1 Shoulder Instability Repair: Why It Fails

Emilio Calvo, Gia Rodriguez-Vaquero, and David Haeni

1.1 Introduction

The glenohumeral (GH) joint is the least constrained joint in the body and allows a wide range of motion (ROM). On the other hand, it is more susceptible to high rates of instability. In the United States, the incidence of shoulder dislocations is 23 per 100,000 person-years, with the highest rates in adults in their 20s [1]. Anterior shoulder instability is the most frequent, and it is estimated that it affects 1.7% of the population. Current surgical techniques treating anterior shoulder instability are classified in soft tissue and bone augmentation procedures [2]. In the past, the open Bankart repair was considered the "gold standard," obtaining satisfactory surgical results since its first description [3]. Concerns regarding this technique were related to the extensive non-sparing subscapularis approach, immediate postoperative pain, loss of external rotation, and secondary osteoarthritis [4]. With the advent of new techniques and the development of new implants, the arthroscopic Bankart repair showed similar recurrence rates and functional outcomes than the open technique [5, 6]. Despite these results, reported recurrence rates after open or arthroscopic Bankart repair ranges between 5% and 15% [7, 8]. Bone augmentation procedures are usually preferred in young and active patients with recurrent shoulder dislocation in the presence of bone loss (Hill-Sachs lesions and/or bony Bankart) [9]. Recently, a prospective multicenter study found that the Latarjet procedure (open or arthroscopic) improves significantly shoulder function [10].

The main complication after surgical shoulder stabilization (whether open or arthroscopic) is recurrent instability. Revision instability surgery is usually a challenge, and patients with postoperative shoulder instability should be carefully evaluated not only to diagnose the failure but also to clearly identify the underlying causes that determined the outcome and to establish a successful therapeutic strategy [7, 8]. Careful preoperative evaluation is critical for the selection of the best treatment. The clinician must collect detailed information about the cause of the instability, the number and frequency of

E. Calvo (✉)
Shoulder and Elbow Reconstructive Surgery Unit, Department of Orthopedic Surgery and Traumatology, Fundacion Jimenez Diaz, Universidad Autónoma, Madrid, Spain
e-mail: ecalvo@fjd.es

G. Rodriguez-Vaquero
Upper Extremity Surgery Unit, Department of Orthopedic Surgery and Traumatology, Hospital General de Villalba, Madrid, Spain
e-mail: gia.rodriguez@fjd.es

D. Haeni
Shoulder and Elbow Surgery Unit, LEONARDO, Hirslanden Klinik Birshof, Basel, Switzerland

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episodes, the degree of trauma necessary for recurrence, the arm position at the time of the initial injury, and the arm position that provokes symptoms [11].

Any patient with surgical treatment failure after shoulder stabilization can be classified in at least one of the following groups (Table 1.1). The first group is composed of patients in whom the problem was misdiagnosed, either because surgery was not indicated (i.e., voluntary instability), because the specific joint abnormalities to be corrected at surgery were not precisely identified, or because the direction of instability was not adequately understood (i.e., patients with multidirectional instability treated only for anterior instability). Patient-related risk factors may also increase the risk of postoperative recurrence and should be taken into account in the decision-making process in order to offer the best surgical treatment for every patient. Another group of subjects includes properly diagnosed patients in whom the treatment was inadequate, in terms of procedure selection or technical execution. Obviously, there could also be patients with combined misdiagnosis and inadequate treatment leading to surgical treatment failure. The last group includes those patients that were properly diagnosed, and in whom joint abnormalities were recognized and corrected with the optimal procedure, but who suffered a new trauma causing postoperative dislocation or subluxation [12, 13].

