Technical Note

"Shoe Shop" Lacing Technique: A New Biceps-Augmented Knotless Suture for Arthroscopic Rotator Cuff Repair

Rocco Bonfatti, M.D., Austin F. Smith, M.D., Antoine Ledoux, M.D., Yves Lefebvre, M.D., and Lionel Neyton, M.D.

Abstract: Advancements in rotator cuff tear repair have led to innovative techniques for complex cases. In this article, we introduce the "shoe shop" lacing technique, a knotless, side-to-side, and tendon-to-bone suture method augmented with the long head of the biceps tendon (LHBT) for anterior margin–deficient massive rotator cuff tears. This approach offers simplicity, durability, and potential advantages in biomechanics. The LHBT integration and knotless sutures make it a promising solution for challenging tear patterns. This technique provides an attractive option for arthroscopic repair, improving outcomes in cases where anterior cable reinforcement is essential.

Significant advancements have been made in the treatment of complex rotator cuff tears over the past several decades. New repair techniques aim at improving construct biomechanics and promoting favorable healing. For massive tears, the side-to-side technique based on margin convergence described by Burkhart et al.[1] as a knotted technique has shown satisfactory outcomes. This type of repair alleviates pain through decreased mechanoreceptor stimulation and reduces overall strain, decreasing the tear gap size, with each additional suture demonstrating a standard rotator cuff repair using suture anchors.[2] Despite the development of strong sutures and various modifications of the technique, recurrences still occur, and certain tear patterns remain challenging to manage. Specifically, when the anterior remnant of the superior-anterior cuff is completely absent or weak, margin convergence is not a feasible option.[3] In such tear patterns, Richards and Burkhart[4] proposed integrating the long head of the biceps tendon (LHBT) in the repair.

In this article, we present the arthroscopic "shoe shop" lacing technique: a knotless, side-to-side, and tendon-to-bone suture technique that involves the biceps as an anterior cable augmentation.

The suture-passing (single-running) method described is convenient and efficient, and this is why it has been used by retail stores' employees to prelace some footwear to facilitate the fitting process for customers. It was also employed by the British military for the additional benefit of having an easy-to-cut upper horizontal section, facilitating the removal of a boot from an injured ankle or foot.

The ease of construction and the durability of this side-to-side and tendon-to-bone suture technique make it an intriguing choice for arthroscopic repair in anterior margin–deficient patterns of complex massive rotator cuff tears.

Surgical Technique

Patient Positioning and Surgical Preparation

After receiving an interscalene block, the patient is transported to the operating room. The patient is then placed in the beach-chair position on the operative table. Following a meticulous clearance assessment of the shoulder and axilla, general anesthesia is administered. The operative extremity is then suspended, with 3 kg of

From the Orthopaedic Surgery and Traumatology Department, University of Modena and Reggio Emilia, Modena, Italy (R.B.); OrthoArizona, Phoenix, Arizona, U.S.A. (A.F.S.); University of Louvain, Louvain, Belgium (A.L.); Clinique Rhena, Chirurgie orthopédique et traumatologique, Strasbourg, France (Y.L.); and Ramsay Santé, Hôpital Privé Jean Mermoz, Centre Orthopédique Santy, Lyon, France (L.N.).

Received November 8, 2023; accepted February 8, 2024.

Address correspondence to Lionel Neyton, M.D., Centre Orthopédique Santy, 24 Avenue Paul Santy, F-69008 Lyon, France. E-mail: neyton.lionel@orange.fr

2212-6287/231613
https://doi.org/10.1016/j.eats.2024.102980

traction applied for female patients and 4 kg for male patients. The shoulder is flexed forward to approximately 30° (Fig 1 a and b). To ensure aseptic conditions, the arm is prepared with iodine alcoholic solution and draped according to standard practices. Anatomic landmarks such as the acromion, coracoid, acromioclavicular joint, coracoacromial ligament, and the primary posterior viewing portal are distinctly marked using a surgical pen (Fig 2 a and b).

