Arthroscopic Capsulolabral Revision Repair for Recurrent Anterior Shoulder Instability

Christoph Bartl, MD, and Andreas B. Imhoff, MD

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Introduction

Arthroscopic capsulolabral reconstruction via the anteroinferior 5:30 portal allows secure placement of the suture anchors in the lower half of the glenoid and adequate retensioning of the inferior glenohumeral ligament.

Arthroscopic reconstruction techniques provide the advantage of allowing the surgeon to diagnose and address all additional intra-articular soft-tissue abnormalities, minimize iatrogenic damage (especially to the subscapularis tendon) caused by the approach, and achieve a better cosmetic result.

Treatment of anterior shoulder instability with an open repair technique following an unsuccessful initial repair was considered the gold standard, with good functional results and a reported lower recurrence rate compared with that following arthroscopic techniques¹⁻⁵. In recent years, arthroscopic instability repair techniques improved and became a standard procedure for the treatment of recurrent anterior shoulder instability with isolated soft-tissue lesions and also as a revision procedure, with outcomes comparable with those of open repair^{1,2,6-9}.

Key steps for a successful revision procedure are a detailed analysis of patient factors, failure analysis of the index repair, a proper physical examination, and sufficient preoperative imaging (Figs. 1 and 2; Table I).

It is important to identify all contributing pathoanatomic soft-tissue and bone factors and to take into account the patients' functional demands and activity level for selection of the adequate revision repair procedure^{1,4,5}.

The following key steps describe our standardized arthroscopic capsulolabral reconstruction:

Step 1: Examination under anesthesia

Step 2: Arthroscopic evaluation and portal placement

Step 3: Mobilization of capsulolabral complex

Step 4: Anchor placement

Step 5: Capsulolabral shift and knot tying

Step 6: Additional tissue reconstruction

Step 7: Rehabilitation

Step 1: Examination Under Anesthesia

With the patient under anesthesia, and prior to surgical intervention, assess the direction of glenohumeral instability and the presence of joint hyperlaxity to confirm the repair strategy preoperatively and to determine if additional procedures such as rotator interval closure or inferior capsular plications are needed. Anterior instability or humeral dislocation with glenoid engagement occurring at midranges of shoulder motion with the arm at the side in external rotation are clinical signs of substantial glenohumeral bone loss.

Step 2: Arthroscopic Evaluation and Portal Placement

Underestimating the anteroinferior bone loss is one of the most common failures of arthroscopic capsulolabral revision repairs.

- With the patient seated in the beach-chair position and under general anesthesia, place the arm into a mechanohydraulic arm-holder (SPIDER Limb Positioner, Smith & Nephew, Memphis, Tennessee). This allows traction and external rotation to be applied to the shoulder, providing easy arthroscopic access to all joint compartments.
- Introduce the arthroscope through a standard posterior portal for diagnostic arthroscopy. To inspect the detached and retracted capsulolabral tissue and to evaluate the osseous anterior glenoid rim, create an anterosuperior viewing and working portal with an "outside-in" technique using a spinal needle, just anterior to the long head of the biceps tendon, high in the area of the rotator interval. Insert 8.25-mm cannulae. Via the anterosuperior portal, it is possible to identify the capsulolabral tissue

that often is retracted behind the glenoid and scarred to the glenoid neck (Figs. 3 and 4).