Table 1.1 Causes of failure of anterior shoulder stabilization

Misdiagnosis
– Surgical treatment not indicated
– Anatomical abnormalities not identified
– Direction of instability
Patient-related risk factors
– Age, sex
– Number of dislocation
– Type of sport
– Concomitant/trigger disease: Epilepsy, Ehlers-Danlos disease
Surgery-related risk factors
– Technical errors
– Inadequate treatment
– Implant failure: Anchor or graft related
Trauma after surgery
Unknown causes

1.1.1 Misdiagnosis

In order to properly address failed surgical treatment, it is essential first to clearly identify if surgery was indicated. Voluntary GH dislocation tends to occur in the young adult, and it is sometimes related to emotional and psychological problems. Huber et al. showed that voluntary subluxation in the childhood shows usually a favorable long-term outcome with conservative treatment and that is not associated with osteoarthritis [14]. Therefore, recurrent postoperative instability in this setting should be managed conservatively with physical therapy.

Once voluntary instability is ruled out, and considering that instability interferes with patient's activities, the most challenging issue is identifying which is the suitable surgical technique for each patient. For this purpose, it is crucial to recognize the direction of the instability, as well as the abnormalities responsible for recurrence to be addressed. Zabinski et al. [15] reported the comparative results of revision instability surgery in two groups of patients diagnosed of anterior and multidirectional instability, respectively. They found that persistent Bankart lesions were less common and the presence of hyperlaxity was almost constant in those diagnosed of multidirectional instability and concluded that while revision shoulder stabilization is a reliable procedure for patients who have recurrent anterior instability, it is unpredictable in patients who have multidirectional instability with surgical failure and reoperation occurring frequently.

Clinical history and meticulous physical examination allow identifying the direction of the instability, providing evidence about the possible causes of failure and potential associated lesions [16]. Physical examination should be performed always comparing the index shoulder to the contralateral side. The degree of instability (dislocation, subluxations, or apprehension) is also important information. The apprehension test is performed with the arm hold at 0°–90°–140° abduction and is considered positive for anterior instability if the patient fears subluxation/dislocation or feels high discomfort during the maneuver. The sulcus sign is considered positive if during inferior traction of the shoulder held in neutral position a "sulcus" between acromion and humeral head is appreciated. A positive painful jerk test suggests postero-inferior labrum tear and a surgical repair should be discussed with the patient [17].

Examination under anesthesia before any revision surgery can be useful since it may overcome the clinical examination limitation due to patient's apprehension. Mechanical symptoms, such as catching or locking, may suggest a displaced labral tear, a loose body, or a large osseous defect that is engaging. Instability that occurs in the midrange of motion or during the sleep may indicate an osseous defect. Decreased ROM may be secondary to postoperative stiffness, chondrolysis, GH osteoarthritis, or excessive tension of the capsulolabral ligamentous complex. Loss of strength could be related to rotator cuff tear or neurological injury. Accurate rotator cuff testing should be performed, especially with regard to subscapularis muscle function in patients with previous open surgery. Sachs et al. [18] found that 23% of the patients undergoing open Bankart repair had a deficient subscapularis function and only 57% of them obtained good or excellent results after revision surgery.

Conventional radiography (CR) represents the first level of investigation in postoperative shoulder instability and should include outlet view, "true" anteroposterior view, and the axillary view. With the axillary view, we can evaluate anterior or posterior humeral head subluxation and the state bone graft healing.

Magnetic resonance imaging (MRI) with intra-articular contrast medium (MR arthrography, MRA) can be used both in presurgical and postsurgical care for shoulder instability giving a good assessment of capsulolabral-ligamentous complex and to evaluate postoperative recurrence or complication. MRA identifies soft tissue injuries, rotator cuff tears, humeral avulsion of the glenohumeral ligament (HAGL) lesions, capsulolabral lesions, chondral lesions, and laxity or rupture of the joint capsule better than standard MRI [19]. MRA in abduction and external rotation (ABER) position is useful to identify patients with atraumatic multidirectional instability. The presence of a layer of contrast medium between the humeral head and the anteroinferior glenohumeral ligament (AIGHL) (crescent sign) combined with a triangular-shaped space between the humeral head, AIGHL, and glenoid (triangle sign) has a sensitivity of 86% and specificity of 94% in diagnosing MDI [20].

Computed tomography (CT) can be used for bone evaluation and in cases in which CR does not give enough information about devices positioning. CT arthrography (CTA) is a valid alternative to MRA when susceptibility artifacts are present.