Diagnostic Arthroscopy

A standard posterior viewing portal is established 2 cm inferior and 2 cm medial to the posterolateral border of the acromion. Following a careful introduction of the arthroscope into the glenohumeral joint, a comprehensive diagnostic arthroscopy is conducted. By using an "outside-in technique" under the direct visualization of a spinal needle, a standard anterior portal is created within the rotator interval, just lateral to the tip of the coracoid. The arthroscope is subsequently repositioned within the subacromial space, and a mid-lateral portal is accurately located using a spinal needle. To ensure optimal visualization and access, a subacromial bursectomy is performed, meticulously removing soft tissue from the anterior, lateral, and posterior gutters. Anteriorly, the subcoracoid space is exposed and debridement of the external surface of the subscapularis muscle is performed. Superiorly, the undersurface of the acromion undergoes the same procedure, and the acromial attachment of the coracoacromial ligament is released. Posteriorly, the debridement is performed toward the adhesions on the external surface of the infraspinatus muscle. This area is scrupulously released of any confining tissues. If necessary, an acromioplasty and lateral acromial shortening are performed to provide adequate space for instrumentation during the rotator cuff repair.

After appropriate releases and debridement have been performed, the morphology of the tear is analyzed to confirm that a standard anatomic repair of the rotator cuff is not feasible due to absence or insufficiency of the anterior cable and superior-anterior rotator cuff. Also, the presence of the LHBT is confirmed.

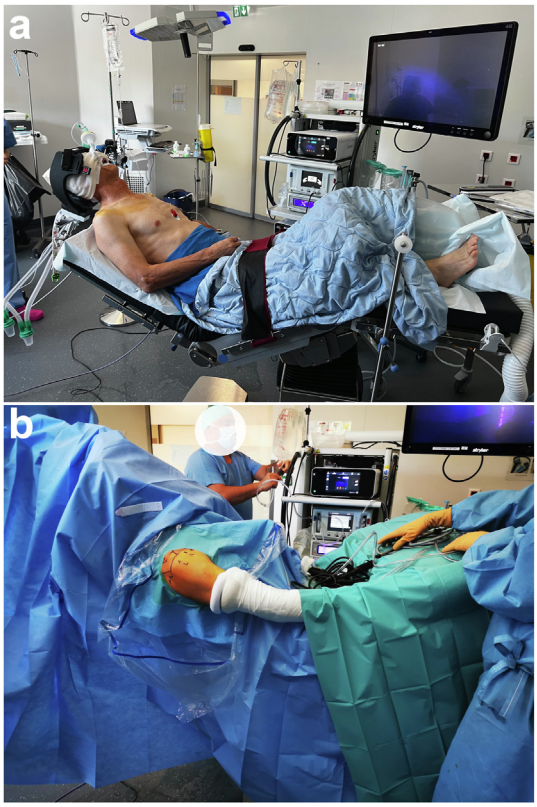

Fig 1. Patient positioning for the arthroscopic "shoe shop" lacing technique suggested for complex anterior-superior rotator cuff tears. (a) The patient is placed in the beach-chair position on the operative table. (b) The operative extremity, in this case the right arm, is then suspended, with 4 kg for a male patient. The shoulder is flexed forward to approximately 30°.

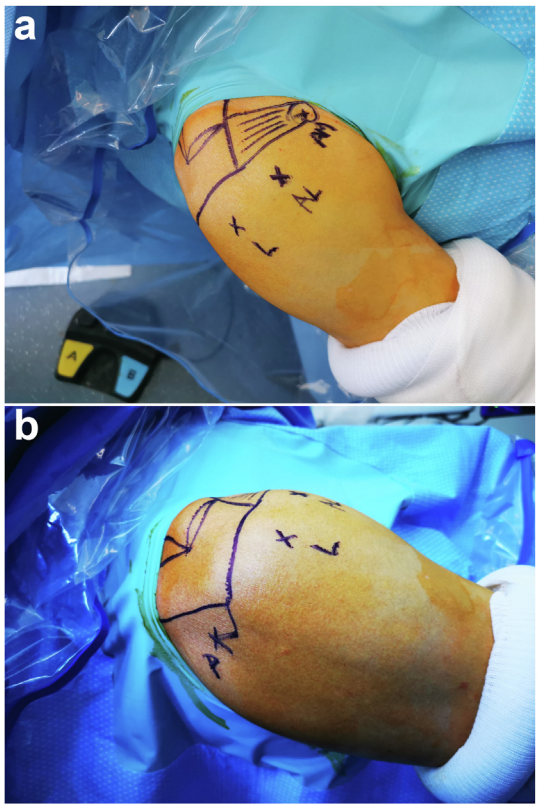

Fig 2. Preoperative procedures for the arthroscopic "shoe shop" lacing technique suggested for complex anterior-superior rotator cuff tears. The patient is placed in the beach-chair position. Anatomic landmarks such as the acromion, coracoid, acromioclavicular joint, coracoacromial ligament, (a) and the arthroscopic portals (primary posterior [P] viewing portal, lateral [L], (b) anterolateral [AL], and anteromedial [AM]) are distinctly marked on the skin of the patient using a surgical pen.

