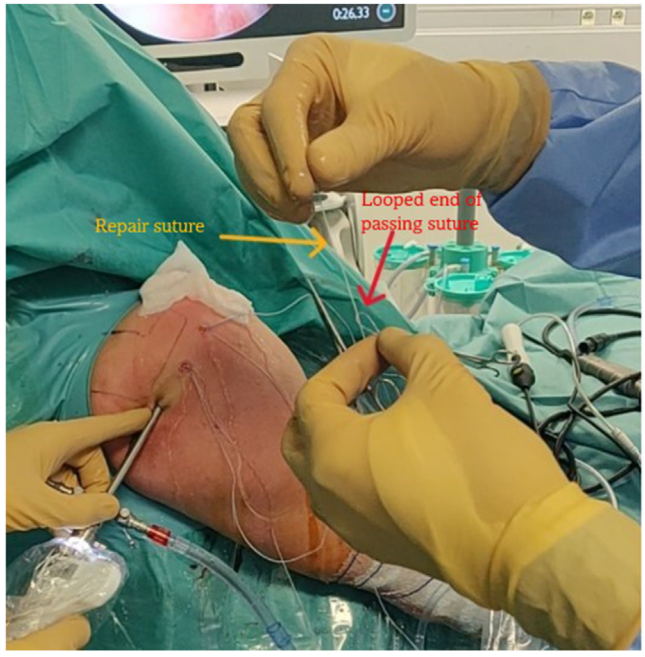

Fig 15. External overview of the right shoulder of the patient in the beach-chair position. The repair suture (yellow arrow) is passed through the looped end of the passing suture (red arrow). This step allows the passing suture to pull the repair suture through the anchor.

repair.[7] Moreover, in one of the few comparative clinical trials between transtendon and conversion repairs, Kim et al.[8] found no clinically relevant differences between the 2 techniques. The transtendinous repair is believed to be stronger, as the intact muscle fibers are maintained. This hypothesis is supported by biomechanical research in cadaveric studies and animal models.[9,10]

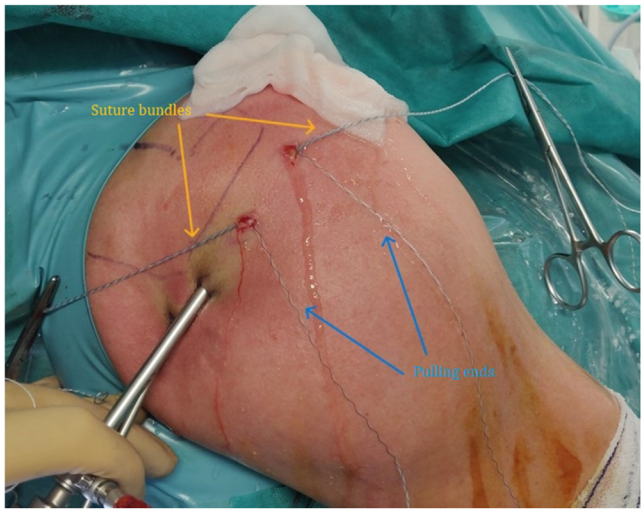

Fig 14. External overview of the right shoulder of the patient in the beach-chair position after retracting the repair sutures through the opposite portals. The pulling ends of the passing suture (blue arrows) have been separated from the other sutures (yellow arrows). Sutures that are not currently used can be secured by holding them or with any suitable equipment.

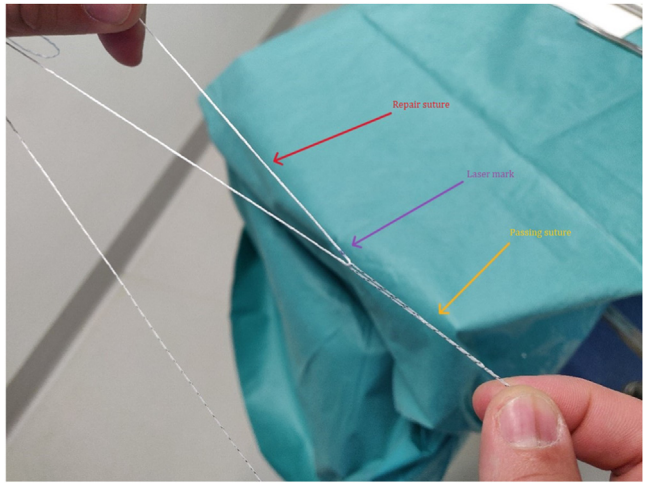

Fig 16. Example of extra-articular view of the laser mark (purple arrow) of the repair suture (red arrow) lined up with the with the loop of pulling suture (yellow arrow) in preparation of passing the repair suture through the anchor. This step ensures that the repair suture will have enough length to be passed through the anchor and back.

