Instability

M. Feucht, S. Braun, N. Rosenstiel

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4.1 Anterior Shoulder Stabilization

M. Feucht, S. Braun

4.1.1 Indication

Symptomatic post-traumatic anterior shoulder instability in young patients as well as in patients with high functional demands.

Anterior instability as a main component of symptomatic multidirectional instability after failure of conservative treatment.

4.1.2 Operation Principle

Arthroscopic anterior stabilization of the shoulder by anatomically reattaching the torn capsulolabral complex to the glenoid rim using suture anchors and at the same time plicating the anterior inferior glenohumeral ligament (aIGHL)

4.1.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom specific history: time, mechanism and direction of the first dislocation, reduction method (spontaneous, patient himself, external), number of recurrent dislocations, treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders)
- Symptom specific examination: range of motion (increased passive range of motion), scapular dyskinesia, anterior and posterior drawer tests, load-and-shift test, anterior and posterior apprehension tests, relocation test, Jerk test, sulcus sign in internal and external rotation, Gagey hyperabduction test.

Neurovascular Condition

Evaluation of the peripheral nerves (axillary and suprascapular nerve)

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) to detect bony lesions (bony bankart lesion, glenoid fractures, Hill-Sachs lesions)
- MRI (optionally with intraarticular contrast medium) to evaluate the capsulo-labral lesion, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff tear)
- CT for suspected relevant glenoid bone defect or Hill-Sachs lesion

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement (mainly external rotation), "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the subclavian artery, implant failure, dislocation or protrusion of anchors with the risk of cartilage damage, osteolysis, switching to an open procedure.

4.1.4 Operative Technique

Positioning and Preparation

- Beach chair position (lateral decubitus position is preferred with multidirectional instability)
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion)
- Positioning of the patient arm in an arm holder

Arthroscopic Anterior Stabilization of the Shoulder Using Suture Anchors

Diagnostic arthroscopy is performed via the posterior standard portal. An anterosuperior working portal is established and the stability of the labrum and the biceps tendon anchor is evaluated using an arthroscopic probe.

The labrum is mobilized using a Bankart knife until it can be easily repositioned. The glenoid rim is freshened with the Bankart rasp until a bleeding bone surface is created. The planned insertion sites of the suture anchors at the 5:30 -, 4:30 -, and 3:00 o 'clock positions (right shoulder joint) are marked using an arthroscopic burr or Rongeur (Fig. 4.1).

The deep anteroinferior portal is created through the lower third of the subscapularis, about 8–10 cm distal to the coracoid and 1 cm lateral to the axillary fold (Fig. 4.2).

For the first suture anchor at the 5:30 o'clock position, a guide instrument (e. g. Spear, Arthrex) is introduced via the anteroinferior portal and placed at the bone-cartilage junction of the glenoid margin in the previously created hole, followed optionally by tapping this hole and then insertion of the suture anchor (e. g. Bio-Fastak 3 mm, Arthrex) (Figs. 4.3 and 4.4a). The sutures are then pulled to confirm the anchor stability.

The capsulolabral complex is pierced with a curved hollow suture passer (through the anteroinferior portal) from inferior towards the anchor, so that the whole capsulolabral complex including the aIGHL is incorporated. A suture lasso (shuttle loop) is then passed through the hollow suture passer (Fig. 4.4b), the suture passer is then removed and the suture lasso together with a suture limb are retrieved out the anterosuperior portal.

The suture limb is passed through the loop of the suture lasso which is then retrieved out through the capsulolabral complex so that finally both suture limbs of the anchor come out the anteroinferior portal (alternatively, this step can be

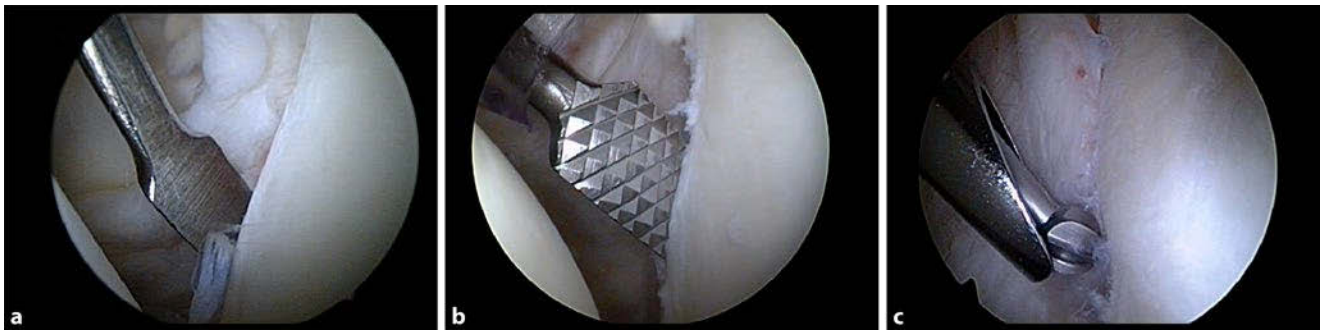


Fig. 4.1a–c **a** Mobilization the labrum with the Bankart knife **b** freshening of the glenoid rim with the Bankart rasp **c** The planned anchor sites at the 5:30 -, 4:30 -, and 3:00 o 'clock position are marked with an arthroscopic burr

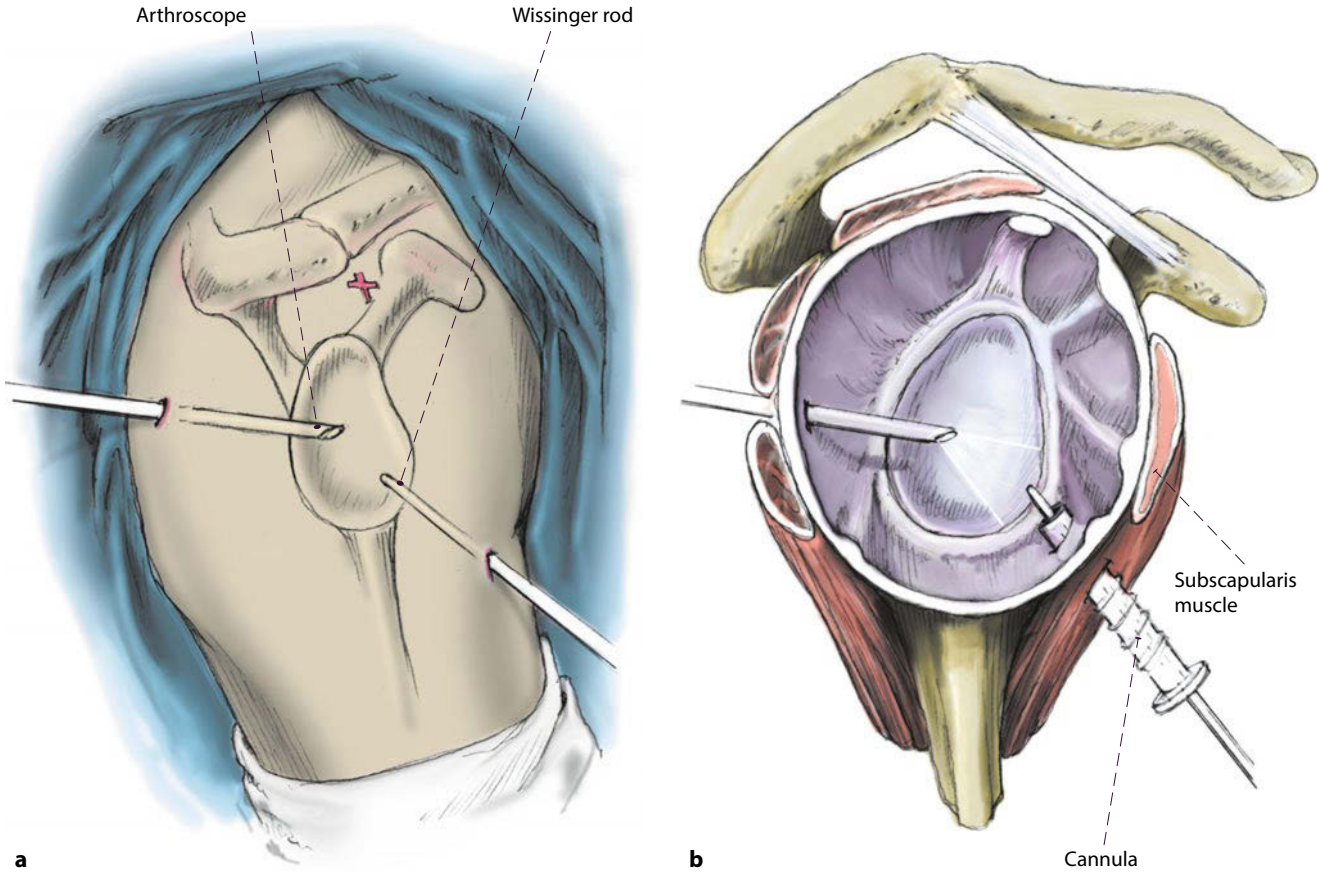


Fig. 4.2a,b Establishing the deep anteroinferior portal. **a** A switching stick is introduced at an angle of about 135 degrees towards the 5:30 position of the glenoid, as far as possible to the humeral side. **b** An arthroscopic cannula (9 cm long and 8.25 mm diameter, e. g. Arthrex) is inserted over the switching stick through the lower third of the subscapularis muscle

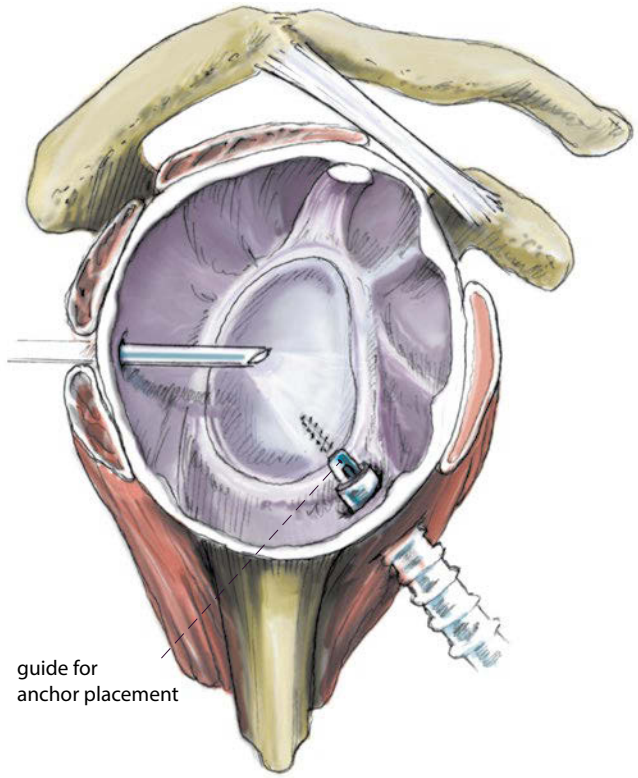


Fig. 4.3 Insertion of the first anchor at the 5:30 o 'clock position via the deep anteroinferior portal

performed intra-articular). The suture limb passing through the capsulolabral complex serves as a "post" over which the knot is tied. (Fig. 4.4c).

The Labrum is fixed with an arthroscopic sliding knot (e. g. modified "fisherman's knot" or "Weston knot" (▶ Chap. 1) followed by three reversing half hitches (Fig. 4.4d).

Two additional suture anchors are usually inserted at the 4:30 and 3:00 o 'clock position in the same technique (Figs. 4.4f and 4.5). Refixation of the capsulolabral complex as well as the mobility are confirmed by passively moving the shoulder under arthroscopic visualization.

4.1.5 Postoperative Management

- Positioning of the arm in an arm sling
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray evaluation.

4.1.6 Follow-Up Management

Immobilization of the shoulder in a sling for 24 h, then for 4 weeks at night and during prolonged activities. The range of motion in the 1st–3rd weeks is restricted to 45° abduction and flexion, 80° internal rotation and 0° external rotation, in the 4th–6th week the range is increased to 90° abduction and flexion, 80° internal rotation and 0° external rotation. From the 7th week free range of motion. Sport specific training is started after 3 months, overhead sports are not allowed earlier than 6th months postoperatively.

4.1.7 Tips & Tricks

Reconstruction of the capsulolabral complex is not sufficient alone in case of glenoid bone defects larger than 20–25 % of the glenoid surface area as well as with engaging Hill-Sachs lesions. The operative procedure should include the treatment of these lesions (e. g. by J-plasty of the glenoid or Remplissage procedure for Hill-Sachs defects) or an alternative procedure should be selected (e. g. Laterjet coracoid transfer).

Normal anatomical variants such as the sublabral foramen or Buford complex should be differentiated from labral lesions, as capsulolabral reconstruction in such cases would result in significant reduction of external rotation.

We recommend the routine use of the deep anteroinferior portal, which allows the most inferior placement of the first anchor exactly in the direction of the glenoid and thus results in a more biomechanically favorable shift of the capsulolabral complex. The insertion of the inferior anchor is particularly difficult when a more superiorly located portal is used (Fig. 4.6).

The anchor should be inserted into the bone at an angle of about 135° to the glenoid surface level. If the anchor is inserted too steep or too shallow, cartilage damage or anchor dislocation may occur (Fig. 4.7). The anchor should also be inserted deep enough below the cartilage level to avoid cartilage injury.

It is important during labrum refixation not only to repair the capsulolabral complex to the edge of the glenoid but also to plicate and shift the anterior inferior glenohumeral ligament cranially and thus decreasing the volume of the inferior pouch.

Knots should be placed away from the glenoid surface to avoid damaging the cartilage of the humeral head or the glenoid (Fig. 4.8).

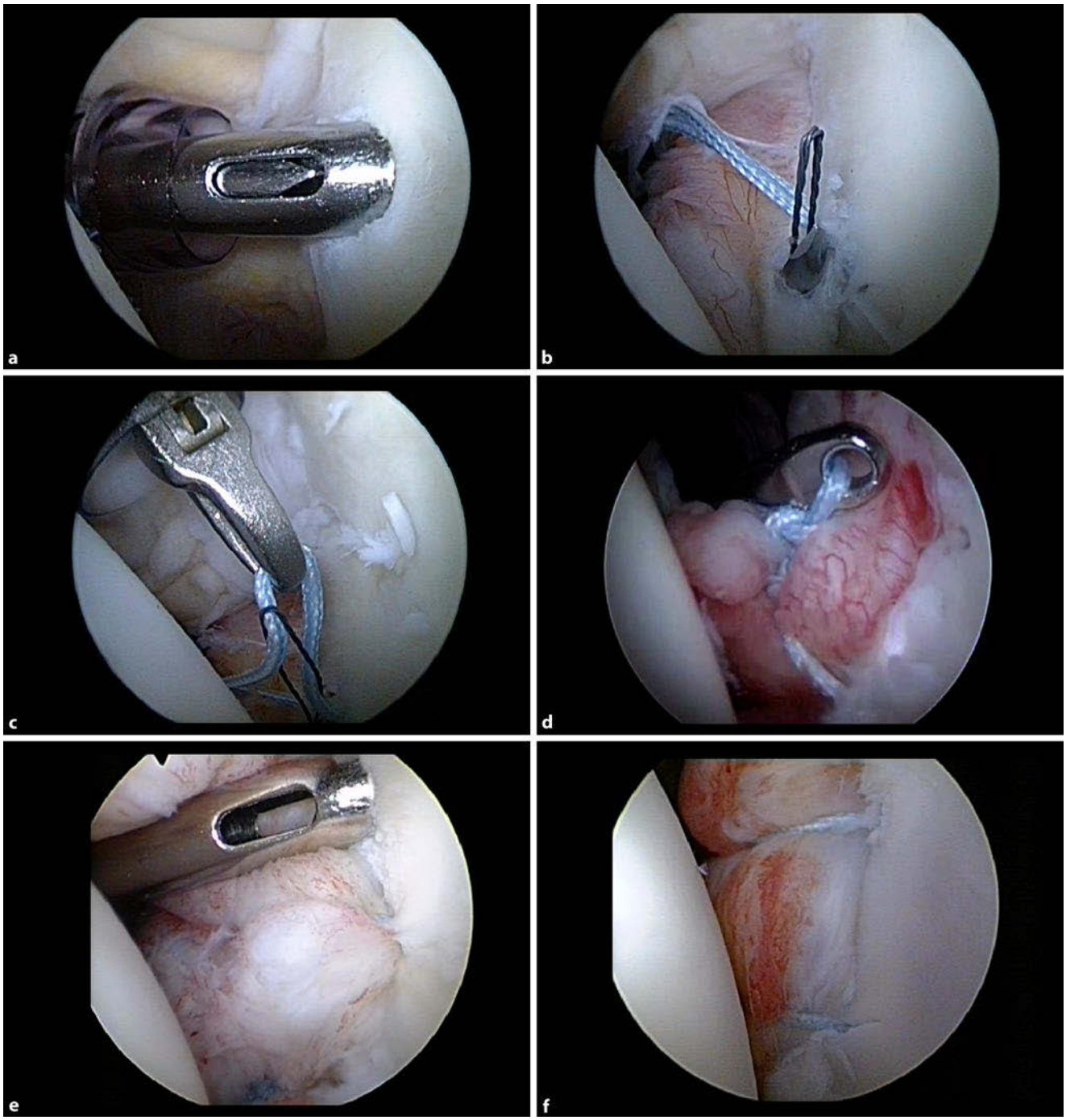


Fig. 4.4a–f **a** Insertion of the first anchor at the 5:30 o 'clock position **b** piercing the capsulolabral complex with a curved hollow suture passer **c** passing a suture limb through the suture lasso **d** tying the sutures using a knot pusher, **e** insertion of an additional anchor at the 4:30 o 'clock position, **f** final result with reattached capsulolabral complex

