Technical Note

Delta-Loop-Stitch: Three-Point Fixation for Combined Radial and Tangential Capsular Shift for the Treatment of Multidirectional Instability of the Shoulder and Hyperlaxity

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Abstract: Multidirectional shoulder instability and hyperlaxity can be treated with arthroscopic shoulder stabilization and capsular shift. In these patients, the joint capsule often becomes the weak link in terms of pullout strength and cutting through of the used sutures, which can further be compromised by reduced quality of the capsular tissue. The described delta-loop-stitch combines a loop stitch through the capsule with a 3-point-fixation to the intact labrum thus distributing the load and reducing the risk of failure of the fixation. The suture knots are directed under the joint capsule away from the articulating surfaces to reduce the risk of iatrogenic lesions of the articular cartilage. The circumferential application of the delta-loop-stitch allows a sufficient capsular shift that combines a radial and tangential shift and reduction of the overall joint volume that can be adjusted to the patient's individual situation and the surgeon's preference.

Multidirectional shoulder instability is a common clinical problem that can be improved by either conservative or operative treatment with inferior capsular shift, as already suggested in 1980 by Neer and Foster, which at that time was performed in an open fashion.[1] The advancement of arthroscopic surgery has led to an improvement in operative technique and concepts that allow for a 270° capsular shift with multiple sutures such as the capsulolabroplasty described by Kim et al. in 2004 and its variations.[2]

The effectiveness of the technique is limited by the quality of the tissue, both the labrum and the capsule, which is often a concern in clinical practice.[3] Simple sutures own the inherent risk of cutting through soft and biomechanically rather incompetent tissue. This phenomenon is familiar to every shoulder surgeon. To improve the pullout strength and reduce the risk of cutting-through of the sutures, a new suturing technique, the delta-loop-stitch is introduced and described further in this paper.

Surgical Technique (With Video Illustration)

The delta-loop-stitch can be used for all cases in which a capsular shift is the goal but was particularly designed for multidirectional shoulder instability. A prerequisite is the presence of an intact and biomechanically stable glenoid labrum at the site of the shift.

Positioning, Portal Placement, and Instruments

The authors' preferred method to position the patient is a lateral decubitus position with double-traction of the operated arm in a longitudinal and axial direction (Fig 1). This allows visualization of the anterior, inferior, and posterior joint and provides enough room for suture manipulation at the 6-o'clock position. Beginning with a standard posterior portal, an anterior portal is established and a working cannula is introduced. A lateral portal is established at the 12-o'clock position and after inspection (and possible repair) of the SLAP region, the viewing portal is switched to the top (lateral portal). The existing posterior portal is held open by a switching stick that is now checked for optimal position

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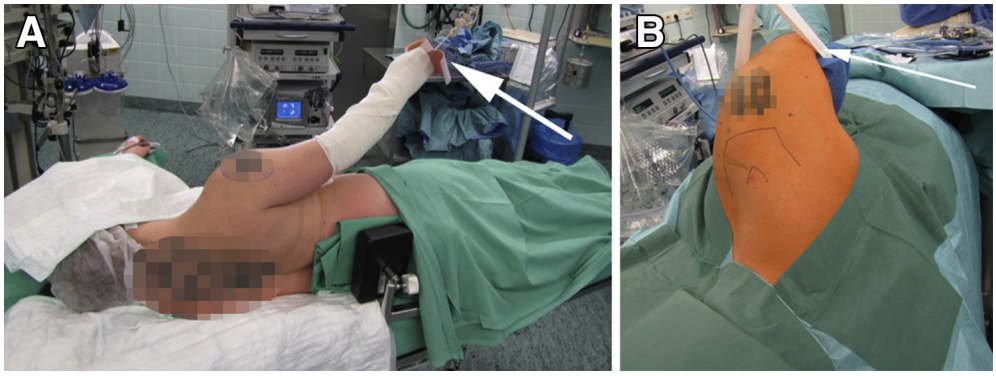

Fig 1. Positioning of the patient: with the right sight affected a lateral decubitus position on the left side with longitudinal arm traction (1A, white arrow) and axial arm traction (1B, white arrow) provides intraoperative space for arthroscopy.

to allow the completion of the entire procedure with 2 working portals (anterior and posterior) (Fig. 2) Sometimes the posterior portal needs to be re-established to obtain a decent low and anterior position in regard to the glenoid surface to provide a good angulation if anchor placement becomes necessary and provide enough room for suture manipulation.

To complete a full 270° capsular shift, the use of 2 angulated suture passing devices, such as a left and right 25° SutureLasso (Arthrex, Naples, FL), is recommended.