1.1.2 Patient-Related Failure

Several studies have attempted to establish the prognostic factors that may increase the risk of postoperative recurrence following surgical stabilization. Young age and participation in risk activities were identified as major prognostic factors in all of them in addition to the presence of bone defects [21–25]. Age at the first dislocation and male gender have been strongly correlated with a significantly higher risk of recurrent instability after a first dislocation, approaching 80% [21, 26]. Coherently to that, young male patients are more prone to recurrence after primary stabilization [11]. In a study of over 5900 patients, those younger than 20 years had a 12.6% risk of postoperative dislocation and a 7.7% revision rate after primary stabilization, compared to 5.5% and 2.8%, respectively, in patients older than 29 years of age [14]. When compared to adults, young patients usually have higher activity level, more compliant tissue, and decreased muscle bulk. Ninety percent of patients with recurrent dislocations after arthroscopic repair are male [16, 17].

The number of dislocations before stabilization, in addition to the number of previous surgeries, negatively correlates with postsurgical success [27]. Wasserstein et al. [26] found that patients with three or more dislocations had double the risk for revision surgery and ten times the risk of re-dislocating. Patients with more than one stabilization procedure trended toward lower functional outcomes and less overall satisfaction [28]. These results are likely related to progressive damage tissue.

Collision athletes and contact overhead athletes are more frequently subject to higher energy trauma that can lead to shoulder dislocation and other injuries. In addition, postoperative return to collision sports is associated to a higher risk of new trauma and re-dislocation. Cho et al. [29] and Rhee et al. [30] reported higher instability recurrence rate in active athletes (17.2%) after arthroscopic Bankart repair. Even higher rates are reported in patients who practice collision sports (25–28%). Uhorchak et al. [31] reported outcomes of open Bankart repair, and they found a recurrence of 12% in collision and contact sports athletes. Castagna et al. [32] analyzed the effectiveness of arthroscopic Bankart repair in adolescent athletes who practiced overhead or contact sports at competitive level and reported higher recurrence rate in very high-energy contact sports (rugby) and in high-energy contact sports associated with overhead position of the arm (water polo). Other authors associated contact sports with higher risk of recurrence, but it does not seem to be a contraindication for arthroscopic Bankart repair [33, 34].

Calvo et al. [21] evaluated prospectively 61 patients treated arthroscopically with Bankart repair for recurrent anterior shoulder instability. They developed a risk score for failure of arthroscopic Bankart repair based upon an analysis of the factors that may determine the outcomes (level of satisfaction and degree of stability). Age younger than 28 years, ligamentous laxity, the presence of a fracture of the glenoid rim involving more than 15% of the articular surface, and postoperative participation in contact or overhead sports were associated with a higher risk of recurrence and scored 1, 1.5, and 1 point, respectively. Those patients with a total score of two or more points had a relative risk of recurrence of 43% and should be treated by open surgery. Later, Balg et al. [22] developed the instability severity index score (ISIS) to predict the success of arthroscopic Bankart repair. The ISIS score ranges from 0 to 10, with higher scores predicting a higher risk of recurrence after stabilization. Six risk factors are considered that can predict a higher recurrence rate: age at the surgery (over or below 20), degree and type of preoperative sport, hyperlaxity, and bone loss studied on CR.

Epileptic seizures can cause shoulder dislocation and instability, but these patients follow a characteristic pattern of instability with peculiar structural lesions. Bühler and Gerber [35] studied 34 shoulders in which initial dislocation had been caused by an epileptic seizure. Fifty percent of them had anterior instability and 50% posterior instability. They also found a higher recurrence rate for anterior instability comparing with posterior instability (47 versus 12%) after primary repair. Most of them were associated to poor control of epilepsy disease. Thangarajah et al. [36] followed up 49 patients with recurrent instability with epilepsy for 15 years: 73% of them showed anterior instability, 15% posterior, and 10% multidirectional instability. Eighty percent of all patients showed bone loss. They identified bone loss and persistent postoperative epileptic seizures as the principal factors for recurrent instability. Epileptic medical control and bone block procedure are associated with lower rate of recurrence.