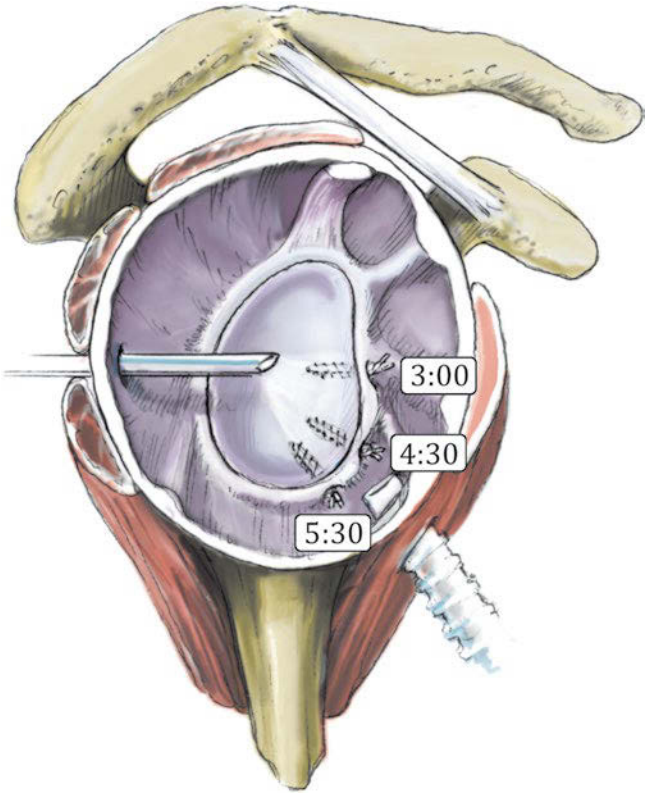


Fig. 4.5 Repaired anteroinferior labrum using suture anchors at the 5:30 - 4:30 - and 3:00 o 'clock positions

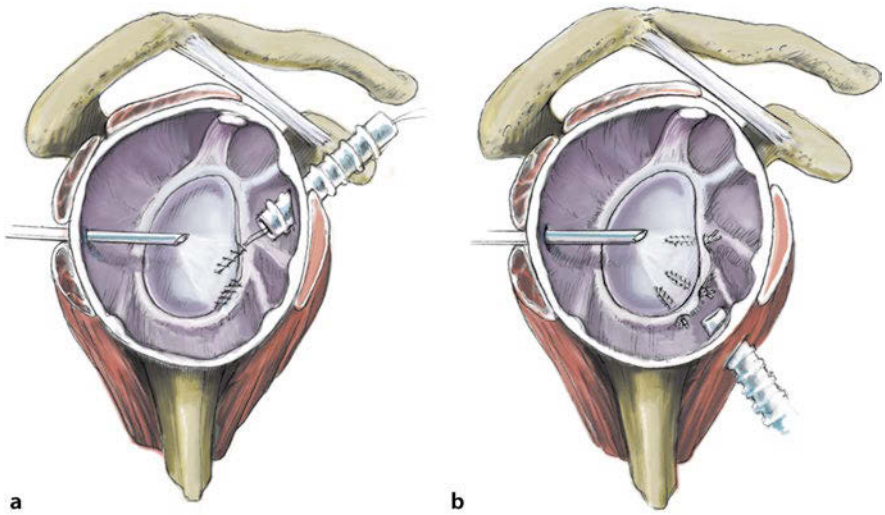


Fig. 4.6a,b Unlike to a more superiorly located anterior portal (**a**) the deep anteroinferior portal allows a more inferior insertion of the first anchor exactly in the direction of the glenoid and thus results in a more biomechanically favorable shift of the capsulolabral complex (**b**)

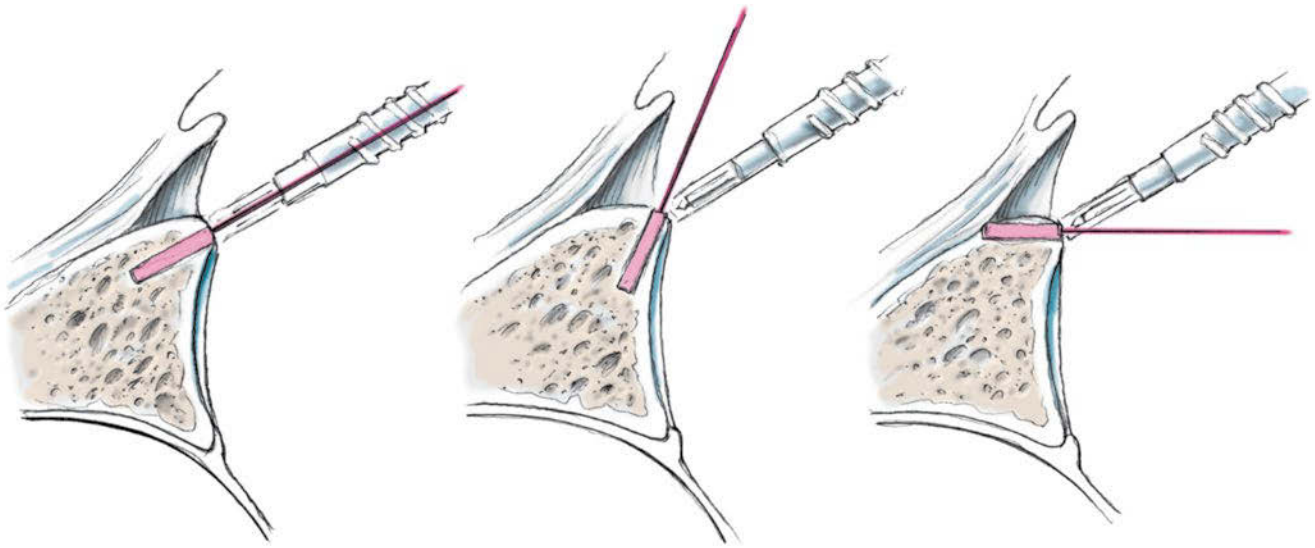


Fig. 4.7a–c The suture anchors are inserted at an angle of approximately 135° to the glenoid plane (**a**) too steep (**b**) or too flat positions (**c**) lead to inadequate anchor stability or damage of the glenoid cartilage

4.2 Posterior Shoulder Stabilization

M. Feucht, S. Braun

4.2.1 Indication

Symptomatic posterior shoulder instability in young patients as well as in patients with high functional demands.

Posterior instability as a main component of multidirectional instability after failure of conservative treatment.

4.2.2 Operation Principle

Arthroscopic posterior stabilization of the shoulder by anatomically reattaching the torn capsulolabral complex to the glenoid rim using suture anchors and at the same time plicating the posterior inferior glenohumeral ligament (pIGHL)

4.2.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom specific history: time, mechanism and direction of the first dislocation, reduction method (spontaneous, patient himself, external, with/without anesthesia), number of recurrent dislocations, voluntary components, treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, chronic polyarthritis, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders)
- Symptom specific examination: range of motion (increased passive range of motion), scapular dyskinesia, anterior and posterior drawer tests, load-and-shift test, anterior and posterior apprehension tests, relocation test, Jerk test, sulcus sign in internal and external rotation, Gagey hyperabduction test.

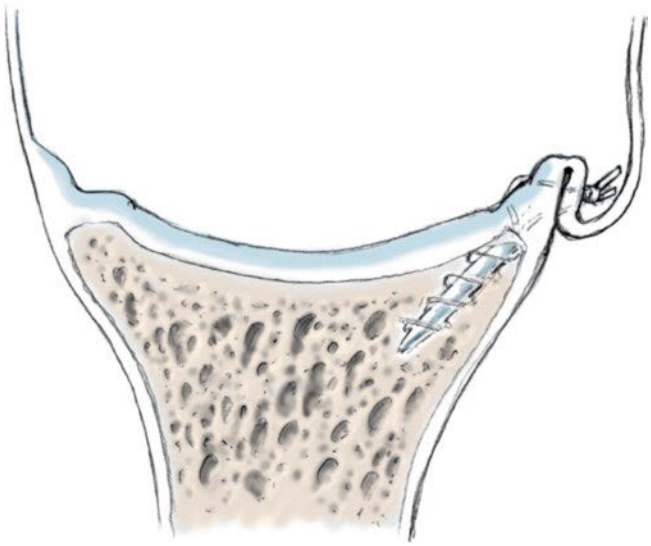


Fig. 4.8 Placement of the knot away from the glenoid surface (medial)

Neurovascular Condition

Evaluation of the peripheral nerves (axillary and suprascapular nerve)

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) to detect bony lesions (glenoid fractures, reverse Hill-Sachs lesion)
- MRI (optionally with intraarticular contrast agent) to evaluate the capsulolabral lesion, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff lesion)

Fig. 4.9 Establishing the deep posterolateral portal in cannula technique

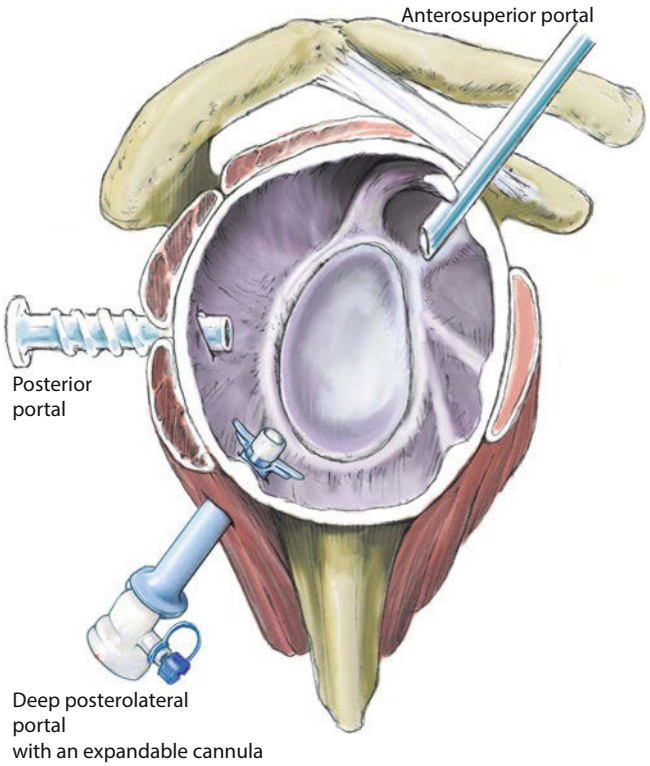


Fig. 4.10 Portals used for posterior stabilization

- CT with suspected relevant glenoid bone defect or reverse Hill-Sachs lesion as well as for evaluation of the glenoid version.

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement, "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the subclavian artery, implant failure, dislocation or protrusion of anchors with the risk of cartilage damage, osteolysis.

4.2.4 Operative Technique

Positioning and Preparation

- Lateral decubitus position (alternatively, beach chair position is also possible)
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion)
- Positioning of the patient arm in an arm holder to allow distal and lateral traction.

Arthroscopic Posterior Shoulder Stabilization Using Suture Anchors

Diagnostic arthroscopy via the posterior standard portal. An anterosuperior portal is established in outside-in technique and the arthroscope is switched to this portal. The labrum is extensively mobilized from the posterior glenoid margin with a Bankart knife through the posterior portal (Fig. 4.14a) until it can be easily repositioned. The glenoid rim is freshened with the Bankart rasp until a bleeding bone surface is created. The planned insertion sites for the suture anchors at the 7:00 -, 8:30 - and if necessary 10 o'clock positions (right shoulder joint) are marked using an arthroscopic burr or Rongeur. The deep posterolateral portal is created about 2 –4 cm lateral and 4–5 cm inferior to the posterolateral acromial edge (Figs. 4.9 and 4.10).

For the first suture anchor at the 7:00 o 'clock position, a guide instrument (e. g. Spear, Arthrex) is introduced via the deep posterolateral portal and placed exactly at the bone-cartilage junction in the previously created mark (Fig. 4.14b), followed by tapping the hole and then insertion of the suture anchor (e. g. Bio-Fastak 3 mm, Arthrex) (Figs. 4.3 and 4.4a). The sutures are then pulled to confirm the anchor stability.

The capsulolabral complex is pierced with a curved hollow suture passer (through the deep posterolateral portal) that is passed from the inferior aspect lateral to the labrum to exit intraarticular between the labrum and the glenoid (Fig. 4.11). A suture lasso (shuttle loop) is then passed through the hollow suture passer (Fig. 4.14c), the suture passer is then removed and the suture lasso together with a suture limb are retrieved out the posterior portal.

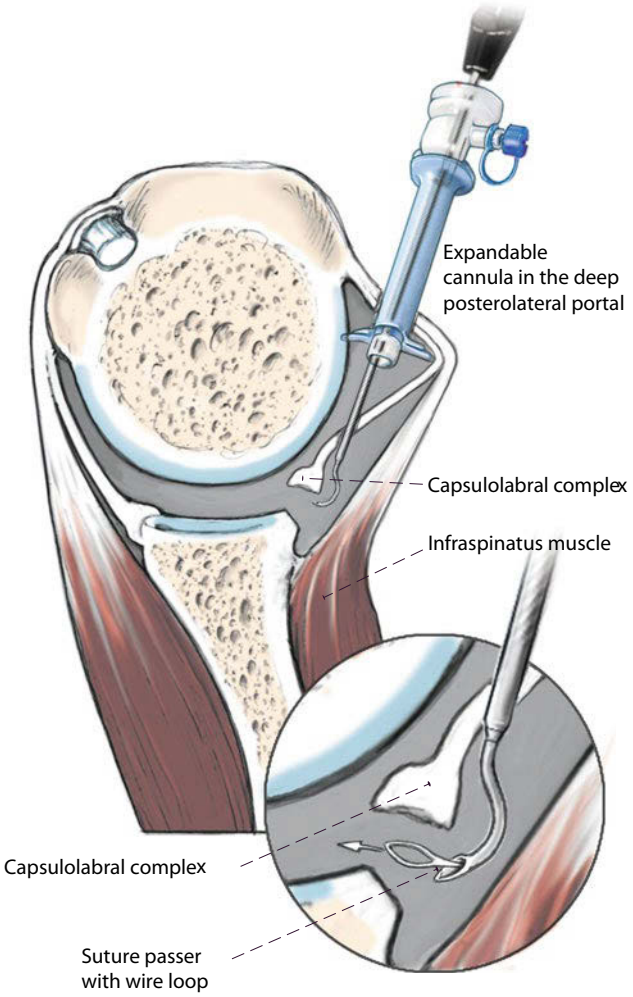


Fig. 4.11 Piercing the capsulolabral complex with a curved suture passer

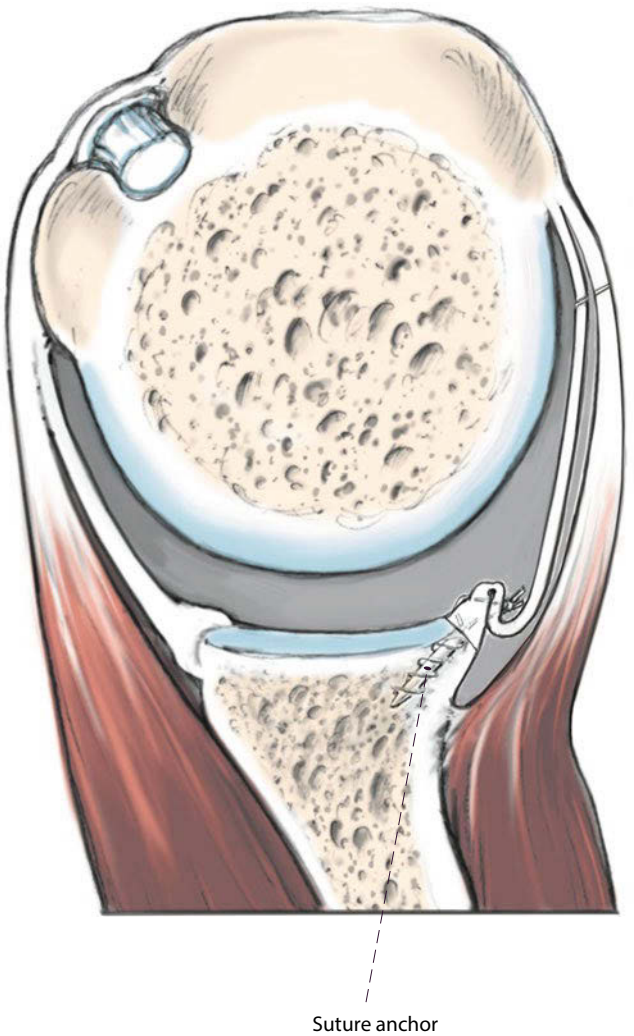


Fig. 4.12 Tying the anchor sutures and refixation of the capsulolabral complex

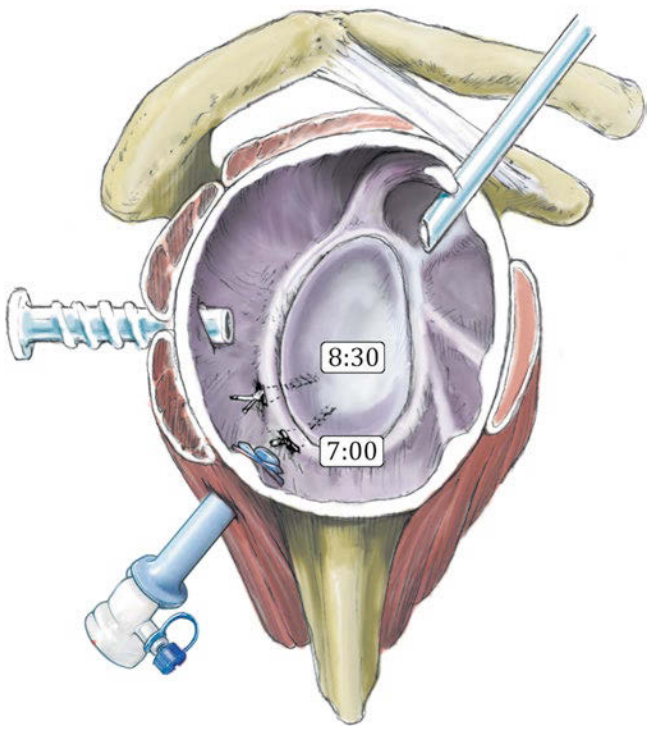


Fig. 4.13 Refixed posteroinferior labrum with suture anchors in the 7:00 and 8:30 o'clock positions