Table 1 presents insights and potential challenges associated with the shoe shop lacing technique.

Rotator Cuff Repair

To obtain an optimal "on top of the mountain" view of the rotator cuff, the arthroscope is directed toward the mid-lateral portal (Figs 3 and 4). An additional working portal is established anteriorly, approximately 2 cm from the anterolateral border of the acromion, using a spinal needle. The tear pattern and mobility of the rotator cuff are assessed with a tissue grasper, while any remaining soft tissue that obstructs visualization or limits mobility is excised. Nonviable tissue is removed, and the margins of the tear are cleaned using a tissue biter and shaver in preparation for repair (Fig 3 a and b).

Once satisfied with the arthroscopic evaluation and preparation, a high proximal biceps tenodesis is conducted within the bicipital groove utilizing the "double lasso-loop" technique as previously described.[5] To preserve the long intra-articular portion of the LHBT, an electrocautery device (or a pair of arthroscopic scissors) is utilized to perform the biceps tenotomy, slightly proximal to the previously positioned suture loops. It is important to ensure that a sufficient length of the intra-articular stump is preserved during the tenotomy process.

Using a Scorpion suture passer (Arthrex), a single permanent SutureTape (1.3 mm; Arthrex) is first passed in the distal-lateral part of the LBHT together with the anterior cuff margin, if present, from the bursal to articular side (Fig 3c).

The SutureTape tip is then reloaded in the Scorpion suture passer and pushed proximally, diagonally, and posteriorly and passed from the articular to bursal side into the posterior cuff margin. The SutureTape is retrieved and reloaded. The Scorpion is reintroduced and pushed toward the medial aspect of the LHBT (± anterior cuff margin) and rotated to allow a bursal to articular passage of the SutureTape. After retrieval and reloading, the SutureTape is passed from the articular to bursal side through the posterior margin, lateral to the previous passage. These steps are then repeated sequentially, allowing the running SutureTape to create a convergence repair of the rotator cuff with the incorporation of the biceps tendon (Fig 3 d and e).

At the end of the passages, the SutureTape limb exits from the posterior margin of the tear and is retrieved in the anterolateral portal. The anterior limb is retrieved through the anterolateral portal from the anterior portal where it was initially docked.

Throughout the procedure, care should be taken to prevent the suture limb from becoming locked.

Traction is now applied to both suture limbs to close the side-to-side repair: when margins are satisfactorily converged, the 2 SutureTape ends are positioned with a suture grasper through the anterolateral portal onto the greater tuberosity to evaluate the appropriate excursion and tension of the rotator cuff for anchor placement. The greater tuberosity footprint is then debrided to

Table 1. Insights (Pearls) and Potential Challenges (Pitfalls) Associated With the "Shoe Shop" Lacing Technique

Pearls	Pitfalls
Optimal visualization is achieved by utilizing the mid-lateral portal as the primary viewing portal.	If previous experience has been limited to posterior portal viewing, a learning curve may be encountered.
For efficient suture management, employ an accessory anterolateral portal as the primary working portal, with additional anterior and posterior portals.	Placing the anterolateral portal too far distally may pose a risk to the cephalic vein.
To create adequate space for repair, perform a wide subacromial debridement.	Inadequate removal of soft tissue within the anterior, lateral, and posterior gutters can hinder visualization and prolong surgical duration.
Maintain an adequate length of the LHBT stump, using as reference the upper part of the bicipital groove.	A too short LHBT stump may result in an asymmetric repair of anterior and posterior margins or in an insufficient strength of the anterior margin in a L-shaped lesion, with high risk of recurrence.
Identify the rotator cable residual and pass the suture through this tissue to enhance the biomechanics of the repair.	Identification of the rotator cable may be challenging, particularly if the bursa is not thoroughly debrided from the superficial rotator cuff or if it is lesioned.
Maintain symmetric distribution of the suture from medial to lateral.	Failure to effectively manage sutures can result in confusion and increased surgical time. It is crucial to establish a consistent methodic system to follow throughout the repair process.
Evaluate and adjust tension individually for each suture passage based on the size and shape of the tear, using manual and visual judgment.	An ineffective traction of the suture limbs may result in asymmetric or incomplete margin convergence or tendon-to-bone repair.
During the procedure, pay attention to avoid crossing of the suture.	To change from bursal-to-articular to articular-to-bursal suture passing, the suture passer needs to be rotated: this may lead to crossing and unwanted knots that put in danger the correct sliding of the suture.