- Check also for midsubstance capsular tears and horizontal labral tears. Bone defects are classified as acute fracture fragments, malunited osseous fragments embedded in the soft tissue, or attritional bone loss of the anteroinferior aspect of the glenoid^{10,11}. Glenoid bone loss most often starts at the level of the glenoid notch, running straight down inferiorly along a line parallel to the long axis of the glenoid⁴. Glenoid bone loss greater than 20% to 25% can lead to the appearance of an inverted pear shape of the glenoid¹¹. With use of the bare-spot technique described by Lo et al.¹², the anteroinferior bone loss can be measured arthroscopically in a reproducible fashion. A 6 to 8-mm reduction in the length of the glenoid, measured from anterior to posterior, indicates approximately a 25% bone loss of the glenoid and may require a change of the operation strategy to a bone augmentation technique. Underestimating the anteroinferior bone loss is one of the most common failures of arthroscopic capsulolabral revision repairs^{4,5,9}.
- Hill-Sachs lesions are present in 80% to 100% of cases following a failed glenohumeral instability repair. Most are clinically irrelevant, involving <25% of the articular surface, so no remplissage repair or bone procedure has to be performed. In the majority of cases, humeral defects are relevant contributors to recurrent instability only in the presence of anteroinferior glenoid bone loss combined with a Hill-Sachs defect lying outside the glenoid track or if the defects have a more oblique orientation with a higher risk of engagement¹¹. Test the engagement of the humeral head at the anterior glenoid rim under arthroscopic viewing with the shoulder in abduction and external rotation.
- Inspect the joint for additional lesions such as a superior labrum anterior and posterior (SLAP) tear, rotator cuff tears (especially in the subscapularis tendon), humeral avulsions of glenohumeral ligaments, posterior instability, or multidirectional instability. Inspect the glenoid and humeral chondral surfaces for chondral defects or osteoarthritis as a source of pain and a reason for failure of the index procedure.
- In addition to the anterosuperior portal, an optional midglenoid working portal can be placed in an outside-in fashion just above the superior border of the subscapularis tendon.
- Create the anteroinferior 5:30 portal by making an incision just lateral to the axillary fold about

8 to 10 cm distal to the coracoid process^{13,14}. The Wissinger rod penetrates the subscapularis muscle in its lower portion (Figs. 5 and 6).

- You can palpate the humeral head with the Wissinger rod and perforate the capsule laterally to create enough space to shift the inferior glenohumeral ligament. The inventor of the technique (A.B.I.) described a safe distance of the portal from the axillary nerve in a cadaveric study with the nerve running laterally at the inferior border of the subscapularis and turning posterior medially to the described portal placement^{13,14}. Perforate the capsule inferiorly under arthroscopic viewing and insert a long 8.25-mm cannula. The trajectory of the portal meets the anteroinferior glenoid at the 5:30 position.

Step 3: Mobilization of Capsulolabral Complex

Mobilize the capsulolabral complex down to the 6:00 position with a bent rasp to create a bleeding surface for biological healing.

- Mobilize the labroligamentous complex via the midglenoid portal. In revision cases, it is often not possible to distinguish residual labrum from the capsular tissue. Mobilize both in continuity using a sharp elevator to have enough tissue for the reconstruction of a neolabrum.
- Separate the adherent labroligamentous complex from the scapular neck with a sharp elevator. Mobilize the capsulolabral complex down to the 6:00 position (in the right shoulder) with a bent rasp to create a bleeding surface for biological healing (Fig. 7). This is a very important step of the procedure, as adequate mobilization of the labroligamentous complex is necessary to achieve a sufficient capsular shift with a new anterior bumper (neolabrum) and to reduce strain on the fixation points.
- Trim the labrum with a shaver. Frayed portions can be excised with an arthroscopic biter (Fig. 8).
- If an osseous fragment is embedded in the labroligamentous tissue, carefully separate the fragment from the glenoid neck and mobilize the capsulolabral complex around it in the same technique, to allow repositioning of the fragment and integration into the repair¹⁰.

Step 4: Anchor Placement

Place anchors at 5:30, 4:30, and 3:00, with additional anchors in the inferior half of the glenoid if more capsular material has to be shifted.