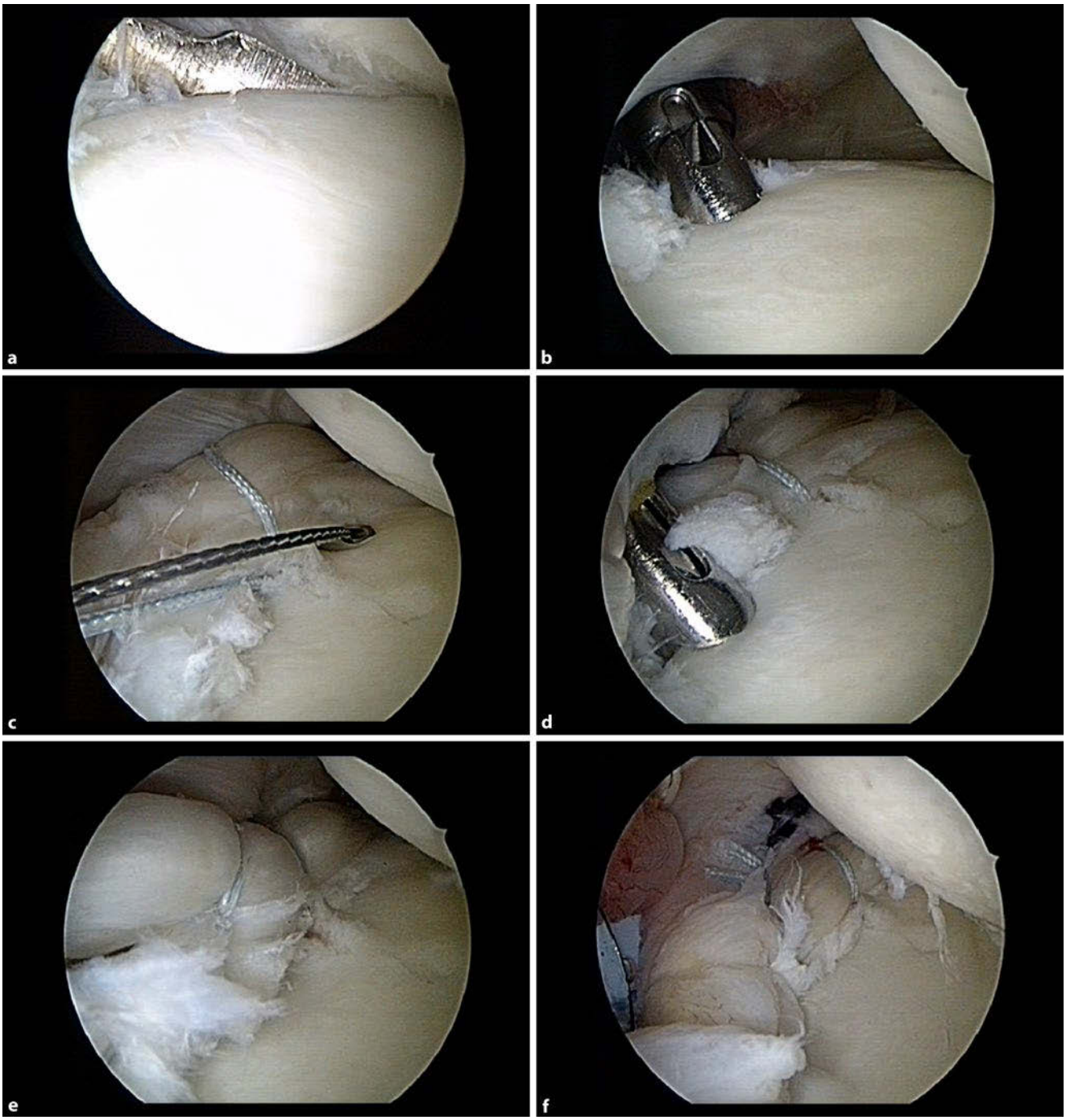


Fig. 4.14a–f Arthroscopic posterior shoulder stabilization. **a** Mobilization of the labrum with the Bankart knife; **b** Insertion of the first suture anchor; **c** Piercing the capsulolabral complex with a shuttling instrument to pass a suture lasso; **d** insertion of the second suture anchor; **e** refixed labrum after tying the sutures of the second anchor; **f** final results after insertion of the third suture anchor

The suture limb is passed through the loop of the suture lasso which is then retrieved out through the capsulolabral complex so that finally both suture limbs of the anchor come out the posterolateral portal. The suture limb passing through the capsulolabral complex serves as a "post" over which the knot is tied.

The labrum is fixed with an arthroscopic sliding knot (e.g. modified "fisherman's knot" or "Weston knot" (▶ Chap. 1) followed by three reversing half hitches (Fig. 4.12).

One or two additional suture anchors (as required) are inserted in the same technique in a caudal to cranial direction (Figs. 4.13 and 4.14d–f). Refixation of the capsulolabral complex as well as the joint mobility are confirmed by passively moving the shoulder under arthroscopic visualization.

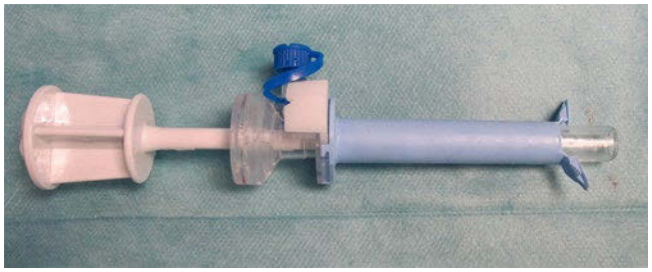


Fig. 4.15 Cannula with deployable wings (Gemini, Arthrex)

4.2.5 Postoperative Management

- The shoulder is immobilized in neutral rotation in a shoulder positioning pad (e. g. SLK 90°, Medi).
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray evaluation.

4.2.6 Follow-Up Management

Immobilization of the shoulder in neutral rotation in a shoulder positioning pad for 6 weeks. The range of motion in the 1st–3rd weeks is restricted to 45° abduction, 30° flexion, 30° internal rotation and 60° external rotation, in the 4th–6th week the range is increased to 90° abduction, 60° flexion, 45° internal rotation and 75° external rotation. Free external rotation is allowed in the 7th–8th weeks. From the 9th week free range of motion. Sport specific training is started after 3 months, overhead sports are not allowed earlier than 6th months postoperatively.

4.2.7 Tips & Tricks

Reconstruction of the capsulolabral complex alone is not sufficient in case of large defects of the posterior glenoid as well as the humeral head (reverse Hill-Sachs-Lesion). The operative procedure should include the treatment of these lesions (e. g. bony reconstruction with auto- or allograft, McLaughlin procedure) A corrective osteotomy should be considered in cases with more than 20° retroversion of the glenoid.

For the deep posterolateral portal, we recommend the use of an arthroscopic cannula with intraarticular deployable wings (Fig. 4.15). The wings prevent the cannula from falling out, and moreover, the working space can be increased by pulling on it.

The anchor should be inserted at an angle of about 135° to the glenoid level. If the anchor is inserted too steep or too shallow, cartilage damage or early anchor dislocation may occur. The anchor should be also inserted deep enough below the cartilage level to avoid cartilage injury.

It is important during labrum refixation not only to repair the capsulolabral complex to the edge of the glenoid but also to plicate and shift the posterior inferior glenohumeral ligament cranially and thus decreasing the volume of the inferior pouch.

Knots should be placed away from the glenoid surface to avoid damaging the cartilage of the humeral head or the glenoid.

4.3 Multidirectional Shoulder Instability

N. Rosenstiel, S. Braun

4.3.1 Indication

Symptomatic, post-traumatic or atraumatic multidirectional shoulder instability with ligamentous hyperlaxity in young patients as well as patients with high functional demands after failure of conservative treatment. Multidirectional hyperlaxity with involuntary dislocation or unidirectional instability with multidirectional hyperlaxity. At least 3–6 months of unsuccessful conservative treatment should be tried before deciding operative treatment.

4.3.2 Operation Principle

Arthroscopic anterior and posterior stabilization of the shoulder by reattaching the labrum using suture anchors and at the same time plicating the anterior inferior glenohumeral ligament (aIGHL) and the posterior inferior glenohumeral ligament (pIGHL).

With markedly increased capsular volume as well as enlarged rotator interval (positive sulcus sign in external rotation) it is mandatory to plicate the capsule arthroscopically or to tighten the rotator interval through rotator interval closure.

4.3.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom specific history: time, mechanism and direction of the first dislocation, reduction method (spontaneous, patient himself, external, with/without anesthesia), previous shoulder dislocations or injuries, number of recurrent dislocations, treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, chronic polyarthritis, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders)
- Symptom specific examination: range of motion (increased passive range of motion), muscular pattern,

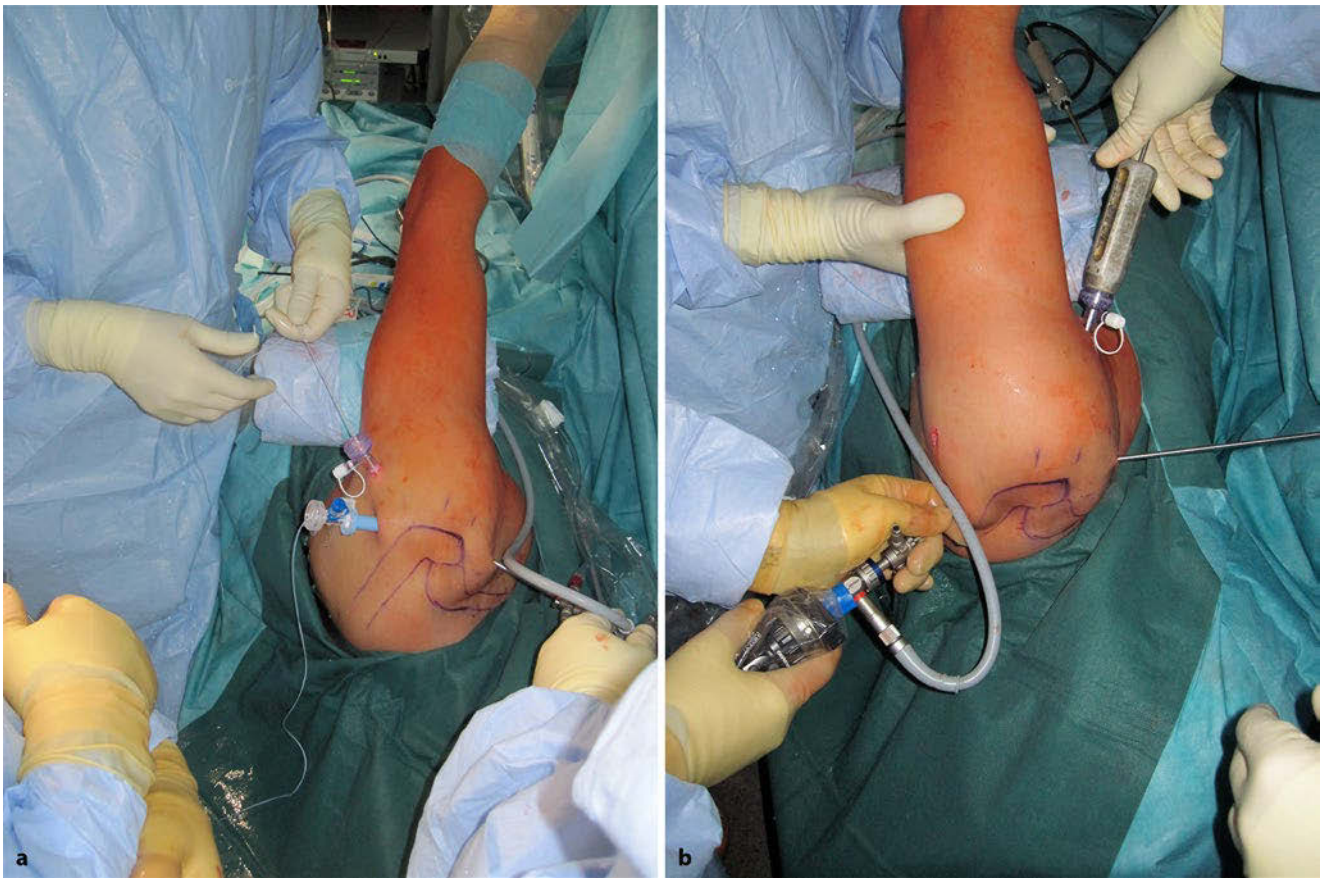


Fig. 4.16a,b Portals used for anterior and posterior shoulder stabilization. **a** Arthroscopic cannulas placed in the standard posterior portal and the deep posterolateral portal; **b** establishing the deep anteroinferior portal with the arthroscope in the standard posterior portal

scapular dyskinesia, increased anteroposterior translation, load-and-shift test, sulcus sign in internal and external rotation, Gagey hyperabduction test, anterior and posterior apprehension tests, relocation test, Jerk test, signs of generalized hyperlaxity.

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) to detect bony lesions (glenoid fractures, reverse Hill-Sachs lesion)
- MRI (optionally with intraarticular contrast agent) to evaluate the capsulolabral lesion, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff lesion)
- CT with suspected relevant glenoid bone defect, Hill-Sachs lesion or reverse Hill-Sachs lesion as well as for evaluation of the glenoid version.

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement (mainly internal and external rotation), "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the subclavian artery, implant failure, dislocation or protrusion of anchors with the risk of cartilage damage, osteolysis, switching to an open operative procedure if needed, postoperative immobilization for 6 weeks.

4.3.4 Operative Technique

Positioning and Preparation

- Lateral decubitus position with long connecting anesthesia tubes to allow positioning of the patients head in the theatre.
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion)
- Positioning of the patient arm in an arm holder that allows traction

Arthroscopic Anterior and Posterior Shoulder Stabilization Using Suture Anchors

In addition to the standard posterior portal and the anterosuperior working portal, the deep anteroinferior and the deep posterolateral portals are created for fixation of the anteroinferior and the posteroinferior capsulolabral complexes respectively (Fig. 4.16). Diagnostic arthroscopy (Fig. 4.17) is performed and the stability of the labrum and the biceps tendon anchor is evaluated using an arthroscopic probe.

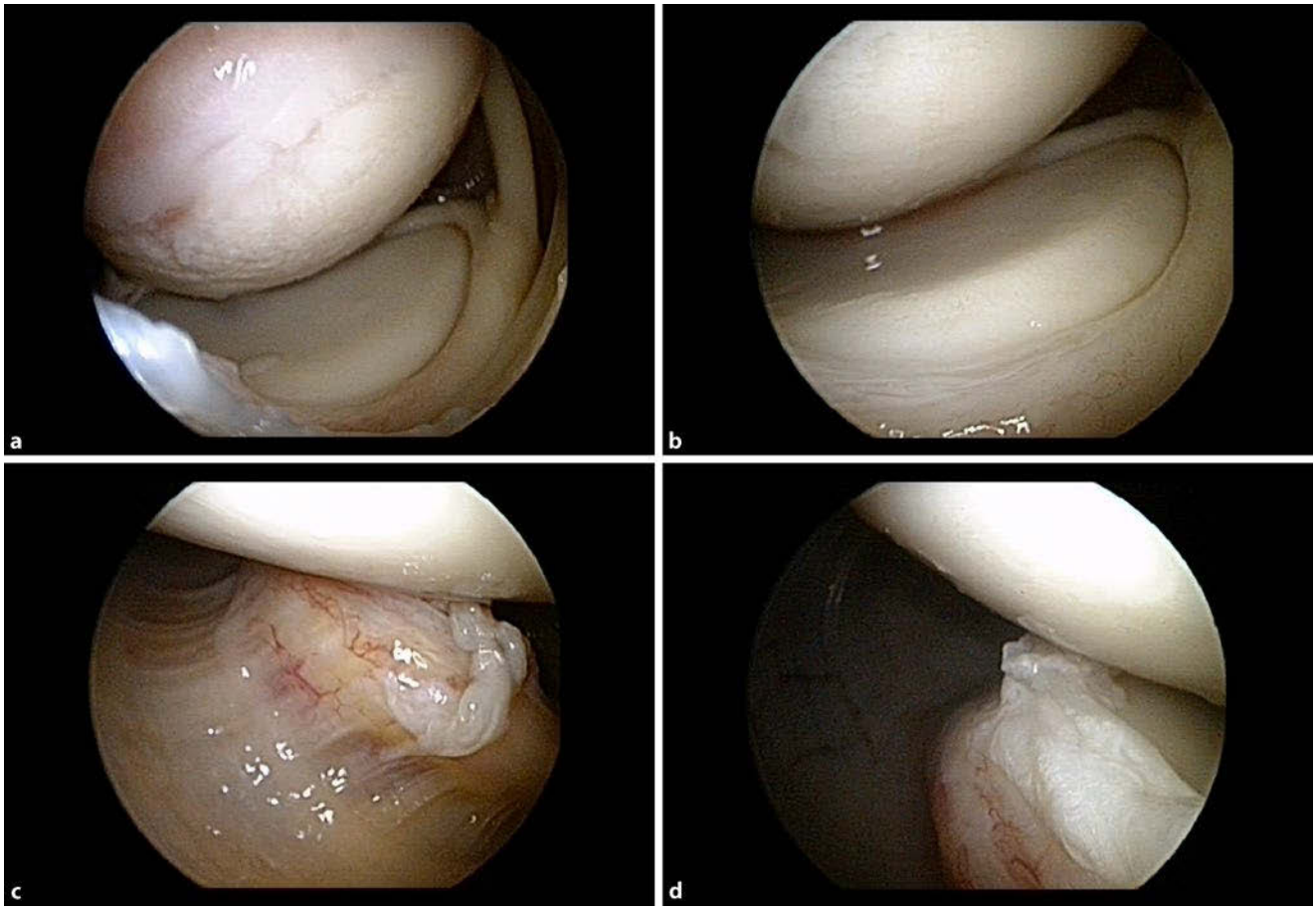


Fig. 4.17a–d Typical appearance in multidirectional instability. It show a lax capsuloligamentous structures (**a**) partly detached labrum (**b**) and rounded glenoid edge (**c** and **d**)

This is followed by posterior and subsequently anterior stabilization, starting in each procedure with the most inferiorly located anchor. The labrum is extensively mobilized with the Bankart knife until it could be easily repositioned. The glenoid rim is freshened with the Bankart rasp until a bleeding bone surface is created.