Capsular Shift

The authors' preferred method is to begin the shift at the 6-o'clock position and continue to shift from inferior to superior alternately anterior and posterior for optimal visualization and to minimize iatrogenic damage to the articular surface by an increasing reduction of capsular volume as the shift progresses and becomes more and more effective.

In a right shoulder, the first move is to pass the left 25°-angulated SutureLasso (Arthrex) from the posterior portal into the inferior capsule and grasp about 1 cm of tissue between entrance and exit (Video 1). The distance to the intact glenoid labrum is about 0.5 to 1 cm. Both the amount of tissue the initial capsular perforation incorporates (1) and the distance to the labrum (2) can be adjusted and are a matter of surgeon's preference and the amount of tangential (1) and radial (2) capsular shift at this site that are intended. The lasso is shuttled anteriorly and the 2 free ends of a bisected suture are introduced into the loop. The lasso is pulled back and the 2 suture ends are shuttled to the posterior portal (Fig. 3C).

Coming from the posterior side, the suture grasper is used to shuttle the loop end of the suture from anterior to posterior. The free ends of the suture are passed through the loop. Pulling the free ends of the suture the loop sets to the inferior capsule creating a loop stitch with a certain amount of capsular tissue that is grasped (Fig 3D). Tightening the loop leads to tangential capsular shift of the inferior capsule (Fig 3E).

Using the suture grasper, both free ends in the posterior working portal are shuttled anteriorly for further use. The 25°-left-angled suture lasso is used to perforate the inferior labrum in a radial way. Care must be taken to keep the violation of the tissue as minimal as possible. The free end of the lasso is shuttled anteriorly and the first free end of the 2 free suture limbs is introduced into the loop and shuttled to the posterior portal in a retrograde fashion. As a result, the first simple stitch is created incorporating the intact labrum (Fig 3F).

Again, the 25°-left-angled SutureLasso is used to perforate the inferior labrum in a radial way with a certain distance to the first suture of about 5 mm. Care

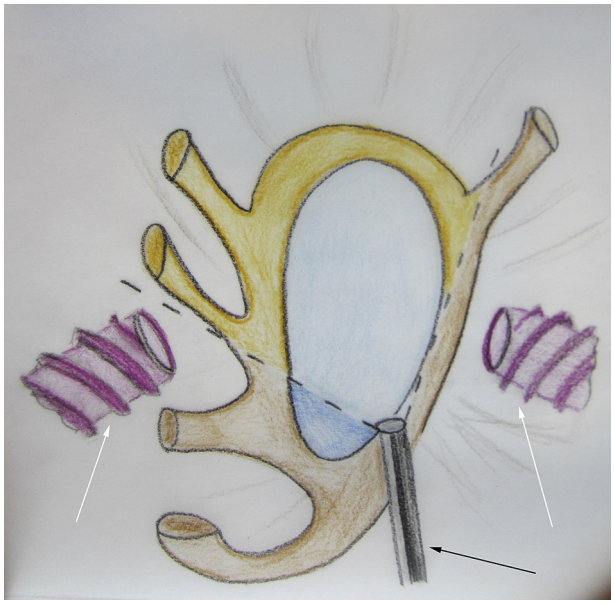

Fig 2. A lateral viewing portal and 2 working cannulas (white arrows) (anterior and posterior) are established that allow the visualization of the entire glenoid and inferior capsule and suture passing in both the anterior-to-posterior and posterior-to-anterior direction (black arrow pointing at the arthroscope in the lateral viewing portal).