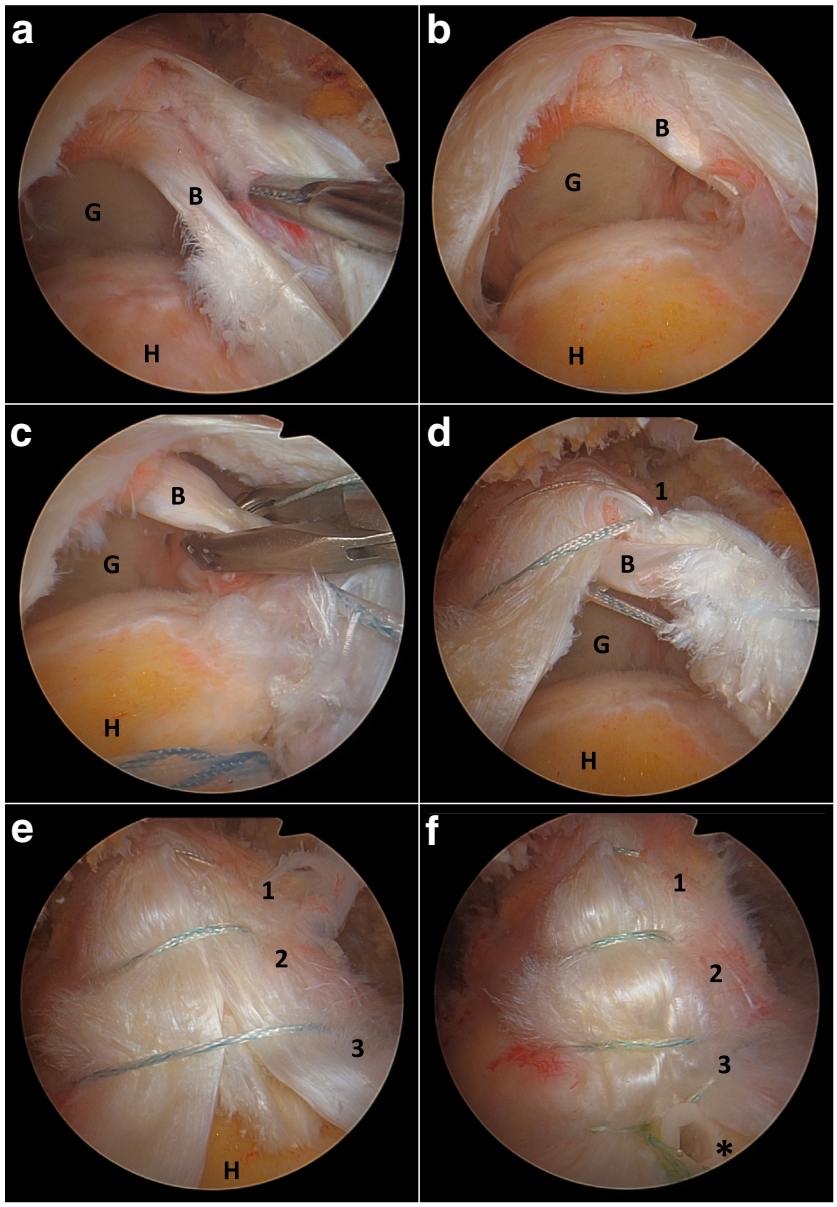

Fig 3. Intraoperative photo-based description of the "shoe shop" lacing technique suggested for complex anterior-superior rotator cuff tears. The patient is a male, and the arm involved is the right shoulder. The patient is placed in the beach-chair position. The operative extremity is suspended with 4 kg. During the diagnostic phase, performed through a standard posterior viewing portal (established 2 cm inferior and 2 cm medial to the posterolateral border of the acromion), a complex anterior-superior rotator cuff tear of the right shoulder is defined. Also, the presence of the long head of the biceps tendon (LHBT) is confirmed. By using an "outside-in technique," a standard anterior (or anteromedial) portal is created within the rotator interval, just lateral to the tip of the coracoid. The arthroscope is subsequently repositioned within the subacromial space, and a mid-lateral (or standard lateral) portal is accurately located. To ensure optimal visualization and access, a subacromial bursectomy is performed. After appropriate releases and debridement have been performed, the morphology of the tear is analyzed to confirm that a standard anatomic repair of the rotator cuff is not feasible due to absence or insufficiency of the anterior cable and superior-anterior rotator cuff. (a) The tear pattern and mobility of the rotator cuff are assessed with a tissue grasper: for this purpose, an "on top of the mountain" view of the rotator cuff with the arthroscope directed toward the mid-lateral (or lateral) portal is used, and an additional working portal is established anteriorly (anterolateral portal), approximately 2 cm from the anterolateral border of the acromion. (b) Then, any remaining soft tissue that obstructs visualization or limits mobility is excised and nonviable tissue is removed: the margins of the tear are cleaned using a tissue biter and shaver in preparation for repairb). (c) Using a Scorpion suture passer (Arthrex), a single permanent SutureTape (1.3 mm; Arthrex) is first passed in the distal-lateral part of the LBHT together with the anterior cuff margin from the bursal to articular side. The SutureTape tip is then reloaded in the Scorpion suture passer and pushed proximally, diagonally, and posteriorly and passed from the articular to bursal side into the posterior cuff margin. The SutureTape is retrieved and reloaded. The Scorpion is reintroduced and pushed toward the medial aspect of the LHBT (+ anterior cuff margin) and rotated to allow a bursal to articular passage of the SutureTape. (d) After retrieval and reloading, the

eliminate any lingering soft tissue, and an arthroscopic burr is employed to create a bone bed in the defined position (approximately 5 mm from the articular rim).