The planned sites for the suture anchors posteriorly at the 7:00 -, 8:30 - and possibly 9:00 o 'clock positions (right shoulder joint) and anteriorly at the 5:30 -, 4:30 -, and 3:00 o 'clock positions are marked using an arthroscopic burr or Rongeur.

The anchors are then inserted followed by fixation of the capsulolabral complexes in the same technique (Fig. 4.18) described in ▶ Sects. 4.1 and 4.2.

Refixation of the capsulolabral complex as well as the mobility are confirmed by passively moving the shoulder under arthroscopic visualization.

Capsular Plication

In addition to an insufficient labrum, multidirectional instability often shows an excessive laxity of the capsuloligamentous complex. Capsular plication (anterior, posterior or combined) is performed if the laxity is not improved after arthroscopic shoulder stabilization. In this procedure, the part of the capsule to be plicated is freshened with a soft tissue shaver. Subsequently, the capsule is pierced with an angled suture passer loaded with a PDS suture starting away from the glenoid to capture about 1–2 cm from the capsule and exits close to the glenoid. The PDS suture is then tied decreasing the capsular volume (Fig. 4.19). The capsule could be plicated in a W-shaped configuration. Plication should be repeated 2–3 times to sufficiently reduce the capsular volume.

Rotator Interval Closure

Rotator interval closure should be performed to supplement capsulolabral reconstruction if there is a positive sulcus sign in external rotation during the shoulder examination under anesthesia.

One or two PDS sutures are passed using a suture passer via the anterosuperior portal through the capsule at the superior margin of the subscapularis tendon and retrieved back using a sharp penetrating instrument passed anterior to the supraspinatus tendon and then tied extracapsular (Fig. 4.20).

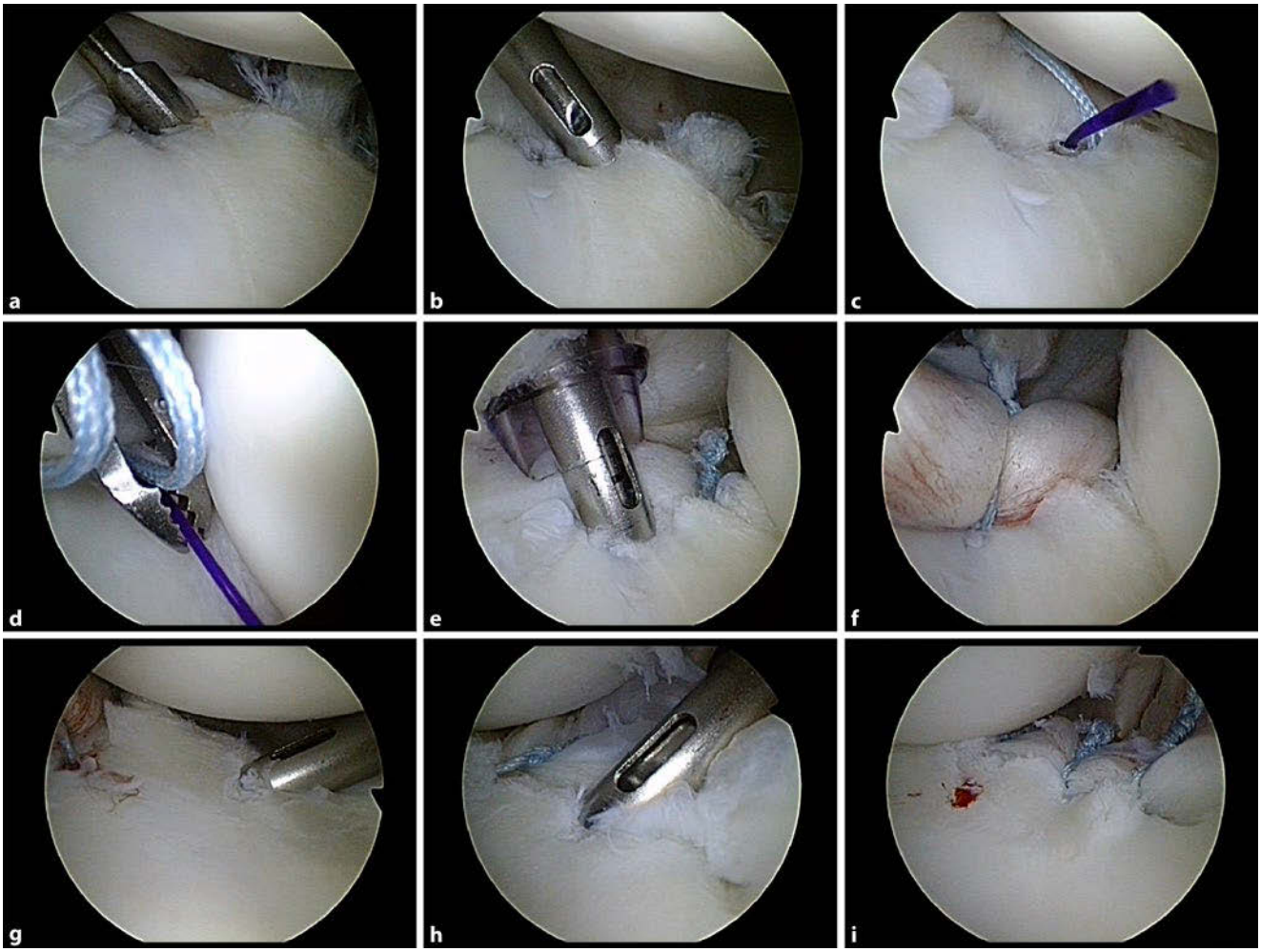


Fig. 4.18a–i Arthroscopic posterior and anterior shoulder stabilization. **a** mobilization of the capsulolabral complex; **b** insertion of the first anchor posteroinferior; **c** piercing the capsule-labrum complex with the shuttling instruments; **d** retrieval of sutures out; **e** insertion of the second posterior anchor; **f** posterior neolabrum after repair using 2 suture anchors; **g** insertion of the first anteroinferior anchor; **h** insertion of the second anterior anchor; **i** anterior neolabrum after repair using 3 suture anchors

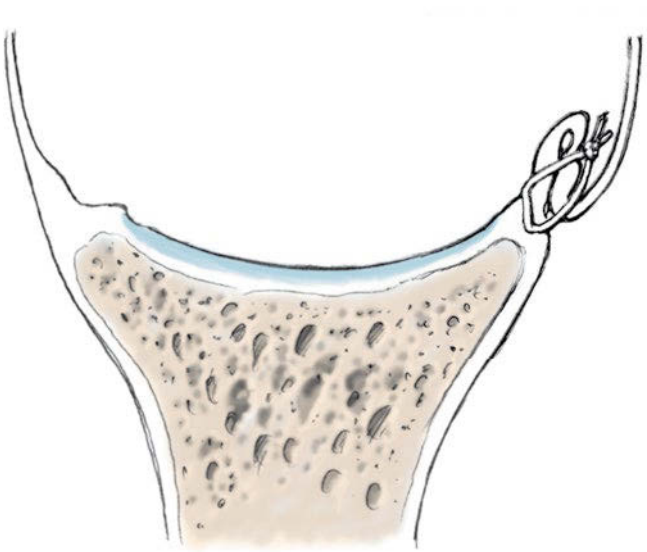


Fig. 4.19 Capsular plication with a PDS suture

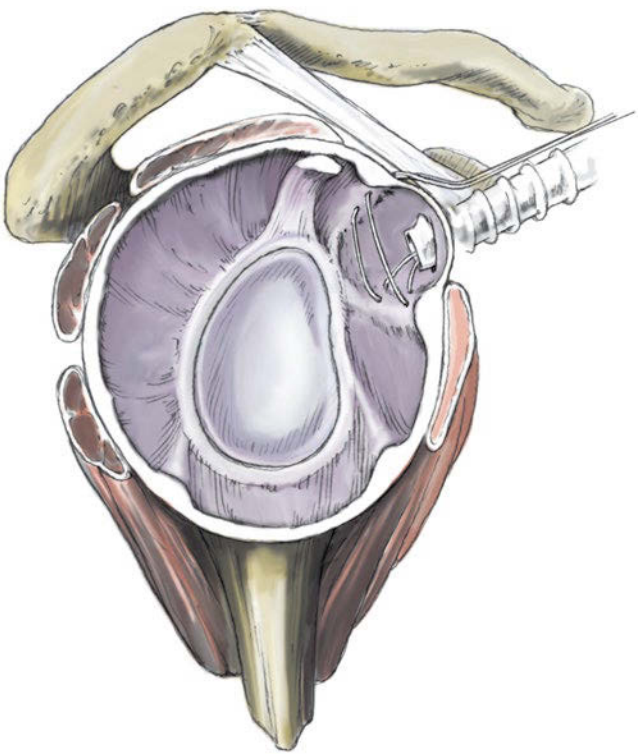


Fig. 4.20 Rotator interval closure using PDS sutures

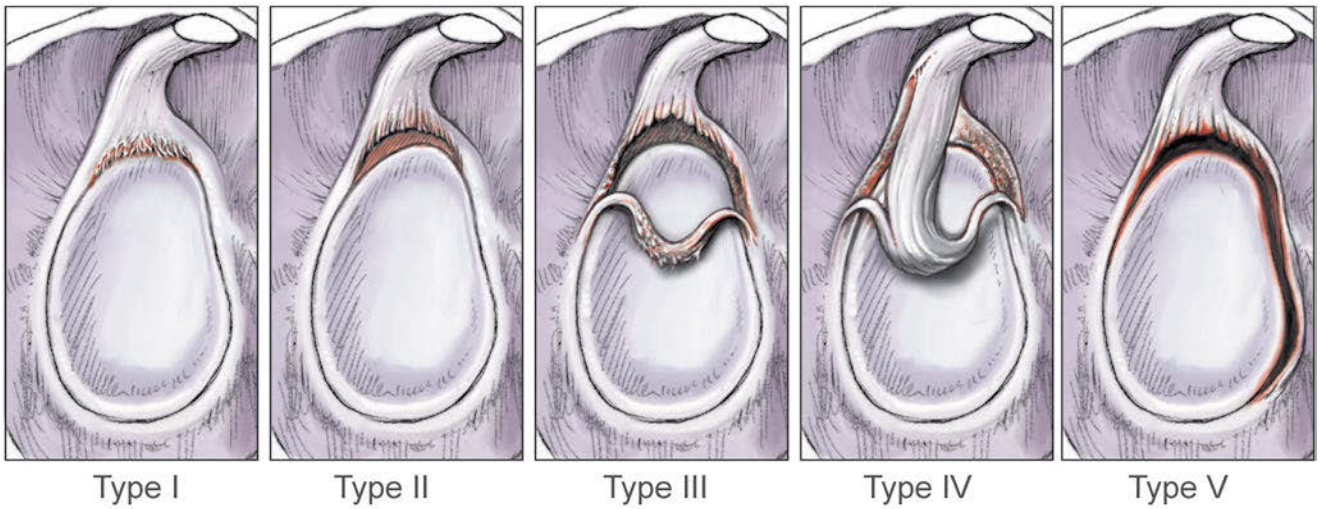


Fig. 4.21 Schematic illustration of the different SLAP lesions. Type I: fraying of SLAP complex; Type II: detachment of the SLAP complex from the superior glenoid rim; Type III: bucket-handle tear of the superior labrum; Type IV: longitudinal splitting of the labrum and the long biceps tendon; Type V: detachment of both the SLAP complex and the anterior labrum

4.3.5 Postoperative Management

- The shoulder is immobilized in neutral rotation in a shoulder positioning pad (e.g. SLK 90°, Medi).
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray evaluation.

4.3.6 Follow-Up Management

Immobilization of the shoulder in neutral rotation in a shoulder positioning pad for 6 weeks. The range of motion in the 1st–3rd weeks is restricted to 45° abduction, 30° flexion, 30° internal rotation and 0° external rotation, in the 4th–6th week the range is increased to 90° abduction, 60° flexion, 45° internal rotation and 0° external rotation. In the 7th–8th week's 90° flexion is allowed, otherwise free mobility. From the 9th week free range of motion. Overhead sports not allowed earlier than 6th months postoperatively. A more restrictive limitation of the range of motion is needed with additional capsular plication.

4.3.7 Tips & Tricks

The medial glenohumeral ligament could be incised at the upper edge and separated from the subscapularis tendon using a blunt instrument to achieve a better capsular mobility during capsular plication. Interval closure should be left to the end of the procedure, otherwise the portals will be close so early.

4.4 SLAP Lesions Type II–V

M. Feucht, S. Braun

4.4.1 Indication

Symptomatic SLAP lesion Snyder and Maffet type II–V (Fig. 4.21).

4.4.2 Operation Principle

The treatment principle differs according to the lesion type:

- **Type II**: arthroscopic refixation of the SLAP-complex to the superior glenoid with suture anchors
- **Type III:** Arthroscopic resection of the bucket handle torn flap displaced into the joint. Refixation of the SLAP-complex with suture anchors is considered with tears of the biceps tendon anchor in a well-vascularized area near to the bone of the supraglenoid tubercle.
- **Type IV:** Tenotomy or tenodesis of the long biceps tendon is generally performed; repair of the ruptured biceps tendon may be taken into consideration in selected cases. Additionally, a SLAP repair is performed if the biceps tendon anchor is unstable and re-fixable.
- **Type V:** Arthroscopic repair of both the SLAP lesion and the anterior capsulolabral lesion using suture anchors.

4.4.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom specific history: mechanism of injury (macrotrauma/repetitive microtrauma due to overhead sports) onset of pain (acute/chronic), previous shoulder dislocations, subjective feeling of instability, snapping or locking.
- Symptom specific examination: O'Brien test, Palm up test, Speed test, Biceps load test, thrower test, examination to delineate associated instability.

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) to exclude bony lesions.
- MRI to evaluate the biceps tendon anchor and possible associated lesions (e. g. Bankart lesion or posterosuperior rotator cuff lesions in over-head athletes); native MRI is sufficient in acute injuries while MRI with intraarticular contrast medium could be optionally performed to increase the diagnostic accuracy.

Patient Information/Consent

Specific operative risks: dislocation or protrusion of anchors with the risk of cartilage damage, osteolysis caused by the anchors, limitation of movement (mainly external rotation in type V), "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the subclavian artery, recurrent rupture of the biceps tendon anchor, rupture of the long biceps tendon with distalization of the muscle belly.

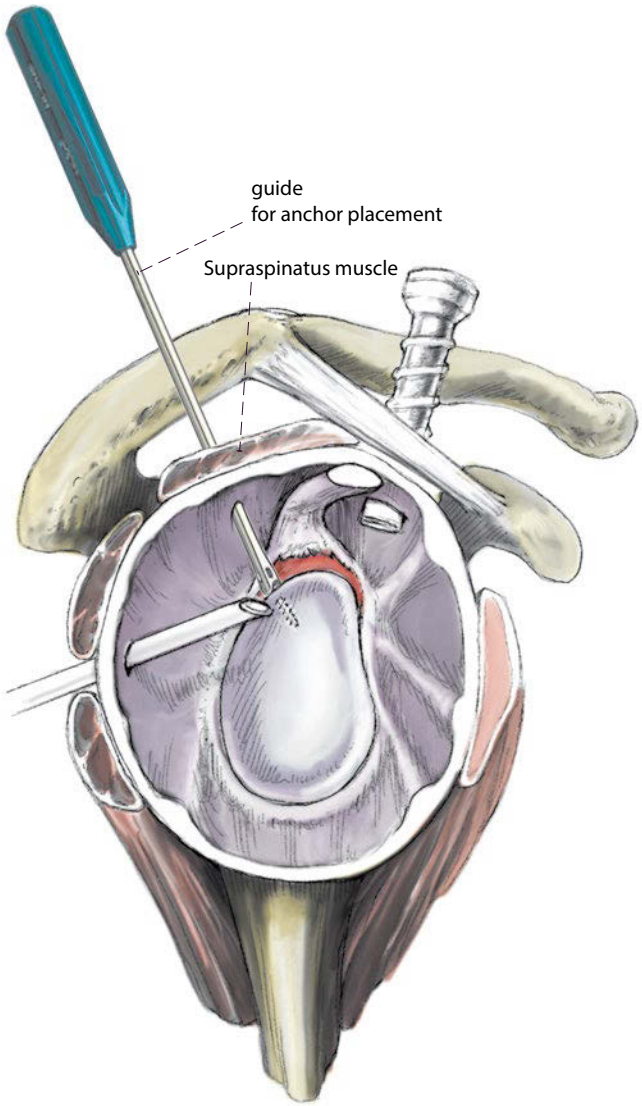


Fig. 4.22 Insertion of the first suture anchor using a guide instrument through a stab incision through the supraspinatus muscle lateral to the acromion

4.4.4 Operative Technique

Positioning and Preparation

- Beach chair position
- Examination under anesthesia (degree and direction of possible associated instability)
- Positioning of the patient arm in an arm holder

Arthroscopic SLAP Repair

Diagnostic arthroscopy is performed via the posterior standard portal. An anterosuperior working portal is established and the stability of the biceps tendon-labrum complex is evaluated using an arthroscopic probe to verify the lesion type.