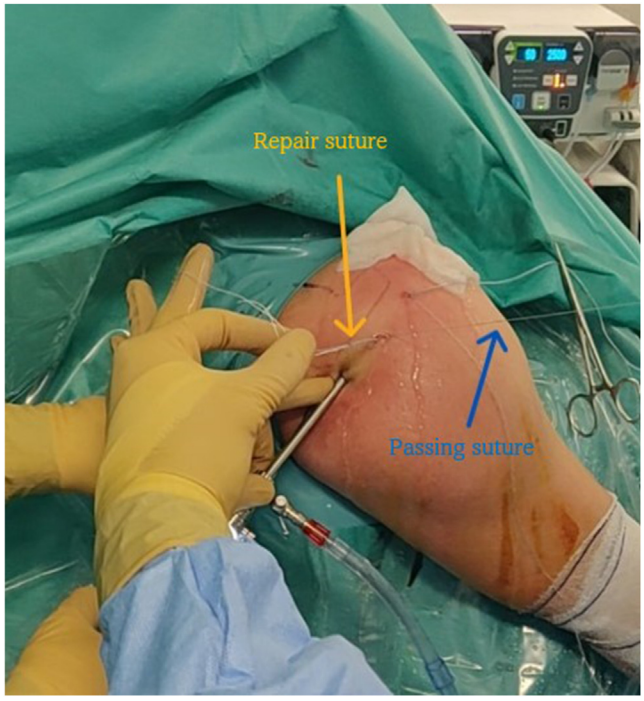

Fig 17. External overview of the right shoulder of the patient in the beach-chair position. After lining up the laser dot of the repair suture from the posterior portal (yellow arrow) with the loop from the passing suture from the posterior portal, the repair suture is pulled through the anchor by gently pulling on the pulling end of the passing suture (blue arrow).

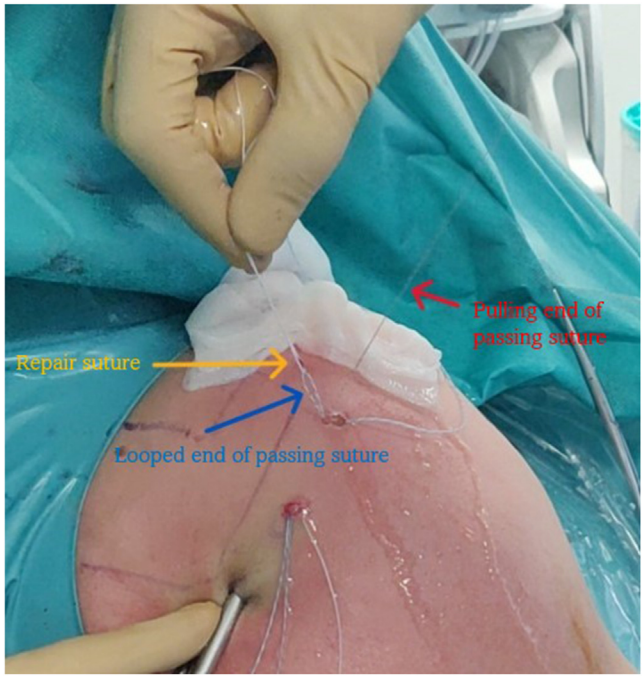

Fig 18. External overview of the right shoulder of the patient in the beach-chair position. After lining up the laser dot of the repair suture from the anterior portal (yellow arrow) with the loop from the passing suture from the anterior portal, (blue arrow) the repair suture is pulled through the anchor by gently pulling on the pulling end of the passing suture (red suture).

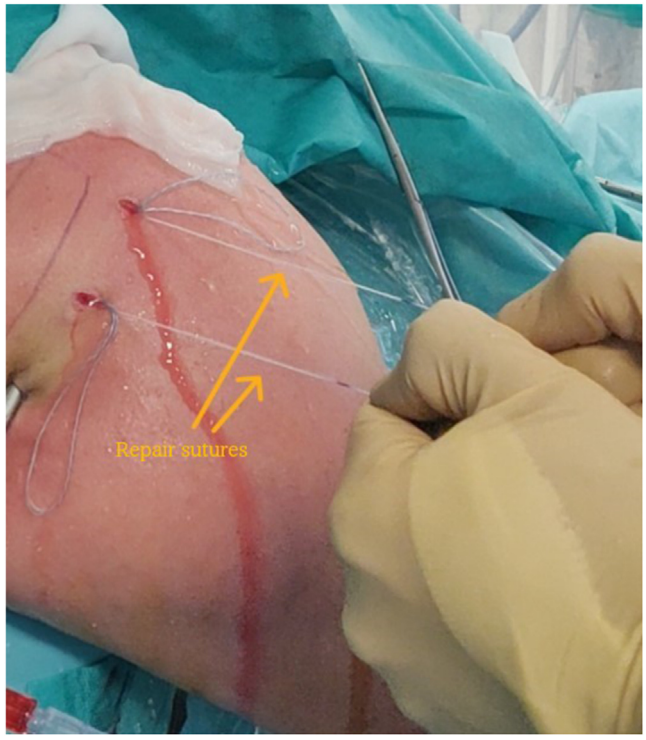

Fig 19. After passing both repair sutures (yellow arrows) through the anchors and discarding the passing sutures, the PASTA bridge repair can be tightened by pulling both repair sutures. The structure of the suture wire allows the suture to pass through the anchor but prevents it from sliding back.