- Following mobilization of the capsulolabral complex, prepare the glenoid rim by removing the scar tissue. Expose the osseous surface at the glenoid rim with a shaver and remove cartilage on the edge of the glenoid to enhance tissue-healing. Remove residual suture material with a rongeur, and remove residual proud anchors from the site of the index repair.
- Mark the insertion points of the anchors at the 5:30, 4:30, and 3:00 positions (in a right shoulder) with a curet or a burr. You can place additional anchors in the inferior half of the glenoid if more capsular material has to be shifted. Place an additional anchor at the 5:00 position for an extensive shift of the inferior glenohumeral ligament. Place additional anchors above the 3:00 position if the lesion extends superiorly. We recommend placing three or four anchors in the lower half of the glenoid to reduce the stress per fixation point and to allow a sufficient shift of the inferior glenohumeral ligament, which is the main restraint against anterior translation of the humeral head in shoulder abduction and external rotation^{1,13}. In our extended experience with more than eighty arthroscopic capsulolabral revision repairs, we used an average of 3.9 anchors per repair.
- Anchors in the lower half of the glenoid can be placed perfectly via the anteroinferior portal. The trajectory of the portal directly meets the desired anchor insertion point. An additional advantage of the anteroinferior portal is that the anchor can be inserted easily into the bone perpendicular to the glenoid bone surface, which allows secure bone fixation. Compared with this technique, anchor placement at the 5:00 position via the midglenoid portal results in less bone fixation of the anchor tangential to the glenoid bone surface.
- Insert a cannulated anchor guide through the anteroinferior portal and place it at the 5:30 position. Make a drill hole for a press-fit anchor or perform threading for a screw-type anchor. Place anchors onto the glenoid rim at the articular cartilage margin, avoiding a nonanatomic position too far medially at the glenoid neck (Figs. 9 and 10).
- Avoid tangential misplacement toward the glenoid surface to minimize cartilage damage. Use bioabsorbable anchors loaded with number-2 nonabsorbable sutures.

Step 5: Capsulolabral Shift and Knot Tying

A sufficient capsular shift of the anterior band of the inferior glenohumeral ligament at the lowest fixation point (5:30 anchor) is a key step of the procedure.

- Perform the capsular shift with a curved suture shuttle device (Spectrum II, ConMed Linvatec, Largo, Florida, or Suture Lasso, Arthrex, Naples, Florida) by perforating the capsule at the most inferior point and shifting it directly toward the anchor insertion. Performing the shift via the anteroinferior portal allows you to integrate a sufficient amount of the anterior band of the inferior glenohumeral ligament¹³ (Figs. 11 and 12).
- Note that the axillary nerve is closest to the capsular surface at the 6:00 position at a distance between 12 and 15 mm; avoid excessive penetration depth in this area^{4,13}. In our experience, treatment of recurrent anteroinferior instability has not necessitated posteroinferior anchor placement or an additional posterior capsular shift.
- Deliver the suture shuttle device through the tissue passing underneath the labrum slightly inferior to the anchor insertion. Pull one suture limb outside via the anterosuperior portal to avoid suture interference. Then attach the suture limb to the passing suture outside, shuttle it through the capsular tissue, and pull it out of the anteroinferior portal. This suture limb represents the post limb, which is the limb running furthest away from the glenoid. The loop limb passes between the glenoid rim and the capsulolabral tissue. To allow strong fixation of the self-locking sliding knot, which is introduced via the anteroinferior portal, pull the capsulolabral tissue upward toward the anchor insertion on the glenoid rim with use of a grasper introduced via the anterosuperior working portal. With this technique, knot security can be improved. Secure the sliding knot with at least three additional half hitches on alternating posts.
- Pass a knot-cutter over both limbs and cut the knot just above the last half hitch. You have the option of using a double-loaded suture anchor at the lowest anchor position to enhance fixation strength of the shifted anterior band of the inferior glenohumeral ligament. With this technique, use one mattress suture and one conventional fixation suture for the most inferior capsular plication. Perform additional anchor placement and capsular shifts from inferior to superior using the same technique^{1,14}. For labral lesions extending superi-

only, then place anchors at the 3:00 position and above via the midglenoid portal. Perform suture passage and capsular tensioning in the same fashion, trying to create a bumper (Fig. 13) and to achieve adequate retensioning of the capsuloligamentous structures.