The superior glenoid edge is freshened using an arthroscopic burr or a shaver introduced via the anterosuperior portal. The planned sites for anchor insertion, anterior and posterior to the biceps tendon insertion, are extensively released to avoid protrusion of the anchors. The anterior capsulolabral complex is additionally mobilized in case of type V SLAP lesion, followed by freshening of the glenoid edge and creation of marking holes at the planned anchor positions.

For the first suture anchor, an additional stab incision is made about 1 cm anterior to the posterior acromion edge and directly lateral to the acromion ("port of Wilmington"). A guide instrument (e. g. Spear, Arthrex) is then passed through the supraspinatus muscle and placed at the previously created marking hole posterior to the biceps tendon insertion (Fig. 4.22).The exact position of the portal should be accurately determined and probed using a needle from outside (Fig. 4.23a). Drilling and tapping followed by insertion of the suture anchor (e. g. Bio-Fastak, Arthrex. Fig. 4.23b). The sutures are then pulled to confirm the anchor stability and then retrieved out through the anterosuperior portal.

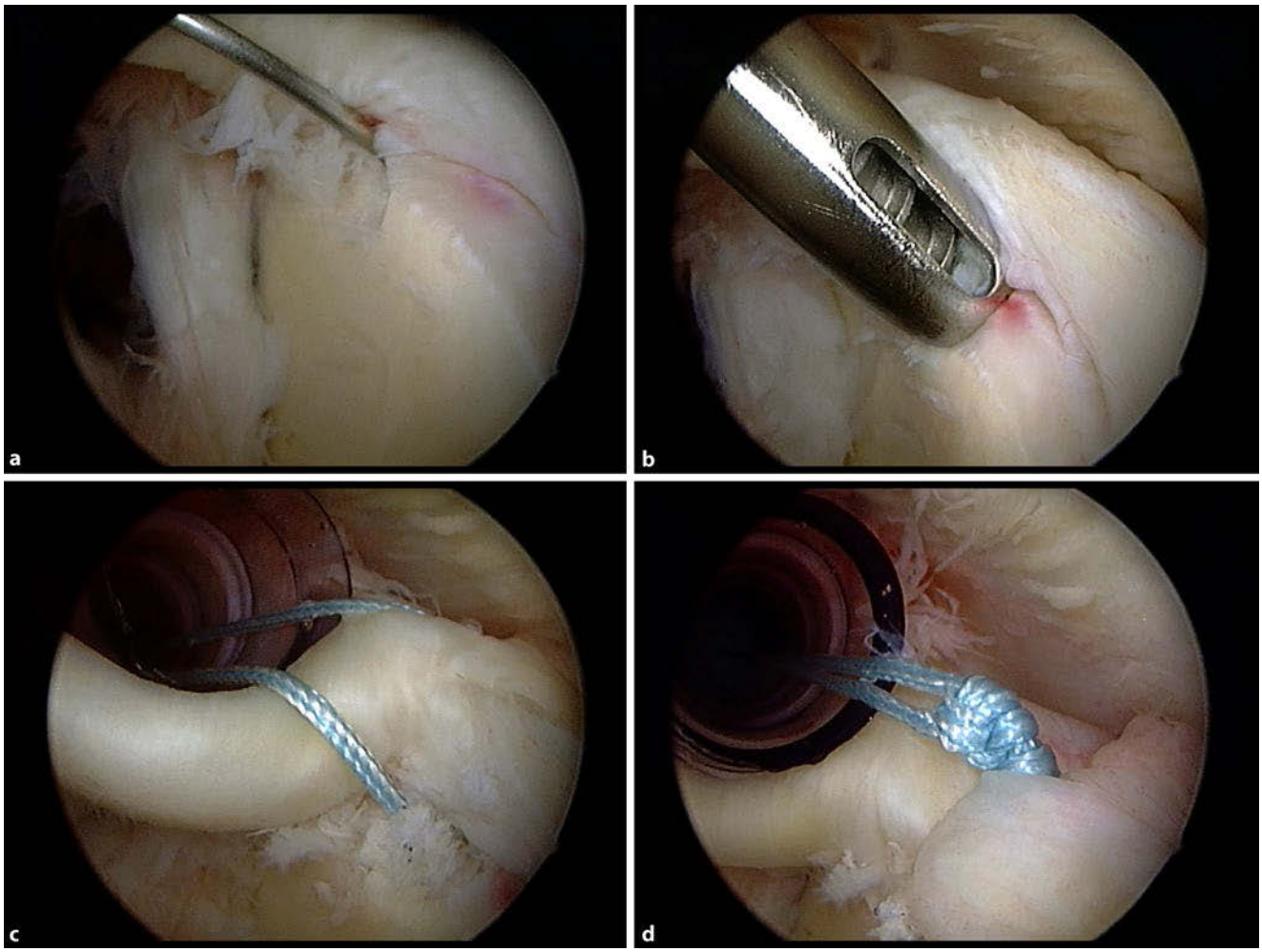


Fig. 4.23a–d Arthroscopic SLAP repair. **a** localization of the stab incision with a needle **b** insertion of the first suture anchor posterior to the biceps tendon **c** one anchor suture is shuttled medially through the SLAP complex d knotting the anchor sutures

The posterosuperior SLAP-complex is pierced from medial to lateral using a sharp tissue penetrating forceps (e. g. Bird Peak, Arthrex, Inc.) or a curved suture passer through the anterosuperior portal.

One suture limb is passed either directly using the tissue penetrator or indirectly using the suture passer to pass a suture lasso, which is then retrieved through the anterosuperior portal and used to shuttle one anchor suture (Fig. 4.23c).

The posterosuperior SLAP-complex in then refixed with an arthroscopic sliding knot (e. g. modified "fisherman's knot" or "Weston knot" (▶ Chap. 1) followed by three reversing half hitches through the anterosuperior portal (Fig. 4.4d).

A second suture anchor is then inserted anterior to the biceps tendon anchor in the same technique. One anchor suture is then shuttled through the anterosuperior SLAP-complex and both anchor sutures are then tied as described above. In type II and III SLAP lesions with unstable biceps tendon insertion, usually 2–3 suture anchors are needed for fixation (Fig. 4.24). With type V lesions, the anterior capsulolabral complex should be stabilized (in the same technique described in ▶ Sect. 4.1) before insertion of the anterior anchor.

4.4.5 Postoperative Management

- Positioning of the arm in an arm sling
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray evaluation.

4.4.6 Follow-Up Management

Immobilization of the shoulder in an arm sling with avoidance of active biceps exercises for 6 weeks. The range of motion in the 1st–3rd weeks is restricted to 45° abduction and flexion, 80° internal rotation and 0° external rotation, in the 4th–6th weeks: the range is increased to 60° abduction, 90° flexion, 80° internal rotation and 0° external rotation. From the 7th week free range of motion. Sport specific training is started after 3 months, overhead sports not allowed earlier than 6th months postoperatively. After repair of type V lesions, the range of external rotation is limited to 30° in the first 3 weeks.

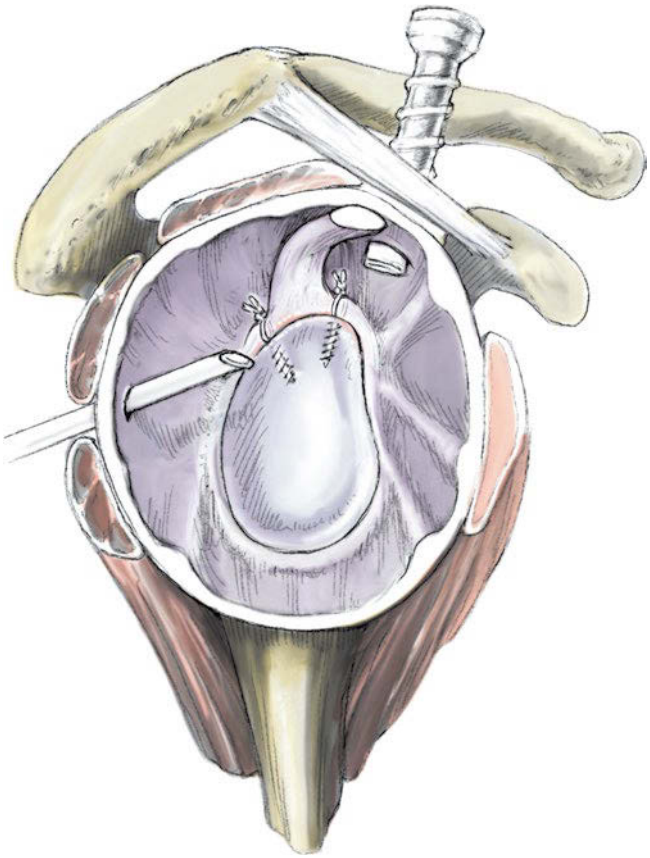


Fig. 4.24 SLAP repair with 2 suture anchors

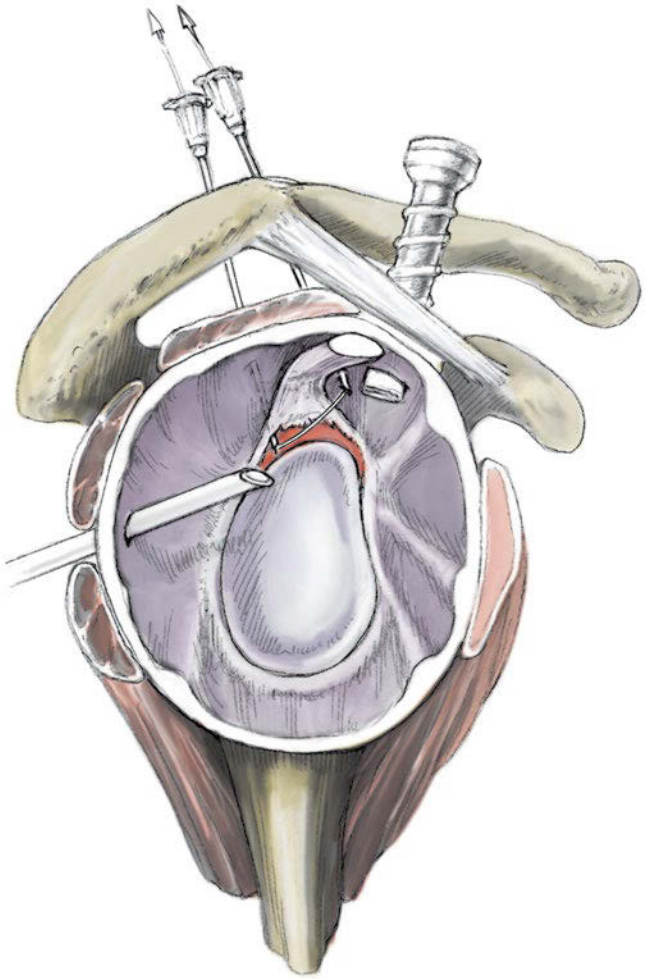


Fig. 4.25 Suspension sling

4.4.7 Tips & Tricks

The anatomy of the labrum-biceps tendon complex is highly variable. Normal variants such as the sublabral recess must be differentiated from actual type II lesion, as they do not require specific treatment.

To create enough space for preparation of the glenoid, the detached SLAP complex can be suspended with a suture loop ("suspension sling"), and can be then pulled in a posterosuperior direction away from the glenoid rim: 2 needles are inserted into the joint in the region of the supraspinous fossa, placing one anterior and the other posterior to the posterosuperior labrum. A PDS suture is introduced into the joint through each needle and retrieved through the anterosuperior portal, the sutures are tied extraarticular and then pulled back into the joint. The labrum can now be kept away from the work space by pulling on the extraarticular suture ends (Fig. 4.25).

During SLAP repair, the insertion type of the long biceps tendon according to Vangsness et al. must be taken into consideration. In case of type I and II insertions, in which most of the labral attachment is posterior, 2 posterior anchors may be necessary.

During repair of type V lesion, it is recommended to insert first the suture anchor posterior to the biceps tendon insertion due to increasing difficulty to visualize this area when the shoulder progressively swells. This is followed by refixation of the anterior capsulolabral complex. Last step is to complete the SLAP repair by inserting the second anchor anterior to the biceps tendon insertion.

The anchor should be inserted into the bone at an angle of about 135° to the glenoid surface level. If the anchor is inserted too steep or too shallow, cartilage damage or early anchor dislocation may occur.

4.5 Posterosuperior Impingement

N. Rosenstiel, P. Braun

4.5.1 Indication

Symptomatic posterosuperior (internal) impingement of the shoulder (Fig. 4.26) with involvement of one or more of the following structures after failed trial of conservative treatment:

- SLAP complex
- Articular side of the rotator cuff (Supraspinatus tendons)

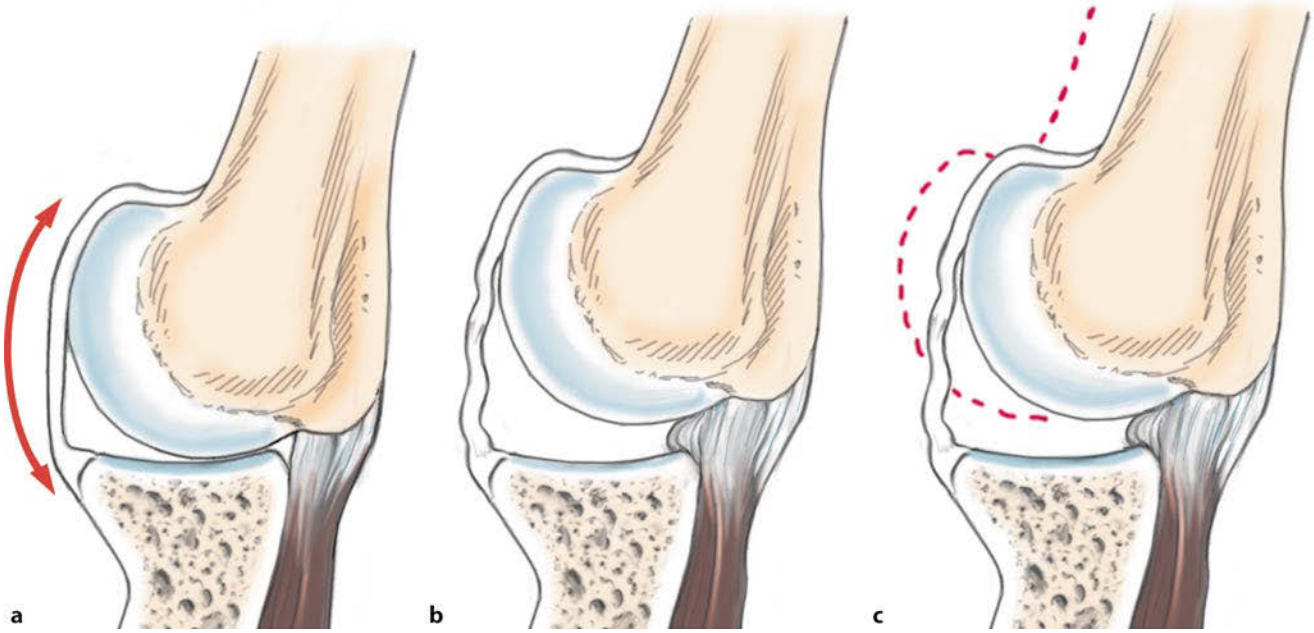


Fig. 4.26a–c Posterosuperior impingement: the arm in high abduction and external rotation position. **a** Abutment of the greater tuberosity on the posterosuperior glenoid causes increased traction on the anteroinferior capsule. **b** This results in posterior displacement of the glenohumeral contact point, which leads to decreased tension on the anteroinferior capsule. **c** comparison between the physiological neutral position (broken line) and the changed position as a result of internal impingement

- Greater tuberosity
- Inferior glenohumeral ligament or inferior capsule
- Posterosuperior glenoid/labrum

Conservative treatment is carried out in a four-phased schema:

- Acute phase: to promote the healing of acute injuries (e. g. anti-inflammatory drugs, limitation of the range of motion, very limited physiotherapy) and pain reduction
- Building/intermediate phase: strengthening, stretching, and normalization of the neuromuscular rhythm.
- Stabilization phase: strength endurance and beginning of overhead sports training
- Return to activity: intensification of the overhead sports up to the original level of performance through position specific training

4.5.2 Operation Principle

The principle of the operative procedure differs according to the type of injury, usually a combination of the following procedures is required:

- Repair of the superior labrum (SLAP repair)
- Repair of anteroinferior and/or posterior capsulolabral complex
- Rotator cuff repair
- Anteroinferior capsular plication.

4.5.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom specific history: previous injuries, infiltrations and operations, pain character and localization (pain, instability, limitation of motion), symptoms duration and triggers, feelings of instability, sport specific history
- Symptom specific examination: Impingement tests, instability tests, rotator cuff tests, painful external rotation in abduction (ABER position "abduction and external rotation"), with loss of strength, tenderness over the posterior joint line, increased external rotation, decreased internal rotation (GIRD syndrome = "glenohumeral internal rotation deficit"); (GIRD; Fig. 4.27)

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial).
- MRI (Arthrography) to differentiate between the intrinsic and extrinsic causes of impingement and to evaluate the rotator cuff tendons, the biceps tendon and its anchor as well as the labrum, additionally in the ABER position.

Patient information/consent

Specific operative risks: Are those associated with the different intraoperative procedures (SLAP-repair: ▶ Sect. 4.4, anterior

Fig. 4.27 Typical clinical picture of a GIRD syndrome of the right shoulder with increased high external rotation and simultaneous decreased high internal rotation

and/or posterior shoulder stabilization ▶ Sects. 4.1, 4.2 and 4.3, rotator cuff repair chapter ▶ Sects. 3.1, 3.2 and 3.3, capsular plication ▶ Sect. 4.3), higher risk of not reaching the preoperative level of performance with overhead athletes.