The 2 limbs are loaded into the eyelet of a 5.5-mm Bio-Composite SwiveLock C Closed Eyelet suture anchor (Arthrex). An awl is advanced with a mallet in the desired position for the anchor. The eyelet introducer on the anchor is inserted into the hole until the bottom of the anchor is flush with the bony surface. Each limb of the SutureTape is manually tensioned under direct visual control, and the suture anchor is then screwed into place (Fig 3f).

Technique Variations

If the age and characteristics of the patient or the quality of the LHBT in the bicipital groove make the patient a poor candidate for a tenodesis procedure, an alternative option is to perform a basic extra-articular tenotomy. Care should be taken to ensure a sufficient length of the intra-articular stump to facilitate the shoe shop lacing technique.

If delamination is present in the remnant tendon, it is important to incorporate all layers in the construct.

The full technique is also described in Video 1.

Postoperative Rehabilitation

Following surgery, the patient is immobilized in a sling with a 20° abduction pillow for 4 weeks. Within 5 days postsurgery, the patient begins a gradual and structured self-stretching exercise regimen, which may incorporate hydrotherapy depending on individual circumstances. After 4 weeks, the abduction pillow is discontinued, and a standard sling is worn for an additional 2 weeks. Notably, there is no prescribed regimen for specific muscle strengthening at this stage. It is anticipated that the patient will be able to resume activities of daily living within 3 months postsurgery, while full participation in all activities is allowed after 6 months of postoperative recovery.

Discussion

Massive superior rotator cuff lesions pose a significant challenge for shoulder surgeons; the Achilles heel of reparability is the anterior supraspinatus where the wear of the cable makes this area weak and prone to repair failure. Some surgical treatments proposed are superior capsular reconstruction (SCR), side-to-side repair, and ballooning.[6]

SCR has demonstrated improvements in clinical outcomes, range of motion, and pain relief, but some studies have reported postoperative complications, including new tears, loss of graft attachment, or partially healed grafts. The revision rate after failure ranges from 6.9% to 8.9%.[7] Some procedures exploit the LHBT as graft: in "The Chinese Way," differently from our technique, the tendon is moved posteriorly and fixed to the great tuberosity.[8]

The eligibility of the LHBT as a rotator cuff augment has been described in recent literature, and now it represents a promising autograft option because of its accessibility, cost-effectiveness, biomechanical strength, and presence of tendon-derived stem cells.[9] Various techniques proposed LHBT use in SCR and anterosuperior longitudinal tears, emphasizing the importance of anterior cable reinforcement or reconstruction. The "shoe shop" lacing suture takes advantage of these characteristics to strengthen the rotator cuff repair, making the margin convergence possible even in complicated rotator cuff tear patterns with weakness or absence of the anterior rim.