Step 6: Additional Tissue Reconstruction

Consider performing a rotator interval closure in patients with joint hyperlaxity or if a residual “drive through” sign with inferior instability remains after retensioning of the capsulolabral structures.

- Repair a midsubstance capsular tear with side-to-side stitches using number-2 nonabsorbable suture material prior to the Bankart repair.
- Repair a SLAP lesion with one suture anchor placed at the 11:30 position (in a right shoulder), just behind the long biceps tendon, and if necessary with an additional anterior anchor at the 12:30 position. Place these anchors through the lateral acromial portal, penetrating the musculotendinous junction of the supraspinatus and infraspinatus, following the Bankart repair.
- In patients with joint hyperlaxity (a positive hyperabduction test and a positive sulcus sign in external rotation), or if a residual “drive through” sign with inferior instability remains after retensioning of the capsulolabral structures, consider performing a rotator interval closure. The rotator interval is closed with vertical PDS (polydioxanone) sutures with the knot lying extra-articularly. This imbrication of the superior glenohumeral ligament to the middle glenohumeral ligament just above the subscapularis tendon improves anterior stability of the glenohumeral joint.
- Perform the closure with the arm held at the side and in maximal external rotation. Pay careful attention to proper capsular tightening to avoid overtensioning resulting in loss of external rotation.

Step 7: Rehabilitation

Start with passive exercises and increase to active-assisted and active exercises.

- Start passive motion exercises and pendulum exercises on the first postoperative day.
- After unidirectional instability repair, place the shoulder in an abduction sling for six weeks, keeping the shoulder in a neutral position. Limit shoulder external rotation to 0° for four

weeks and to 20° for an additional two weeks. After six weeks allow free shoulder motion.

- As part of a phased rehabilitation program, start with passive exercises and increase to active-assisted and active exercises. Allow a gradual return to sports activity after four to six months.

Results

In our study of fifty-six patients treated with arthroscopic capsulolabral revision repair for recurrent anterior shoulder instability¹, arthroscopic evaluation at the revision repair showed glenoid bone loss measuring up to 10% of the inferior glenoid width due to compression fracture of the glenoid rim in almost 50% of the cases and glenoid bone loss measuring 10% to 20% in about 20% of the cases. A minimum of three anchors were placed in the lower half of the glenoid for the revision repairs. Recurrent glenohumeral instability after the revision procedure was found in six cases (11%), with four cases of recurrent instability due to trauma and two cases of atraumatic repeat instability. We found an anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesion in 61% of the revision procedures and a Bankart lesion in 39%. Normal labral tissue was found in only 30% of the cases; a markedly thinned or absent labrum was seen in 70% of the cases.

Three of the six patients with recurrent instability had signs of joint hyperlaxity, with three having a thinned capsule and three having a patulous capsule. Age was an important predictive factor for recurrent glenohumeral instability after the revision procedure: patients with recurrent instability had an average age of 22.6 years (range, eighteen to twenty-five years), whereas those with a stable shoulder had an average age of 30.8 years (range, eighteen to fifty-one years) ($p < 0.05$). The Rowe and Constant scores and the results of the Simple Shoulder Test were all significantly improved by the procedure. Arthroscopic revision repair did not result in additional loss of shoulder external rotation when compared with the status after the index repair. The mean prerevision external rotation deficit with the arm at the side in 0° abduction in the patients who had had a primary arthroscopic procedure was significantly less than that in the patients treated with primary open repair (6° versus 11°; $p < 0.05$). Subscapularis muscle insufficiency was detected at the time of the revision repair in 18% of the patients who had had an open index repair performed through a partial or complete subscapularis tenotomy approach. We did not detect partial or complete subscapularis muscle insufficiency in any of the patients with an arthroscopic index repair or after any arthroscopic revision procedure done with our 5:30 ap-

proach with perforation of the lower part of the subscapularis muscle.