4.5.4 Operative Technique

Positioning and Preparation

- Beach chair position (alternatively lateral decubitus position)
- Positioning of the patient arm in an arm holder

Surgical Technique

Diagnostic arthroscopy and dynamic shoulder examination (in the ABER position) via the posterior standard portal to assess particularly the superior labrum with biceps tendon/biceps tendon anchor, the anterior and anteroinferior capsulolabral complex, the rotator cuff (esp. supra- and infraspinatus) and the greater tuberosity ("kissing lesion" between the undersurface of the rotator cuff and the posterior labrum).

The operative procedure should be based on the results of arthroscopic examination and correlated with the patient's symptoms and the clinical findings. Usually a combination of the following procedures is required: Repair of the superior labrum (SLAP refixation, ▶ Sect. 4.4), reconstruction of the anteroinferior and/or the posterior capsulolabral complex (▶ Sects. 4.1, 4.2 and 4.3), rotator cuff repair ▶ Sects. 3.1, 3.2 and 3.3 and capsular plication (▶ Sect. 4.3).

4.5.5 Postoperative Management

Depends on the performed operative procedure (see respective chapters)

4.5.6 Follow-Up Management

Depends on the performed operative procedure (see respective chapters)

4.5.7 Tips & Tricks

Lesions of the supraspinatus tendon are usually located in the anterior part close to the greater tuberosity. Intratendinous articular surface ruptures often occur.

Cysts and impressions of the posterior part of the greater tuberosity, seen as an increased signal intensity on MRI, indicate a posterosuperior impingement.

4.6 Reconstruction of Glenoid Bone Defects

S. Braun

4.6.1 Indication

Primary or revision procedures in recurrent shoulder dislocation with:

- Glenoid bone defects (erosion-type) more than 15–25 % of the glenoid surface area
- Glenoid bone defects (fragment-type) more than 15–25 % of the glenoid surface area that are not amenable to fixation or reconstruction

Specific contraindications:

- Recurrent shoulder dislocation without glenoid bone defect
- Recurrent habitual shoulder dislocation with generalized hyperlaxity

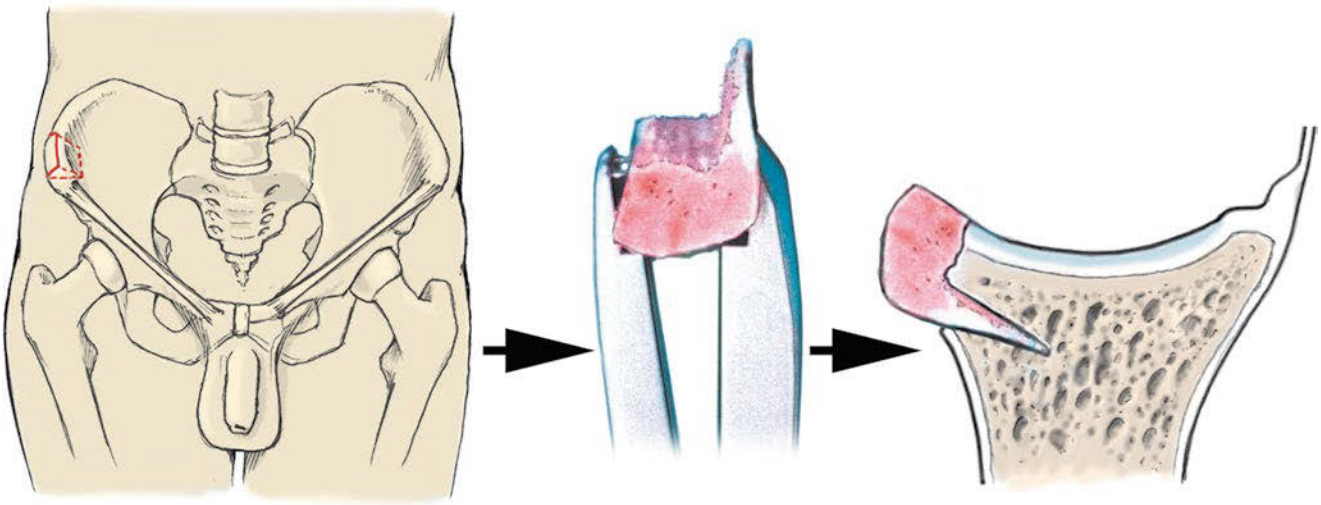


Fig. 4.28 Operation principle: anatomical reconstruction of the anterior glenoid rim and surface with a J-shaped bicortical bone graft harvested from the iliac crest

- Multidirectional instability (with or without generalized hyperlaxity)
- Open growth plates in the pelvic region

4.6.2 Operation Principle

Anatomic reconstruction of the anterior glenoid rim and surface with a J-shaped bicortical iliac bone graft (Fig. 4.28)

4.6.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom-specific history: time and mechanism of the first dislocation, reduction method (spontaneous, patient himself, external, with/without anesthesia), previous shoulder dislocations or injuries, number of recurrences, mechanism and method of reduction of any recurrence (renewed trauma, trivial incident spontaneous), treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, chronic polyarthritis, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders)
- Symptom-specific examination: range of motion (increased passive range of motion), anterior and posterior translation, load and shift test, sulcus sign in internal and external rotation, Gagey hyperabduction test, anterior and posterior apprehension tests, relocation test, Jerk test, exclusion of generalized ligamentous hyperlaxity.

Neurovascular Examination

Assessment of the peripheral nerves (particularly the axillary nerve) and the peripheral vascularity.

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) as a basic diagnostic tool.
- MRI (optionally with intraarticular contrast agent) to assess the capsulo-labral lesions, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff)
- CT for accurate assessment of the anterior glenoid rim, size and location of the bone defect, 3-D CT reconstruction of the CT helps in better planning of the desired procedure.

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement (mainly external and internal rotation), "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the axillary vessels, implant failure, loosening or resorption of the bone graft, dislocation or protrusion of the anchors or screws with the risk of cartilage damage, osteolysis, fracture of the bone graft with recurrent traumatic dislocation, high risk of osteoarthritis despite anatomical reconstruction of the glenoid surface due previous dislocations, prolonged postoperative pain or bleeding at the site of the bone graft harvesting from the iliac crest.

4.6.4 Operative Technique

Positioning and Preparation

- Beach chair position with more horizontal positioning of the upper part of the body, to allow better access to the ipsilateral anterior part of the iliac crest.
- Positioning of the patient arm in an arm holder
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion)
- Diagnostic arthroscopy via the posterior standard portal.

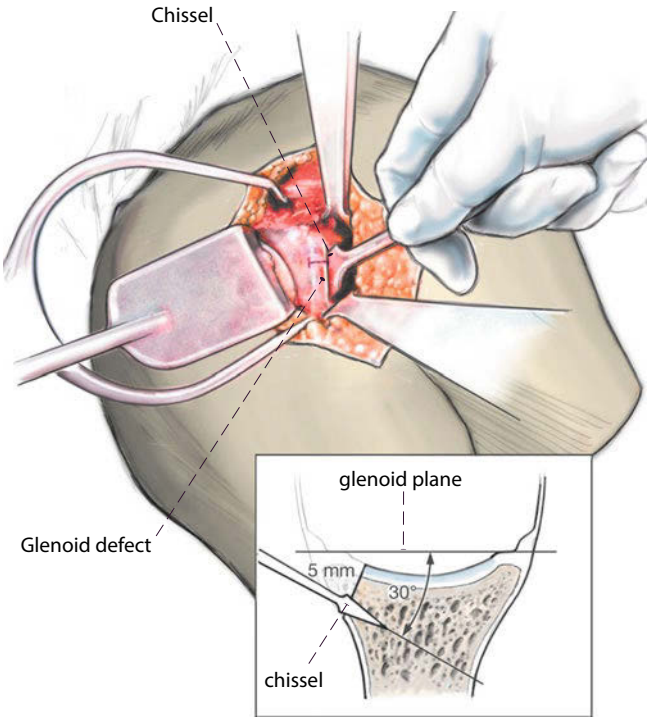


Fig. 4.29 Partial osteotomy of the glenoid neck with an osteotome at an angle of 30° to the glenoid plane.

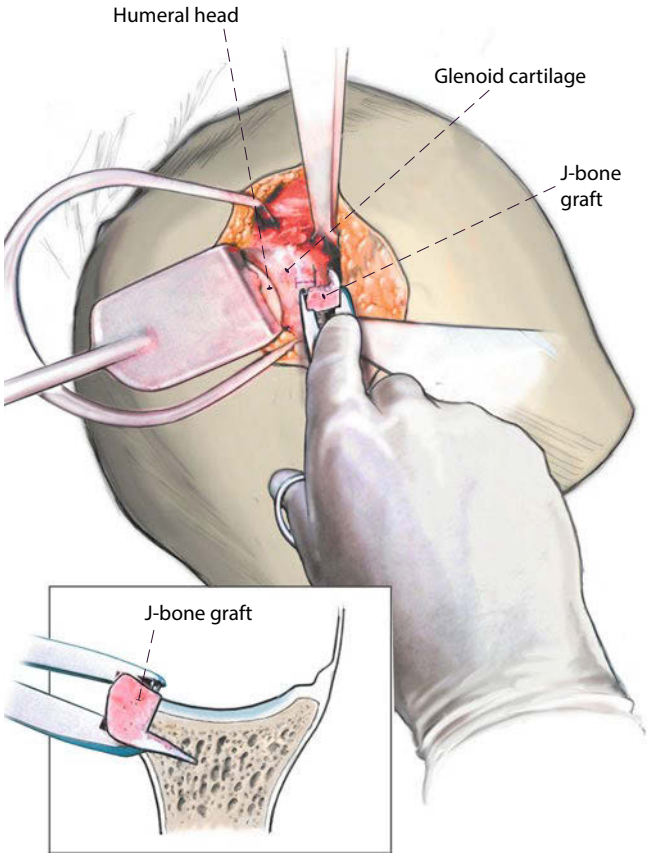


Fig. 4.30 Insertion of the J-bone graft into the osteotomy

Anatomical Glenoid Reconstruction with J-shaped Iliac Crest Bone Graft

Limited deltopectoral approach: about 5–8 cm skin incision, starting proximal and medial to the palpable coracoid tip. Dissection along the deltopectoral groove and exposure of the cephalic vein. The vein is retracted laterally to avoid disruption of the venous drainage of the deltoid muscle, otherwise, side branches should be ligated to allow medial retraction of the vein.

The conjoint tendon and the coracoid are exposed and the subscapularis tendon and its muscular part are identified in mild external rotation (identification of the subscapularis tendon is easier when it is moderately tensioned).

To expose the anterior glenoid rim, the subscapularis tendon is split at the junction between the upper tendinous third and the middle third (muscle fibers) and there is no need to release the tendon insertion from the lesser tuberosity. A Gelpi self-retaining retractor is used to retract the split tendon and expose the joint capsule.

The exposed joint capsule is then sharply released from the subscapularis tendon, especially laterally. The capsule is incised parallel to the split of the subscapularis. For better exposure of the anterior glenoid rim, a T-shaped incision can be performed with the base of the T lying ideally along the glenoid. This makes a subsequent additional capsular shift possible. The capsule is retracted both cranially and distally using traction sutures.

The humeral head is retracted posterolaterlly using a Fukuda retractor to expose the anterior glenoid rim. The anterior glenoid rim and the scapular neck are completely dissected and exposed. Hohmann retractors are placed at the at 3 and 6 o'clock to allow an adequate exposure of the bony glenoid defect zone. This is carefully exposed and freshened using a periosteal elevator. The defect zone is then analyzed and measured in situ. Harvesting the bicortical J span graft from the ipsilateral iliac crest is determined by the intraoperative as well as the radiological (3D-CT) dimensions of the defect zone.

Approach to the ipsilateral anterior iliac crest and harvesting the span graft: skin incision of 3–5 cm just lateral to the palpated iliac crest, sharp dissection directly down to the bone, electrothermal device is used to incise and reflect the periosteum together with a periosteal elevator, so that closure of the periosteum could be possible. The planned iliac crest span graft is marked with the electrothermal device adding about 2–3 mm on each side to allow modeling of the graft later on. The bone block should not be harvested too small.

The bone graft is harvested using an oscillating saw, a sharp osteotome or chisel. It is recommended here to harvest the bone block from the upper cortical margin as well as the outer cortex of the iliac crest. The cancellous bone at the base of the block is removed, resulting in a J-shaped graft. The fine modeling of the graft can be performed with a burr,

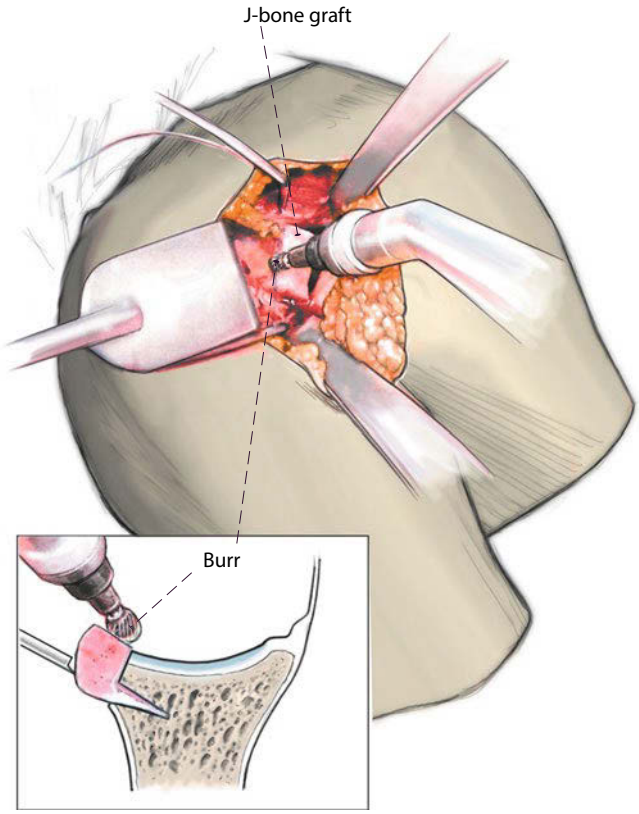


Fig. 4.31 Adapting the J-graft to the glenoid with a burr

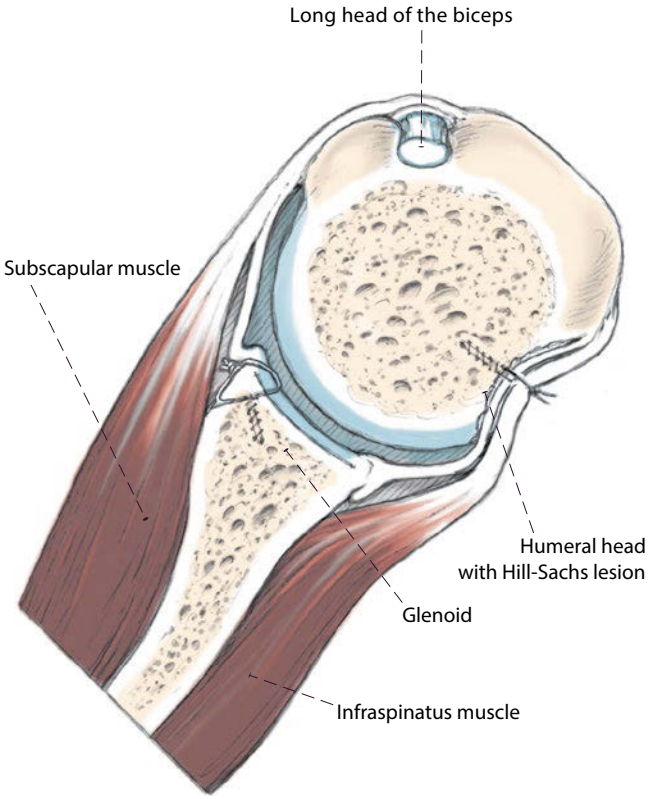


Fig. 4.32 Principle of Hill-Sachs Remplissage. The defect is obliterated and the external rotation is limited through tenodesis of the infraspinatus tendon using suture anchors into the defect. This prevents the engagement of the Hill-Sachs defect over the anterior glenoid rim. Additionally, the usually torn anteroinferior capsulolabral complex is refixed using suture anchors

the angles and edges of the graft chip are carefully trimmed and prepared.

Placement of the bone graft: A 10- or 15-mm chisel is used to create a partial osteotomy on the glenoid neck in a 30° angle inclination to the glenoid surface (Fig. 4.29), into which the wedge shaped J-Span graft can be inserted. The distance between the osteotomy and the joint surface should be about 5 mm, which corresponds to the width of the base of the bone graft to avoid protruding above the articular surface. The depth of the osteotomy is tailored to the length of the bone graft and should not be parallel to the joint surface to avoid fracture.

The J-Span graft is inserted gently using a bone forcep into the osteotomy and impacted firmly after perfect positioning with a bone impactor (Fig. 4.30). Shear forces must be avoided during impaction to avoid fracture of the graft. Subsequently, the graft is smoothened and leveled to the joint surface using a motorized burr (Fig. 4.31). It should be ensured that there will be no contact between the bone block and the humeral head up to 60° abduction and 30° flexion. Otherwise, the block must be debulked and trimmed again with the burr. Finally, the capsule is closed using the previously placed stay sutures directly or after performing a capsular shift. The subscapularis split is closed with strong sutures (non-absorbable, e.g. FiberWire, Arthrex).

4.6.5 Postoperative Management

- Positioning of the arm in an arm sling
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray or CT evaluation.

4.6.6 Follow-Up Management

Immobilization of the shoulder in a sling for 4–6 weeks. The range of motion in the 1st–3rd weeks is restricted to 30° abduction and flexion, 80° internal rotation and 0° external rotation, in the 4th–6th week the range is increased to 60° abduction and 90° flexion, 80° internal rotation and 0° external rotation. From the 7th week free range of motion. Sport specific training is started after 3 months, overhead sports not allowed earlier than 6th months postoperatively.

4.6.7 Tips & Tricks

An adequate depth of the osteotomy is a prerequisite for a well-fitting of the J-bone graft.