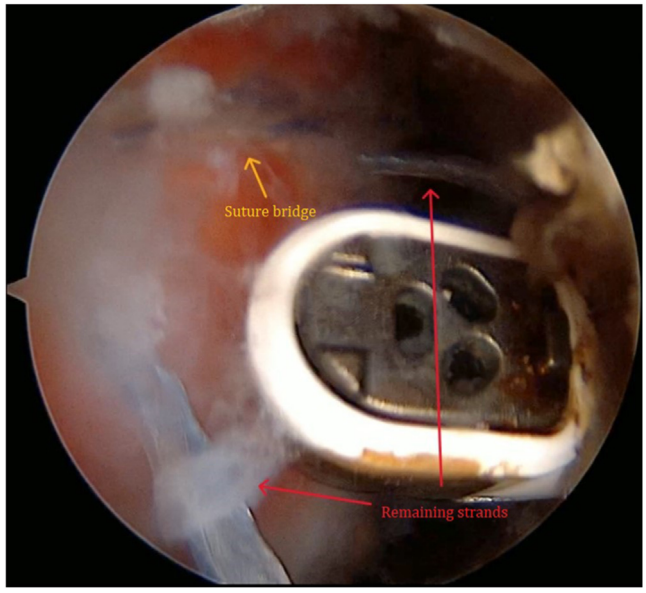

Fig 20. With the patient placed in the beach-chair position and viewing the bursal space of the right shoulder through the posterolateral portal (B), the tightened PASTA suture bridge (yellow arrow) can be seen on the tightened into the bursal side of the tendon with the remaining strands of the repair sutures (red arrows).

Table 1. Advantages and Disadvantages

Advantages and disadvantages compared with the technique described by Hirahara et al.[11]:
Advantages
Fewer tissue lesions
Less anchors (2 vs 3)
Smaller transtendinous anchors (1.8 mm vs 3.9 mm)
Technically less demanding and reproducible
Faster, more cost-effective repair
Disadvantages
Concerns regarding the pull-out strength of soft anchors

NOTE. Both techniques use 5 portals. The number of portals could be reduced in the current technique when the (A) portal shows good visibility on the sutures, the posterolateral (B) portal can be omitted. Omitting further portals, for instance, combining (C) and (D) into a single lateral portal, would require very precise suture management. Moreover, the sutures could get tangled in the process of being pulled out of the portal holders.

One of the main arguments against a transtendon repair is the technical difficulty of the intervention.[7] This demonstrates the need for easier approaches to transtendinous repairs of PASTA lesions. Of the many transtendinous approaches, the PASTA-bridge technique is relatively well known,[11] as it is the only technique that has been biomechanically evaluated in human models for partial tears.[12]

We propose 2 main adaptations to the aforementioned technique. The advantages and disadvantages of these adaptations are summarized in Table 1. Most importantly, we use knotless all-suture anchors instead of traditional solid-body anchors. As all-suture anchors are smaller than solid-body anchors, they require smaller drilling holes through the tendon as well as less bone removal upon implantation. Multiple studies on animal and cadaveric models have found comparable biomechanical performance between all-suture anchors and traditional solid-body anchors when used for rotator cuff repair.[13,14] Moreover, the pullout strength for all-suture anchors greatly depends on the angle of anchor insertion and the angle of pulling on the anchor.[15] We use a placement angle of 90° and the pulling angle of (closer to) 45°, both of which result in greater pullout strength and therefore a stronger repair. The use of all-suture anchors has been described before in relation to the repair of PASTA lesions.[16] Secondly, we chose not to place the distal anchor as it is not necessary. It potentially devascularizes intact distal tendinous tissue and has little function, as the idea of the PASTA single-row bridge repair is to compress only the medial tear on its footprint and not to prevent the tear from retracting.

In conclusion, the pearls an pitfalls of our new technique are summarized in Table 2.

Table 2. Pearls and Pitfalls

Pearls
Technically not more demanding than a full-thickness cuff repair
Remaining integrity of intact cuff fibers
No need to retrieve suture through different places of the cuff other than the transtendinous position.
No need the tie knots, just pulling sutures through opposite anchors with locking mechanism
Sutures will not be cut or damaged when using electrocautery, when necessary to decompress the subacromial bursa after anchor placement.
A probe or switching stick can be placed through the E portal to lift the cuff and visualize the tear better, as well as improves visualization of anchor placement
In case of failure of the technique, it remains possible to convert to a full-thickness tear and repair technique
Pitfalls
Difficulty of intra-articular visualization of anchor placement.
As sutures are not rerouted from the transtendinous anchor placement, if anchors enter too lateral through the intact cuff fibers, no medial compression is possible using the current technique.
Overtightening any of the passing or repair sutures may cause anchor pull-out

Disclosures

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