We performed an additional rotator interval closure in about one-fourth of the cases, as these cases showed clinical signs of hyperlaxity following the capsulolabral repair.

Sports activity level was significantly improved by the revision procedure. Use of the shoulder sports activity assessment tool showed that 76% of the athletes returned to their previous level with no or minimal limitation. Twenty-four percent of the athletes returned to a lower level of competition or changed to a less demanding sports activity after the revision surgery.

What to Watch For

Indications

- Recurrent anteroinferior glenohumeral instability following an arthroscopic or open index instability repair

Contraindications

- Glenoid bone loss of $\geq 25\%$
- Humeral bone loss of $\geq 30\%$ with an engaging Hill-Sachs lesion

Pitfalls & Challenges

- Diagnosis should include:
  - sufficient preoperative imaging (radiographs, magnetic resonance imaging, and computed tomography/three-dimensional computed tomography)
  - diagnosis and addressing all instability sources (e.g., bone loss and hyperlaxity)
  - checking for humeral avulsions of the glenohumeral ligaments, SLAP lesions, and subscapularis tears/insufficiency.
- Surgical technique should include:
  - assessment of labral and capsular tissue quality
  - accurate placement of the inferior 5:30 portal
  - sufficient capsulolabral mobilization down to the 6:00 position
  - accurate debridement, tissue liberation, and preparation of a bleeding bone bed to enhance biological healing
  - adequate capsular shift and capsular re-tensioning, especially of the inferior glenohumeral ligament
  - anatomic placement of three anchors in the lower half of the glenoid onto the glenoid rim

- rotator interval closure only in cases of substantial hyperlaxity

Clinical Comments

- What are the indications for arthroscopic capsulolabral revision repair?
- What are the complications of arthroscopic revision instability repair?
- What are the advantages of arthroscopic revision instability repair?

An accurate analysis of the index repair and all contributing factors leading to recurrent anterior instability is the key to a successful arthroscopic revision repair^{4-6,9}. Careful clinical examination including evaluation of the patients' history and functional demands, accurate preoperative imaging, and arthroscopic inspection of all soft-tissue and osseous factors, as well as present contraindications, allow the correct selection of an arthroscopic revision repair^{6,15}.

Traumatic recurrent glenohumeral dislocations with isolated soft-tissue lesions or following an index repair with obvious technical errors, such as poor capsular retensioning or use of only two anchors, can be safely treated with an arthroscopic revision repair^{1,7,8}. Recurrent instability cases with glenoid bone loss or joint hyperlaxity are more challenging to treat, and a combination of both factors (including a bone loss of $>25\%$) leads to a recurrence rate of 75% after an arthroscopic repair, as shown by Balg and Boileau¹⁵. The most common cause of failure after an open or arthroscopic instability repair is the inadequate treatment of substantial glenoid bone loss at the index repair^{4,11}. If the glenoid bone loss measures up to 20% of the inferior glenoid width, arthroscopic revision repairs have good outcomes, even in overhead athletes^{2,6}. There is no consensus about a threshold at which a glenoid bone deficiency should be treated with bone-grafting, but most experts agree that a deficiency of $<20\%$ can be managed with an arthroscopic soft-tissue repair^{1,4,7,8}. Sufficient retensioning of the inferior glenohumeral ligament and use of at least three anchors in the lower half of the glenoid are key technical steps for a successful arthroscopic revision repair^{1,6,7,15}. Any osseous fragments that are present should always be integrated in the repair, as the glenoid bone stock is very important for restoring glenohumeral stability^{10,16}. Open revision surgery with bone augmentation should be performed to lengthen the glenoid arc in patients with substantial glenoid bone loss measuring $>25\%$ or an engaging Hill-Sachs lesion¹¹.