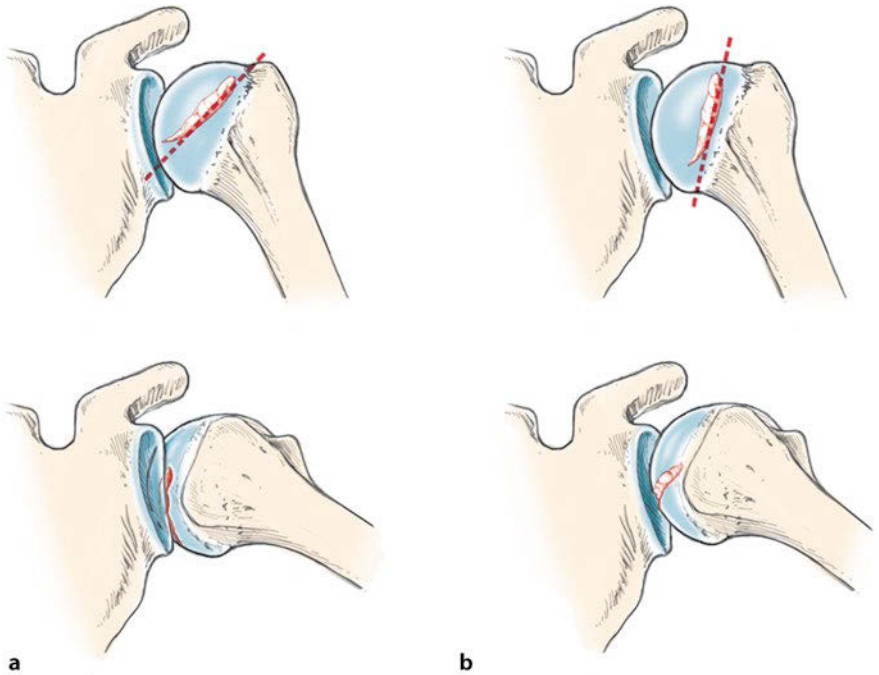


Fig. 4.33a,b Different forms of Hill-Sachs lesions. **a** Engaging lesion: with abduction and external rotation movement, the defect comes to lie parallel to the anterior glenoid margin and can drop over it anteriorly (engage). **b** non engaging lesion: the defect is not parallel to the anterior glenoid margin in abduction and external rotation and therefore will not engage

The bone graft should be harvested a little bit large enough to allow in situ remodeling with the burr.

The osteotomy should be about 5 mm medial to the articular surface and created slowly and cautiously at an angle of 30° to it to avoid glenoid fracture.

If the keel of the J-graft is broken, the bone block could be fixed using a cannulated screw inserted over a predrilled K-wire, thus providing additional protection if the primary stability is doubtful.

4.7 Remplissage of Hill-Sachs Lesions

S. Braun

4.7.1 Indication

Engaging Hill-Sachs defect after anteroinferior shoulder dislocation

4.7.2 Operation Principle

The operation aims to prevent engagement of the bony defect, which may exist in the vicinity of an anteroinferior dislocation in the posterolateral humeral head area, at the anterior glenoid margin during external rotation-abduction movements. This involves filling the impression in the humeral head through infraspinatus tenodesis using suture anchors. This results in limitation of the external rotation and subsequently avoiding engagement of the defect (Fig. 4.32). Usually, an additional repair of the anteroinferior capsulolabral complex is performed.

4.7.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom-specific history: time and mechanism of the first dislocation as well as reduction method (spontaneous, patient himself, external, with/without anesthesia), previous shoulder dislocations or injuries, number of recurrences, mechanism and method of reduction of any recurrence (renewed trauma, trivial incident spontaneous), snapping or blocking with particular movements, treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, chronic polyarthritis, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders), generalized ligamentous hyperlaxity.
- Symptom-specific examination: evaluation of the range of motion taking into account possible engagement of the humeral head in abduction and external rotation, anterior and posterior translation of the humeral head, load and shift test, anterior and posterior apprehension tests, relocation test, Jerk test, sulcus sign in internal and external rotation, Gagey hyperabduction test.

Neurovascular Examination

Assessment of the peripheral nerves (particularly the axillary nerve) and the peripheral vascularity.

Fig. 4.34a–c Arthroscopic view of an engaging Hill-Sachs defect. **a** large Hill-Sachs defect in neutral position of the head of the humerus. **b** with increasing abduction and external rotation the defect comes to lie parallel to the anterior glenoid rim. **c** With more abduction and external rotation the defect engages the anterior glenoid edge. HS Hill-Sachs defect, G glenoid

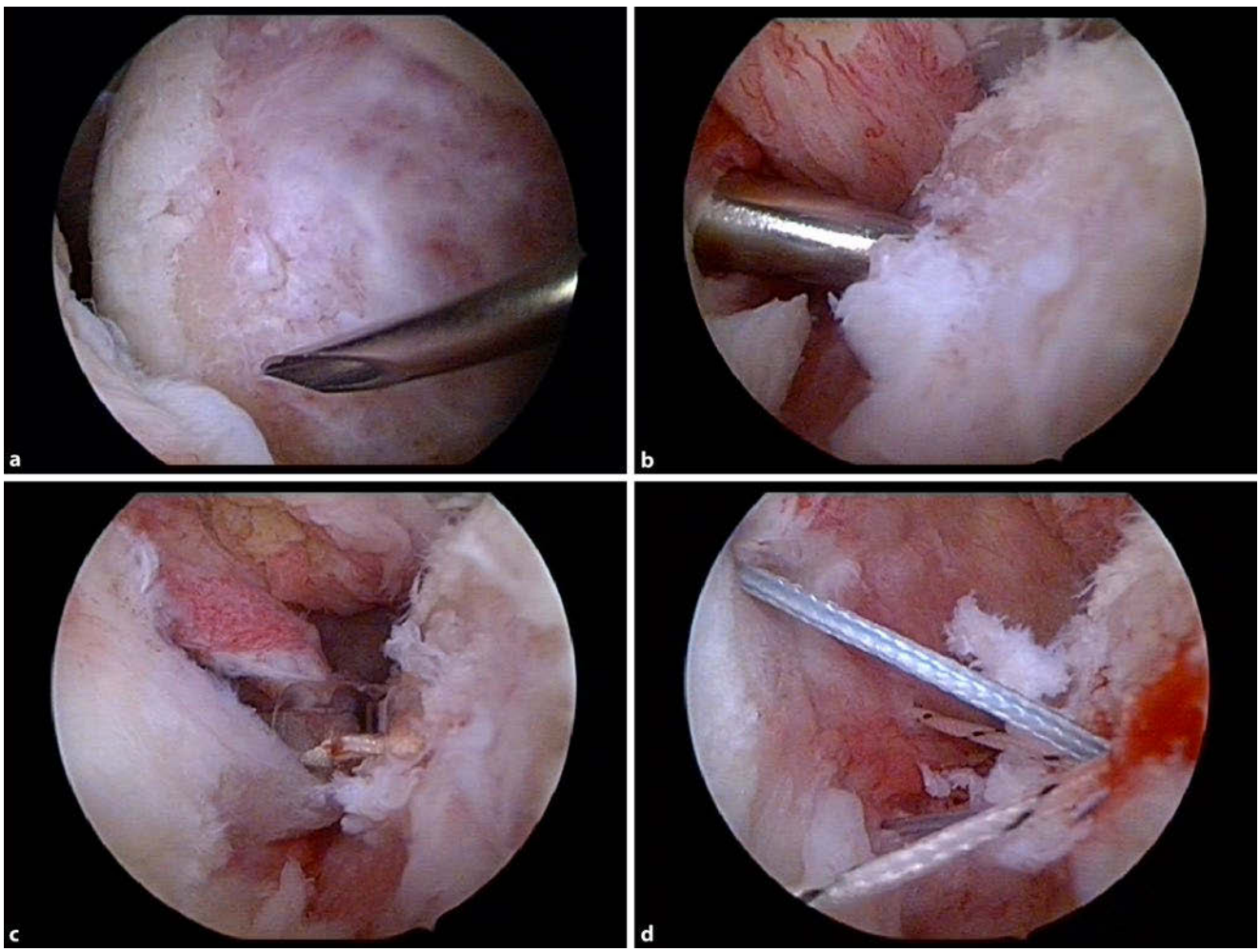


Fig. 4.35a–d Arthroscopic remplissage of Hill-Sachs lesions. **a** deep posterolaterl portal is created after probing with a needle; **b** The arthroscope is switched into the anterolateral portal and the defect zone is freshened (in this example through microfracturing using a punch), **c** A suture anchor is inserted into the defect zone **d** Sutures are shuttled through the joint capsule and infraspinatus, so that finally mattress sutures could be tied subacromially

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial) to evaluate bony lesions and the degree of existing osteoarthritis.
- MRI (optionally with intraarticular contrast agent) to assess the capsulo-labral lesions, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff)
- CT (wherever possible with 3D reconstruction) for accurate assessment of the size and location of the Hill-Sachs lesion.

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement (mainly external and possibly internal rotation), "fro-

zen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the axillary vessels, implant failure, dislocation or protrusion of the anchors or screws with the risk of cartilage damage, osteolysis, risk of osteoarthritis.

4.7.4 Operative Technique

Positioning and Preparation

- Beach chair position or alternatively lateral decubitus position which allows an easier access to the Hill-Sachs lesions.
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion).
- Diagnostic arthroscopy via the standard posterior portal. Here, particular attention to the assessment of the Hill-Sachs lesion is needed. The arm is slowly moved into abduction and external rotation and the possibility of engagement of the Hill-Sachs defect over the anterior glenoid rim is checked under arthroscopic visualization.

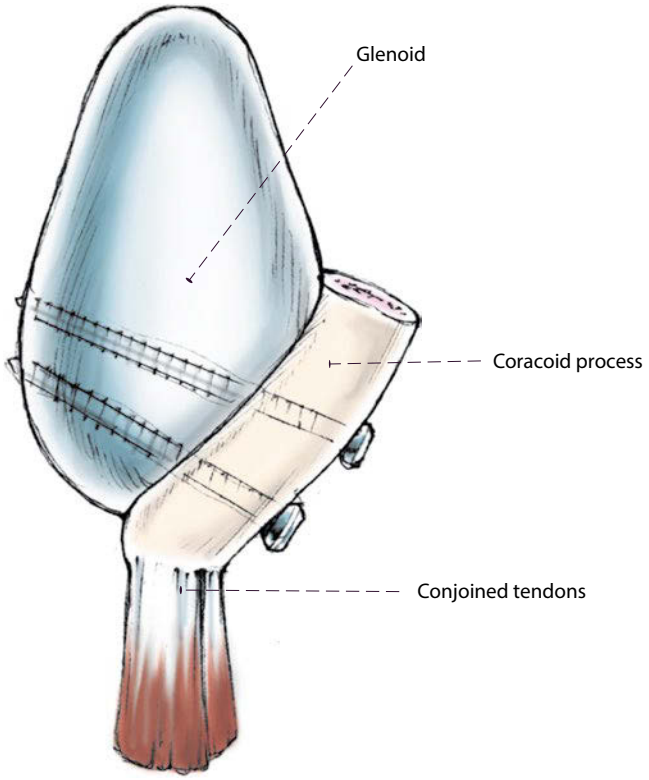
It should be noted that only those defects that lie parallel to the anterior glenoid rim in abduction and external rotation and could be rotated further anteriorly, could be classified as engaging defects (◘ Figs. 4.33 and 4.34).

Remplissage of Hill-Sachs Lesions with Tenodesis of the Infraspinatus Tendon.

A deep posterolateral portal is created using a needle for localization about 3–4 cm distal to the posterolateral edge of the acromion to allow direct access to the Hill-Sachs defect (◘ Fig. 4.35a). A working cannula is inserted to allow easier suture management. Cannulas with deployable wings (e. g., Gemini cannula, Arthrex), which allow traction on the capsule and thus increase the intraarticular space and allow a better visualization are ideal here.

The arthroscope is placed in the anterolateral portal (dorsal to the long biceps tendon) to provide a direct view of the of the Hill-Sachs defect. Freshening and gentle debridement of the Hill-Sachs lesion with a burr or shaver to allow subsequent healing of the infraspinatus in this area. Optionally, a microfracture with awls or a punch could be performed for anchor placement (◘ Fig. 4.35b).

Depending on the extent of the Hill-Sachs lesion, 1 or 2 suture anchors (e. g. Bio-Corkscrew FT 5.5, Arthrex) are inserted into the defect through the cannula (◘ Fig. 4.35c). The inferior anchor should be inserted first. The working cannula is then withdrawn into the subacromial space. A sharp suture passer (e. g. penetrator or Bird-beak, Arthrex) could be used to penetrate the infraspinatus and the joint capsule and the sutures are retrieved individually into the subacromial space shuttled outside through the working cannula, so that finally mattress sutures could be tied in the subacromial space (◘ Fig. 4.35d).



◘ **Fig. 4.36** Operation principle: transfer of the coracoid process with the attached end of the "conjoined tendons" to the glenoid defect

The arthroscope is switched to the subacromial space and the corresponding suture threads are tied in a mattress suture to fix the rotator cuff under direct visualization. The arthroscope is switched again intraarticular, to check the Remplissage. Here, the Hill-Sachs lesion should be filled with the infraspinatus and engagement of the defect over the anterior glenoid rim is no longer possible. The extent of external rotation is evaluated under direct visualization to notice the mechanical limitation of the post-operative rehabilitation program.

4.7.5 Postoperative Management

- Positioning of the arm in an arm sling
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray evaluation.

4.7.6 Follow-Up Management

Immobilization of the shoulder in a sling for 6 weeks. The range of motion in the 1st–3rd weeks is restricted to 45° abduction and flexion, 80° internal rotation and 30° external rotation, in the 4th–6th week the range is increased to 90° abduction and flexion, 80° internal rotation and 0° external rotation. From the 7th week free range of motion. Sport specific training

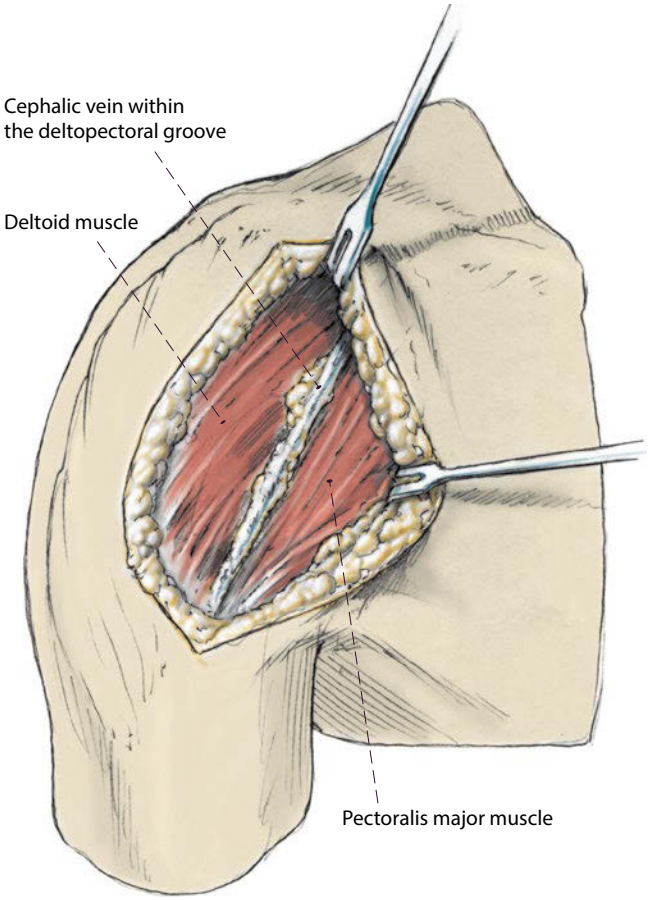


Fig. 4.37 Short deltopectoral approach, starting proximal and medial to the tip of the coracoid.

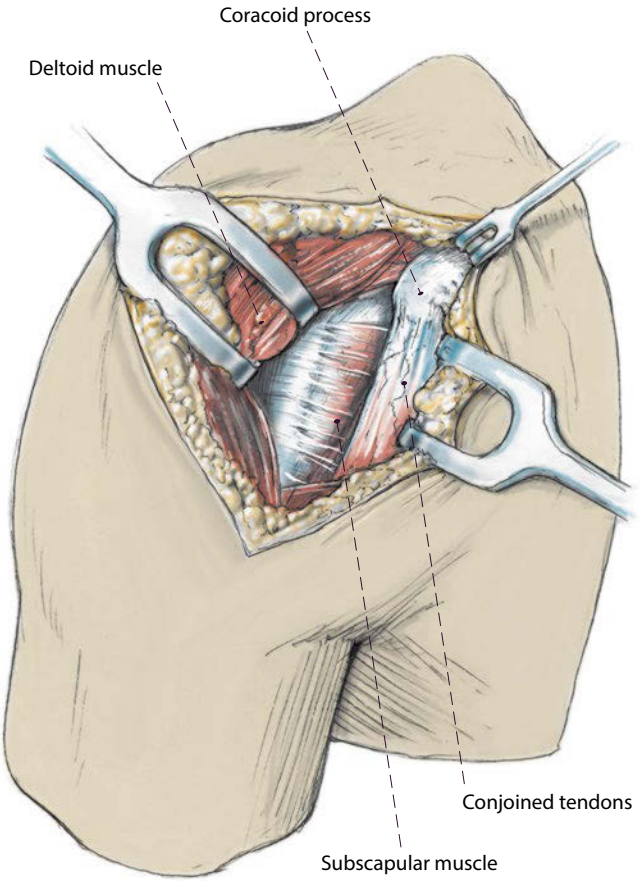


Fig. 4.38 Exposure of the coracoid process and the "conjoined tendons"

is started after 3 months, overhead sports not allowed earlier than 6th months postoperatively.