Biomechanical studies on side-to-side repair have proven that margin convergence can decrease strain across the rotator cuff by up to 58%, and clinical studies that incorporated tendon-to-bone repair reported favorable outcomes.[2] Our technique differs from the first described margin convergence method, for the use of a continuous knotless suture and the anterior augmentation with the LHBT: these allow one to exploit the benefits of both side-to-side and tendon-to-bone repair, retrieving the superior rotator cuff to an anatomic configuration.[4]

In the first margin convergence method descriptions, Richards and Burkhart[4] do not propose performing a LHBT tenotomy, and in our opinion, this may lead to 2 negative consequences: first, fixing the intact LHBT in the repair may generate nonanatomic biomechanics, thus potentially limiting anterior elevation.[10] Second, LHBT has been identified as a pain generator, and tenotomy/tenodesis has proven to be effective on pain relief: its persistence may be a cause of poor outcomes.[11]

The "shoe shop" lacing technique offers easy reproducibility, fast execution, and cost-effectiveness. LHBT augmentation and knotless sutures provide both

SutureTape is passed from the articular to bursal side through the posterior margin, lateral to the previous passage. (e) These steps are then repeated sequentially 2 more times, allowing the running SutureTape to create a convergence repair of the rotator cuff with the incorporation of the biceps tendon, which is released with an extra-articular tenotomy distal to the SutureTape's first more lateral passage. (f) Traction is now applied to both suture limbs to close the side-to-side repair: when margins are satisfactorily converged, the 2 limbs are loaded and a 5.5-mm Bio-Composite SwiveLock C Closed Eyelet suture anchor (Arthrex) is then screwed into place . For each photo: anterior side of the shoulder on the right and posterior side on the left. Passages of the suture through the anterior cuff margin: (1) first passage, (2) second passage, (3) third passage, and (*) suture anchor. (B, long head of the biceps tendon; G, glenoid; H, humeral head.)