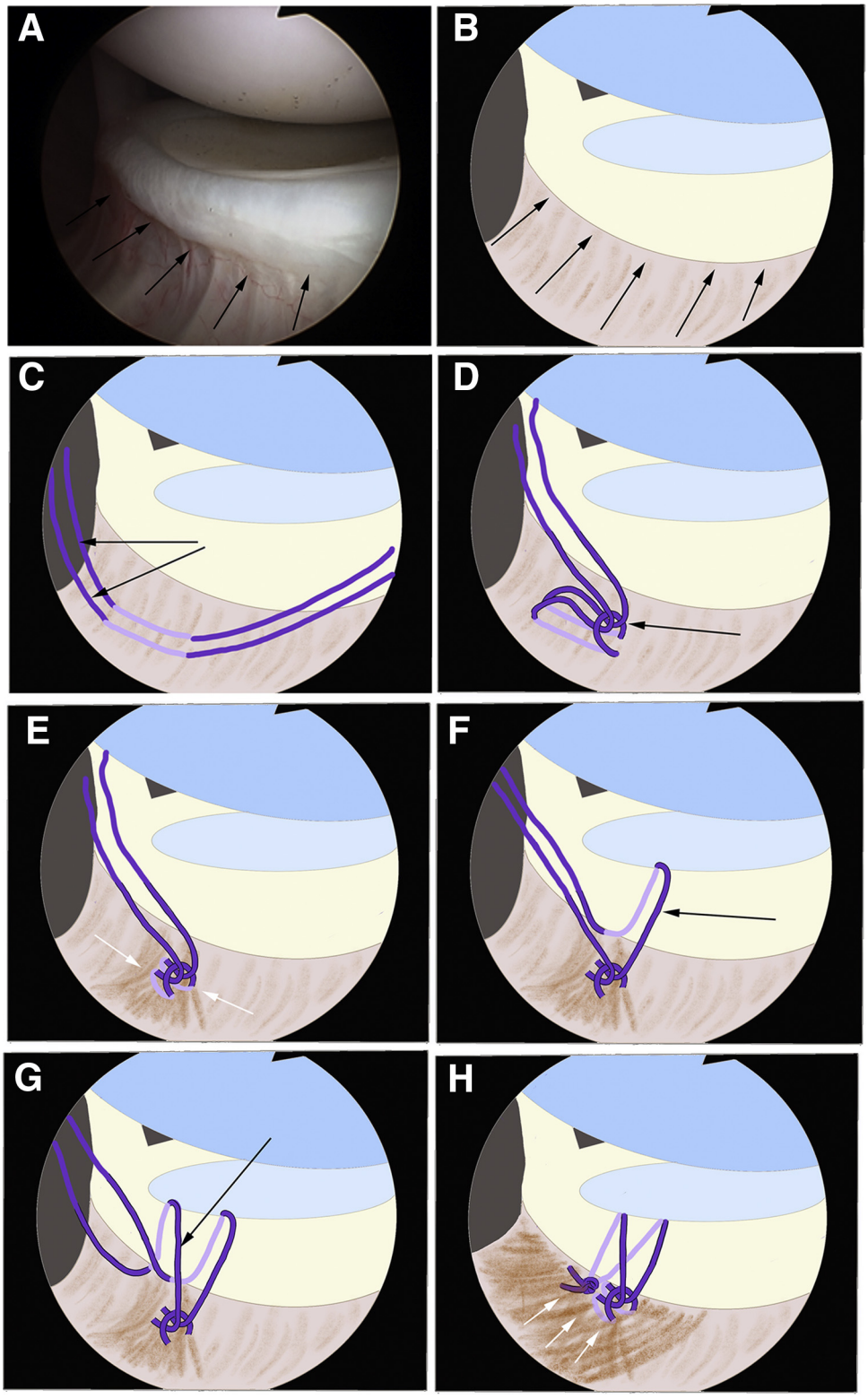

Fig 3. Arthroscopic view (A) from posteroinferior in a right shoulder into the glenohumeral joint and drawing of the same picture (B). The joint capsule attaches very deeply to the glenoid neck (black arrows) and the intact labrum creating a Table-Mountain configuration with a prominent glenoid surface. A bisected suture (black arrows) is transported through the posterior capsule (C). A loop stitch (black arrow) is created by passing the 2 free ends through the loop at the other end of the suture (D). Pulling and tightening of the suture leads to a tangential capsular shift (white arrows) (E). The first free suture end (black arrow) is passed around the intact labrum in a retrograde fashion (F). The second remaining free suture (black arrow) end is passed around the intact labrum in a retrograde fashion (G). Tightening of the knot leads to a radial shift (white arrows) (H). The result is a 3-point fixation with a covered suture knot underneath the joint capsule (black arrow) with a combined radial 3 parallel white arrows) and tangential (2 opposing blue arrows) capsular shift and reduction of the joint volume (J). The insertion of the capsule is elevated to the level of the labrum correcting the Table-Mountain configuration (J). The circumferential application of the delta-loop-stitch allows for completion of the procedure (7-8 delta-loop-stitches for a 270° shift, red arrows) and adjustment to the surgeon's preference and the patient's individual need for correction (K).