4.7.7 Tips & Tricks

The Remplissage procedure is usually combined with the anterior shoulder stabilization described in ▶ Sect. 4.1.4. It is recommended to perform the Remplissage before the anteroinferior stabilization. Very large Hill Sachs defects, in which the Remplissage will result in an unacceptable reduction of the humeral articular surface area, require an alternative procedure, for example, filling of the bone defect (▶ Sect. 5.3) or a prosthetic resurfacing (▶ Sect. 6.1).

4.8 Laterjet Coracoid Transfer

S. Braun

4.8.1 Indication

Glenoid bone defects larger than 20–25 % of the glenoid surface area. Failed arthroscopic or open anterior stabilization with recurrent dislocation. In high-risk athletes with higher demands of stability also as a primary procedure.

Specific contraindications: bone defects or glenoid fractures of more than one third of the glenoid surface area; in such cases, the bone substance of the transferred coracoid process is not sufficient in most cases to reconstruct the glenoid.

4.8.2 Operation Principle

Transfer of the coracoid process with the attached "conjoined tendons" (insertion of the coracobrachialis and the short head of the biceps brachii) to the area of glenoid defect (Fig. 4.36).

The stabilization of the shoulder result through 2 effects:

- Bony effect: filling of the glenoid defect
- Soft tissue effect: dynamic stabilization and reinforcement of the anterior band of the inferior glenohumeral ligament by the "conjoined tendon", which is tensioned in abduction and external rotation of the humeral head.

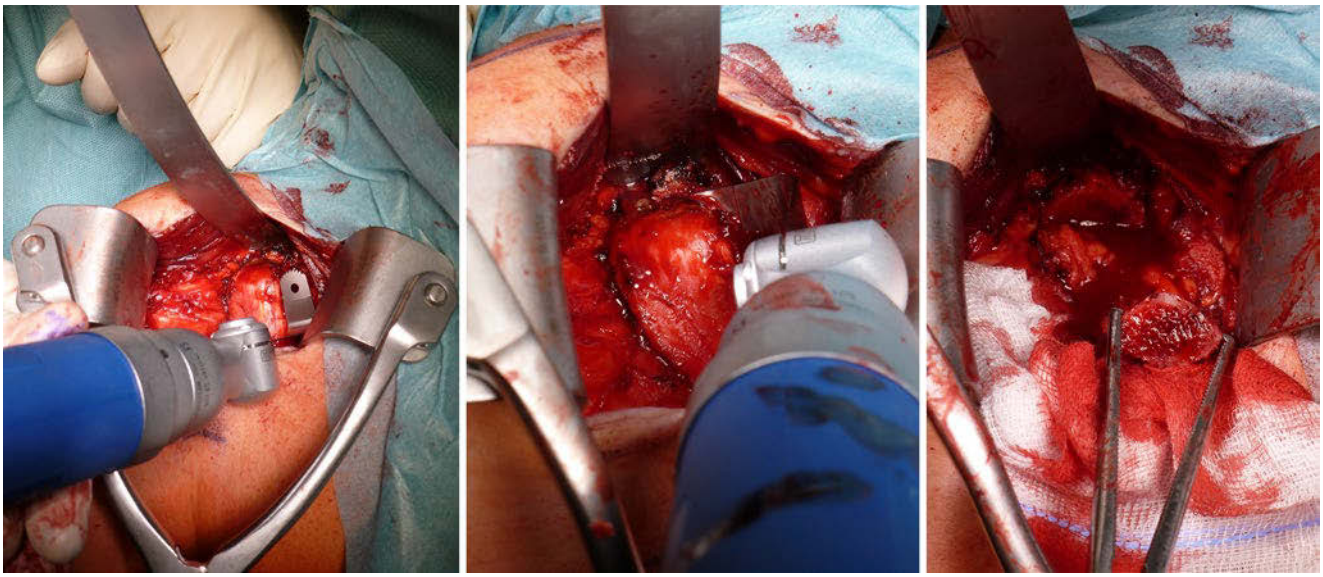


Fig. 4.39 Osteotomy of the coracoid process using an angled blade saw at the junction to the coracoid base

4.8.3 Preoperative Assessment

Diagnosis

Clinical

- Symptom-specific history: time and mechanism of the first dislocation, reduction method (spontaneous, patient himself, external, with/without anesthesia), previous shoulder dislocations or injuries, number of recurrences, treatment history, sport/functional demands, relevant comorbidities (e. g. epilepsy, chronic polyarthritis, Marfan syndrome, Ehlers-Danlos syndrome, psychological disorders).
- Symptom-specific examination: range of motion (increased passive range of motion), anterior and posterior translation, load and shift test, sulcus sign in internal and external rotation, Gagey hyperabduction test, anterior and posterior apprehension tests, relocation test, Jerk test, generalized hyperlaxity signs.

Neurovascular Examination

Assessment of the peripheral nerves (axillary and musculocutaneous nerves).

Imaging

- X-rays of the shoulder in three views (true AP, y-view, axial)
- MRI (optionally with intraarticular contrast agent) to assess the capsulo-labral lesions, capsular volume and any associated injuries (e. g. SLAP lesion, rotator cuff)
- CT for accurate evaluation of the anterior glenoid rim, extent of glenoid defect as well as the coracoid configuration.

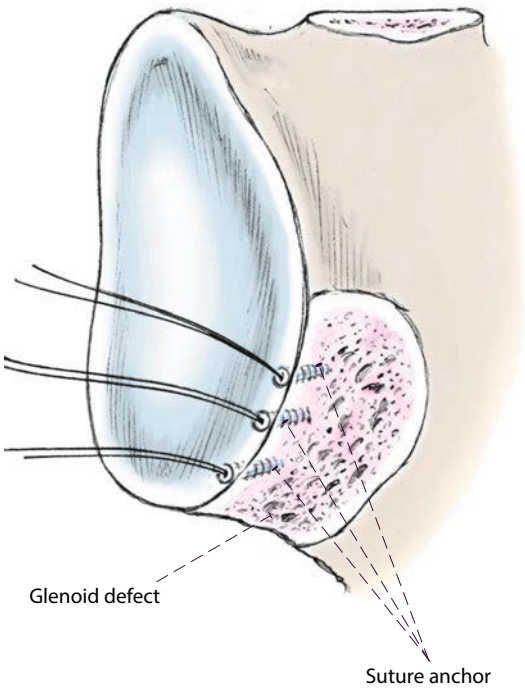


Fig. 4.40 Placement of suture anchors at the osteochondral junction of the anterior glenoid edge for repairing the capsule later

Patient Information/Consent

Specific operative risks: re-dislocation, limitation of movement (mainly external rotation), "frozen shoulder", nerve injury (axillary nerve, musculocutaneous nerve, brachial plexus), injury of the subclavian artery, implant failure, dislocation or protrusion of the anchors or screws with the risk of cartilage damage, osteolysis, risk of osteoarthritis.

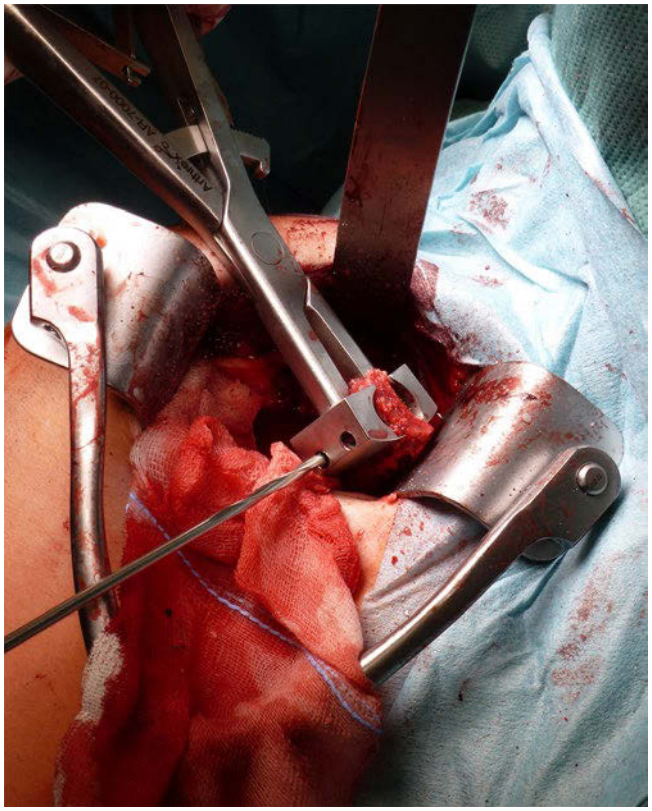


Fig. 4.41 Drilling two holes in the coracoid bone block

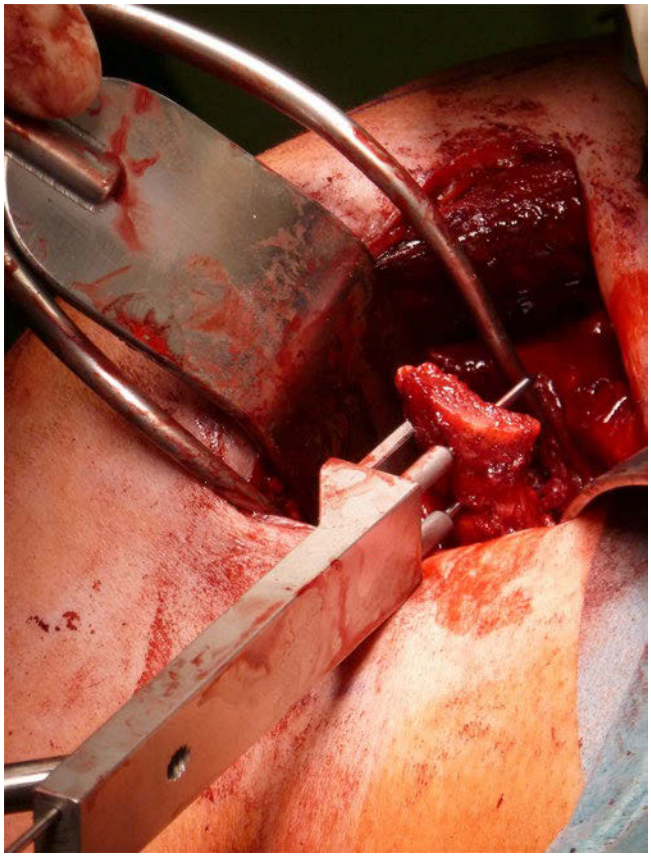


Fig. 4.42 Fixation of the coracoid bone block to the glenoid with the aid of the special drill guide and offset

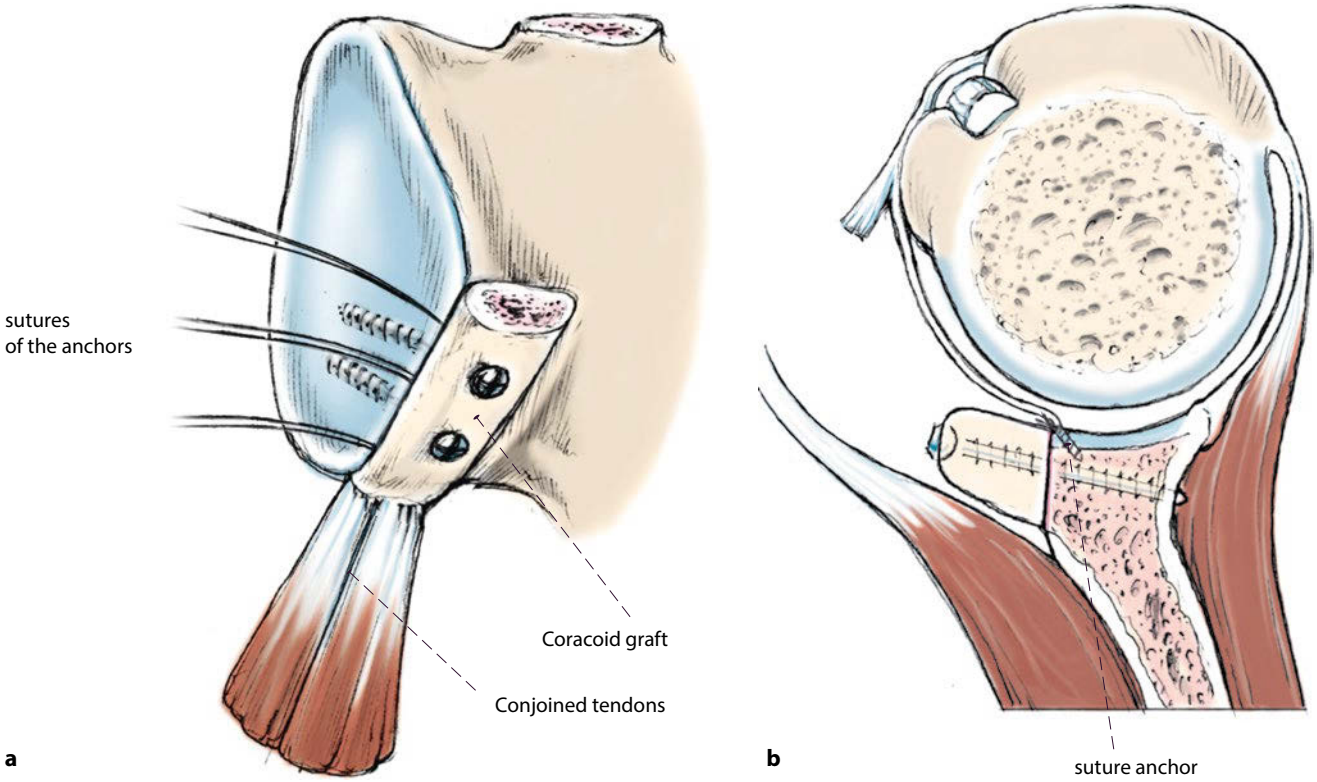


Fig. 4.43a,b After loose fixation of the coracoid block with screws (**a**) the capsule is interposed using the previously placed suture anchors, so that the coracoid block remains extraarticular (**b**)

4.8.4 Operative Technique

Positioning and Preparation

- Beach chair position
- Examination under anesthesia (degree and direction of instability, hyperlaxity, range of motion).
- Diagnostic arthroscopy via the standard posterior portal.

Open Coracoid Transfer with Capsular Interposition

Short deltopectoral approach: about 5–8 cm skin incision, starting proximal and medial to the palpable coracoid tip. Dissection along the deltopectoral groove and exposure of the cephalic vein (Fig. 4.37). The vein is retracted laterally to avoid disruption of the venous drainage of the deltoid muscle, otherwise, side branches should be ligated to allow medial retraction of the vein.

The coracoacromial ligament is incised about 1 cm proximal to its coracoid insertion and the coracohumeral ligament is released. Exposure of the "conjoined tendons" and the coracoid in a medial direction (Fig. 4.38) and identification of the pectoralis minor tendon.

The tendon of the pectoralis minor muscle is released directly at the coracoid preserving the tendon stump. Dissection is carried out using electrocautery, taking care not to reach the tip of the coracoid laterally to avoid compromising the blood supply to the bone block. The base of the coracoid is carefully exposed at the junction of the horizontal and the vertical parts. Osteotomy of the coracoid is performed with an angled blade saw at the junction to the coracoid base (Fig. 4.39), anterolateral to the coracoclavicular ligaments to harvest a bone block of about 2.5–3 cm length. The "conjoined tendons" remain attached to the bone block. The arm should remain adducted in this step, to relax the neurovascular bundle under the pectoralis minor (axillary artery and brachial plexus) and not to be pulled close to the coracoid.

Meticulous and blunt mobilization of the "conjoined tendons" from the lateral aspect to avoid injury to the musculocutaneous nerve, which enters the coracobrachialis muscle from its medial aspect. The subscapularis tendon is longitudinally split in line of its fibers at the junction of the upper and middle thirds, exposing the underlying joint capsule, which is incised in the same way. The exposed anterior glenoid rim is prepared and freshened. 2–3 suture anchors (e. g. BioFastak, Arthrex) could be inserted at the 5:30, 4:30 and 3:00 clock positions to allow repairing of the capsule later (Fig. 4.40).

The coracoid is prepared with a burr to adapt to the curvature of the glenoid. Two holes are drilled in the coracoid block (4-mm drill bit) using a special forceps and drill guide (Coracoid drill guide, Arthrex) (Fig. 4.41). The coracoid block is then fitted to the glenoid, temporary fixed with K-wires, superiorly and inferiorly, optionally using a drill guide with an offset (parallel drill guide, Arthrex. Fig. 4.42) to avoid protrusion above the glenoid edge. The K-wires are overdrilled with a 3-mm cannulated drill. The K-wires and the drill bit should be directed at an angle of 45° to the glenoid surface. Depth measurement followed by screw fixation of the bone block without tightening (using cannulated 3.7-mm or 4.5-mm screws). The level of the screw heads is checked to avoid protrusion into the joint. Capsular interposition with the previously inserted suture anchors, so that the bone block is then definitely fixed extra-articular with the already placed screws (Fig. 4.43).

4.8.5 Postoperative Management

- Positioning of the arm in an arm sling
- Monitoring of peripheral circulation, motor and sensory innervation
- Postoperative X-ray/CT evaluation.

4.8.6 Follow-Up Management

Immobilization of the shoulder in a sling for 6 weeks. The range of motion in the 1st–3rd weeks is restricted to 45° abduction and flexion, 80° internal rotation and 30° external rotation, in the 4th–6th week the range is increased to 90° abduction and flexion, 80° internal rotation and 0° external rotation. From the 7th week free range of motion. Sport specific training is started after 3 months, overhead sports not allowed earlier than 6th months postoperatively.

4.8.7 Tips & Tricks

Cannulated screws are often not sufficiently stable, alternatively 4.5-mm malleolar screws could be used.

It is important that the coracoid bone block is placed flush to the level of the glenoid articular surface and shouldn't be placed too far laterally or medially. If the coracoid block is prominent after fixation, it can be further resected with a burr.

Arthroscopic techniques for coracoid transfer are described, however, these are very challenging and therefore should be restricted to the experienced surgeon.

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