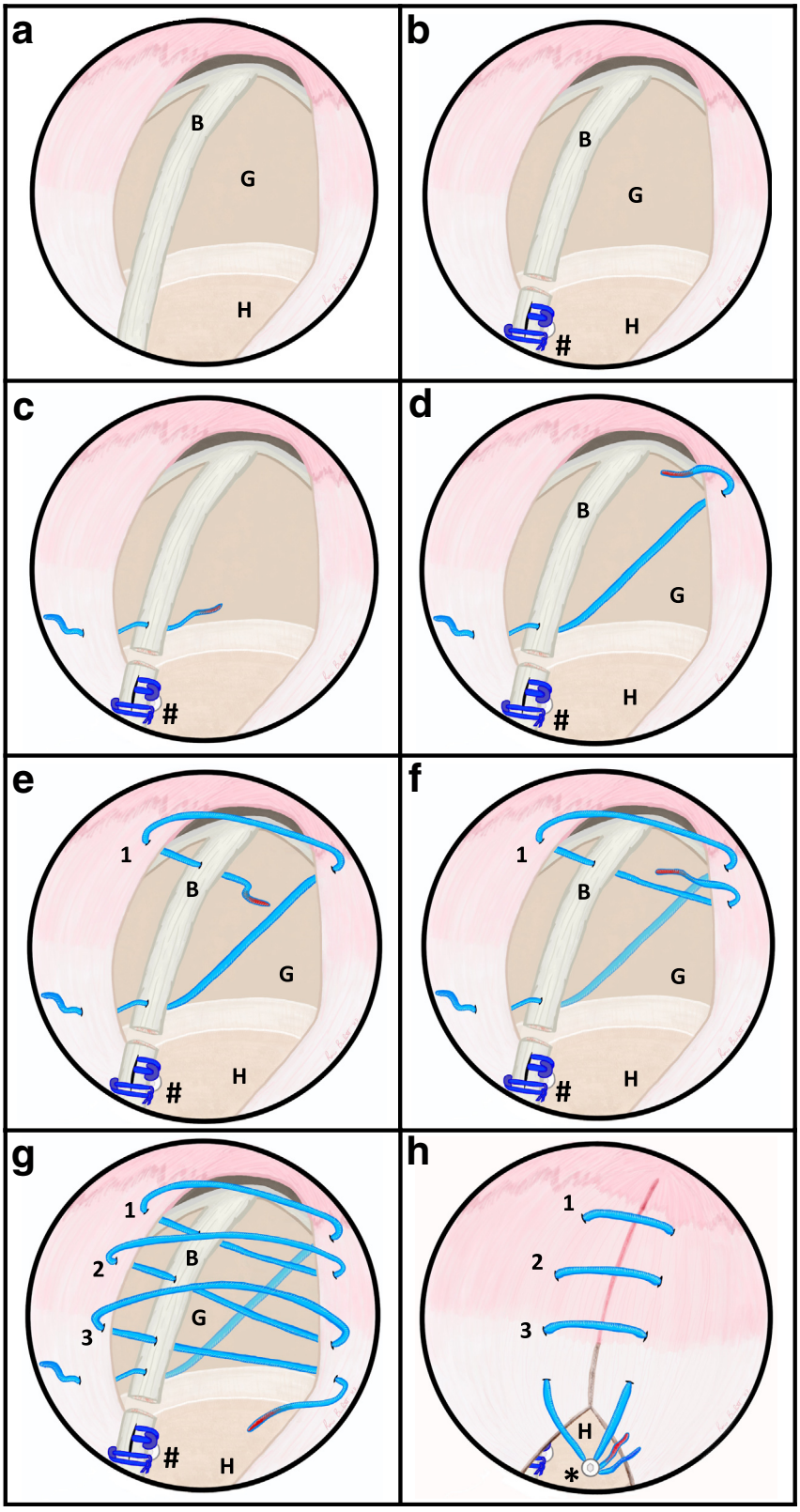

Fig 4. Drawing-based description of the "shoe shop" lacing technique suggested for complex anterior-superior rotator cuff tears. The patient is placed in the beach-chair position. The subacromial space of the left shoulder is shown through an arthroscopic "on top of the mountain" view of the rotator cuff with the arthroscope directed toward the mid-lateral (or standard lateral) portal. (a) It can be recognized as a complex anterior-superior rotator cuff tear with a full-integrity long head of the biceps tendon (LHBT). (b) High proximal biceps tenotomy and tenodesis within the bicipital groove utilizing the "double lasso-loop" technique and an anchor. (c) A single permanent tape is first passed in the distal-lateral part of the LBHT together with the anterior cuff margin from the bursal to articular side. (d) The tape tip is then reloaded in the suture passer and pushed proximally, diagonally, and posteriorly and passed from the articular to bursal side into the posterior cuff margin. (e) The tape is retrieved and reloaded. The wire is reintroduced and pushed toward the medial aspect of the LHBT (+ anterior cuff margin) to allow a bursal to articular passage. (f) The tape is then passed from the articular to bursal side through the posterior margin, lateral to the previous passage. (g) These steps are then repeated sequentially 2 more times, allowing the running tape to create a convergence repair of the rotator cuff with the incorporation of the biceps tendon. (h) Traction is now applied to both suture limbs to close the side-to-side repair: when margins are satisfactorily converged, the 2 limbs are loaded, and a suture anchor is then screwed into place. For each drawing: anterior side of the shoulder on the left and posterior side on the right. Blue tip of the suture: staying end. Red tip of the suture: running end. Passages of the suture through the anterior cuff margin: (1) first passage, (2) second passage, (3) third passage, (*) suture anchor, and (#) biceps tenodesis. (B, long head of the biceps tendon; G, glenoid; H, humeral head.)

biological and biomechanical additional advantages to the side-to-side and subsequent tendon-to-bone repair. This combination can be particularly beneficial for complex anterior-superior rotator cuff tears.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Y.L. reports a relationship with Move up that includes royalties or licenses or consulting and a relationship with Arthrex that includes consulting. L.N. reports a relationship with Arthrex (consulting) Stryker (consulting and royalties), Sparta-Biopharma (equity or stocks) and Statera (equity or stocks). All other authors (R.B., A.F.S., A.L.) 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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