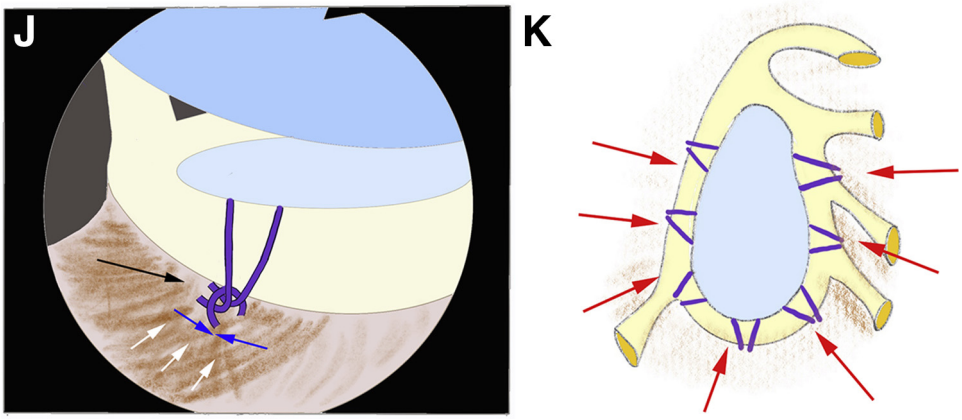

Fig 3. Continued.

must be taken to keep the violation of the tissue as minimal as possible and to keep the tissue bridge between both stitches intact. The free end of the lasso is shuttled anteriorly and the second and remaining free suture limb is introduced into the loop and shuttled to the posterior portal in a retrograde fashion. As a result, the second simple stitch is created incorporating the intact labrum. With the tensioned loop stitch and the 2 retrograde simple stitches around the labrum a delta-shaped 3-point fixation of the capsulolabral complex is ready (Fig 3G).

The knot-pusher is used to tighten the construct and adjust the tension with 5 simple knots that will be covered by capsular tissue and will lay outside the articulating surfaces (Fig 3H). The amount of tangential shift is determined by the distance between the inlet and outlet perforations of the suture lasso in the first step. The amount of radial shift is determined by the distance of the 2 previous perforations to the glenoid labrum. Both the tangential and radial shift will be combined and need to be adjusted to the patient's individual situation and pathoanatomy. As a result, the capsular insertion will be moved to the level of the labrum and the Table Mountain configuration will be corrected (Fig 3 J and K).

The procedure is continued in the aforementioned way from inferior to superior until the entire capsule with the exception of the superior part is shift toward the labrum. Seven or eight delta-loop-stitches usually are sufficient to complete a 270° circumferential capsular shift (Fig 4 E and F).

Discussion

Initially, stabilization procedures were performed with an open approach, including a shift of the inferior and/or anterior and posterior capsule.[1,4-9] With the development of techniques and understanding of the pathology, arthroscopic procedures more and more replaced the open approaches.[2,3,10-17]

Concerns remain for the potential of iatrogenic damage to the articular surface by the sutures and protruding knots as well as for insufficiency of the suture due to limited tissue quality in terms of pullout and cutting through. This can be addressed and minimized by the use of partially resorbable sutures such as ORTHOCORD (Ethicon, Norderstedt, Germany) or complete resorbable sutures such as PDS-II (Ethicon) and the application of the lasso-loop stitch, that has been shown to reduce the risk for cutting through the tissue.[18]

The possibility to cover the knots under the capsule away from the articulating surface is considered to be a big advantage of the technique and was one of the main goals that led to the design of this particular stitch configuration (Table 1). Simples stitches, even if carefully performed with knots oriented away from the labrum, can settle by time and thus find a way to become in contact with the humeral cartilage.

The amount of capsular shift that is necessary to achieve the goal of reducing the capsular volume and provide a stable joint is highly subjective and remains a matter of personal experience. A landmark that can provide orientation is the paper of Ponce et al.,[19] who described a reduction of capsular volume of 10% for every 1 cm of shifted tissue and a 50% reduction of capsular volume using 5 suture anchors in cadaver testing.

The delta-shaped suture arrangement of the described stitch configuration results in a 3-point fixation that provides a distribution of forces to a bigger area and as a result reduced overall risk for failure (Table 1). The author has successfully been using that