Stiffness is a rare problem postoperatively, especially following an arthroscopic stabilization. Stiffness and substantial loss of external rotation can be the result of anterior capsular overtightening or

excessive plications used to close the rotator interval. Stiffness following subscapularis tightening procedures, especially with loss of external rotation, occur mainly after open instability repair procedures^{3,17}. Overtightening of the anterior structures is recognized as a risk factor for early arthrosis. It is also important to inform the patient about chondral damage detected at the revision repair, as this can be a source of pain or discomfort at the time of longer-term follow-up despite good shoulder stability.

Subscapularis rupture and subscapularis muscle insufficiency are extremely disabling and are mainly observed after open instability repairs done with a subscapularis tenotomy or subscapularis split

approach. An arthroscopic revision procedure should therefore always be preferred over an open revision repair, especially in a patient who had an open index repair or currently has subscapularis insufficiency^{1,17}.

Overall, the results of arthroscopic revision instability repairs are inferior to those of primary stabilization procedures, but several studies have shown a significant improvement in the clinical results of arthroscopic revision repairs over the last ten years, when all risk factors were taken into account when determining whether an arthroscopic repair was indicated and when all surgical key steps were performed accurately^{1,4,7-9}.

Christoph Bartl, MD

Department of Orthopaedic Trauma Surgery, University of Ulm, Steinhoevelstrasse 9, 89075 Ulm, Germany. E-mail address: christoph.bartl@uniklinik-ulm.de

Andreas B. Imhoff, MD

Department of Orthopaedic Sports Medicine, Technical University Munich, Ismaningerstrasse 22, 81675 Munich, Germany. E-mail address: a.imhoff@sportortho.de

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TABLE I Factors Adversely Affecting Success of Arthroscopic Capsulolabral Revision Repair

Surgeon factors	Instability misdiagnosis (failure to identify multidirectional or posterior instability)
	Failure to correct capsular laxity
	Failure to identify additional SLAP lesions, humeral avulsions of the glenohumeral ligaments, subscapularis tears/insufficiency
	Failure to address substantial glenoid or humeral bone loss correctly
Technical issues	Nonanatomic labroligamentous repair (inadequate labrum mobilization, inadequate preparation of anterior glenoid rim for repair, poor retensioning of capsulolabral structures, use of less than three anchors/fixation points for the capsular shift below midglenoid notch)
Patient factors	Young age
	Contact or collision sports

Figures

Fig. 1

Computed tomography sagittal view showing minimal anteroinferior glenoid bone loss with a small fragment (circled) before the revision repair. Note the placement of the lowest anchor (arrow) at the 4:00 position at the index repair.

Fig. 2

Axial magnetic resonance image showing an anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesion (arrow) with medial retraction of the labroligamentous complex.

Fig. 3

Inspection of the retracted labrum (arrowheads) with a probe through the posterior portal.

Fig. 4

The retraction of the labroligamentous complex (arrowheads) with scarring to the glenoid neck is best seen through the antero-superior portal.

Fig. 5

The anteroinferior 5:30 portal is placed through the lower part of the subscapularis muscle. The axillary nerve runs dorsally medial to the anteroinferior portal.

Fig. 6

The incision is just lateral to the axillary fold, about 8 to 10 cm distal to the coracoid process.

Fig. 7

Mobilization of the capsulolabral complex with a rasp, to create a healing bone bed.

Fig. 8

Preparation of the anchor insertion site on the glenoid rim (arrow).

Fig. 9 Fig. 10

Figs. 9 and 10 Placement of the lowest anchor at the 5:30 position via the anteroinferior portal.

Fig. 11 Fig. 12

Figs. 11 and 12 The amount of the shifted capsular material can be checked during the shift procedure with the curved shuttle instrument.

Fig. 13

Note the creation of the anterior neolabrum (bumper) after knot tying.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

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Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13