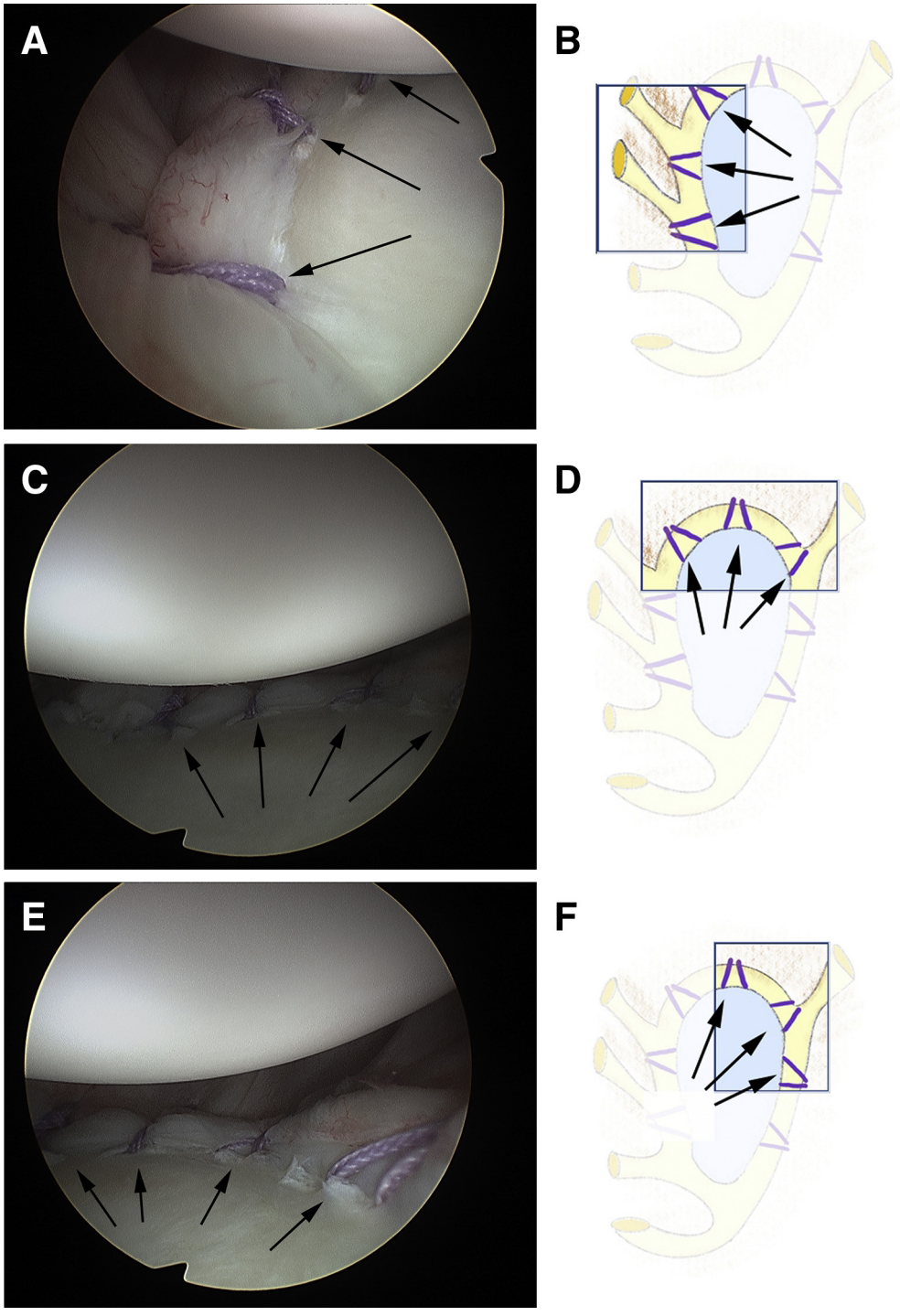

Fig 4. Arthroscopic view from a lateral viewing portal onto the glenoid surface in a right shoulder with a completed 270° capsulolabroplasty with capsular shift at the anterior (A, drawing B), inferior (C, drawing D) and posterior compartment (E, drawing F) of the shoulder joint (black arrows pointing at multiple delta-loop-stitches).

delta-loop stitch as the main surgical technique for multidirectional instability cases or in combination with suture-anchor placement for cases with a compromised labrum and hyperlax patients in a large number of surgeries for the last 10 years. Clinical results are reliably very good and will be the subject of separate publications that are beyond the scope of this technical paper.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Complete arthroscopic procedure	An intact labrum is a prerequisite for the technique
Minimally invasive	Technically demanding
Covered knots under the capsule with less potential for iatrogenic chondral damage	Various suture passing instruments (left and right angled) are necessary
The amount of capsular shift can be varied by modification of the amount of capsule in the loop-stitch (tangential shift) and the distance from the glenoid (radial shift)	Overtightening of the capsule can lead to stiffness and capsulorrhaphy arthropathy in the long-term
Capsular shift can be adjusted in numerous positions (anterior, inferior, posterior) in relation to the specific anatomy and pathology of the patient	No clear anatomical landmarks to define and control the amount of capsular shift
Pullout and cutting through of the sutures are less likely due to load distribution to 3 points in multiple locations	HAGL lesions must be excluded or repaired if present to avoid failure and recurrence of instability

HAGL, humeral avulsion of the glenohumeral ligament.

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