1.1.3 Inadequate Treatment: Anatomic Abnormalities and Technique of Stabilization

Shoulder stabilization surgery should be tailored to the patient and to the specific abnormalities existing in the shoulder. In a cohort of 32 patients surgically revised for recurrent anterior dislocation of the shoulder after surgical repair, Rowe et al. [37] found that an abnormality that had not been adequately addressed and explaining the recurrence could be identified in more than 85% of the patients with postoperative shoulder instability. Moreover, Meeham and Petersen [12] proved in a similar investigation that in almost half of the cases there is more than one lesion. Therefore, in revision instability surgery, it is crucial to study and identify the specific anatomic abnormalities responsible for the poor outcome. The most frequent abnormalities that can lead to shoulder instability surgery failure are the presence of non-repaired or medially repaired Bankart lesion (Fig. 1.1), poor capsulolabral tissue (Fig. 1.2) or hyperlaxity, and unaddressed bone defects (either on the glenoid or the humeral side) [12, 15, 37, 38].

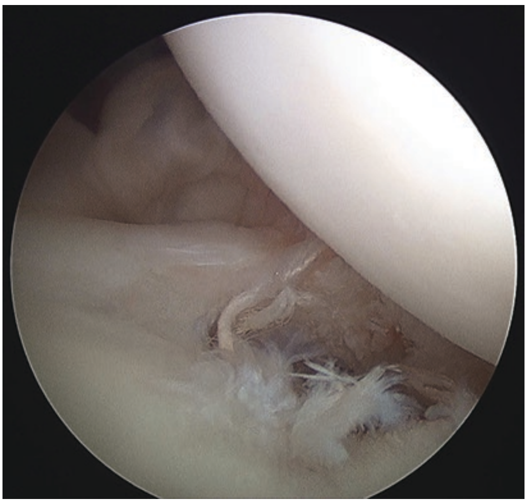

Fig. 1.1 Left shoulder. Arthroscopic view from the posterior portal: medially repaired Bankart lesion

Insufficient labral detachment followed by anatomic re-fixation of a medially healed labrum after multiple episodes of recurrence is probably the most common error during Bankart repair. Anterior labro-ligamentous periosteal sleeve avulsion (ALPSA) lesions have been identified as a risk factor for recurrence comparing with isolated Bankart lesion [27, 39] (Fig. 1.3). This lesion is present more frequently in patients with high number of dislocations. The reason of recurrence after repair may be related to the poor quality of capsulolabral tissue, due to progressive damage. Underestimation of HAGL lesions is also responsible for persistent postoperative instability (Fig. 1.4). A high index of suspicion is necessary to identify and repair this lesion, which can appear in 9% of anterior instability cases [40, 41]. Cases of first-time shoulder dislocation without Bankart lesion and no multidirectional laxity can show a high incidence of HAGL lesions [42].

Poorly positioned anchors have also been associated with recurrence of instability [43]. The number of suture anchors used for primary arthroscopic Bankart repair plays also an important role in the recurrence rate, and three or more anchors are usually recommended in most common cases of anterior shoulder instability [27, 44, 45]. With regard to the type of anchors, data showed no difference in recurrence rate between

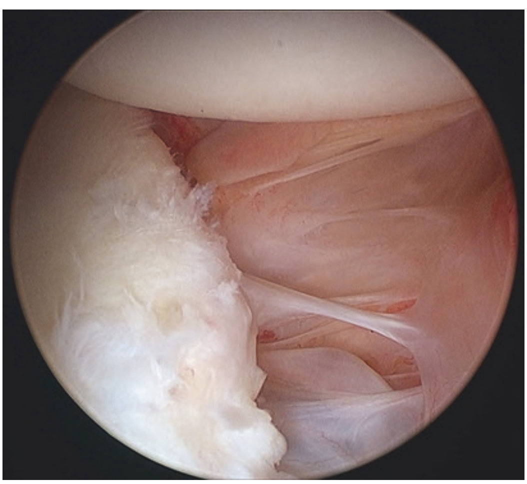

Fig. 1.2 Left shoulder. Arthroscopic view from the anterosuperior portal: poor capsulolabral tissue

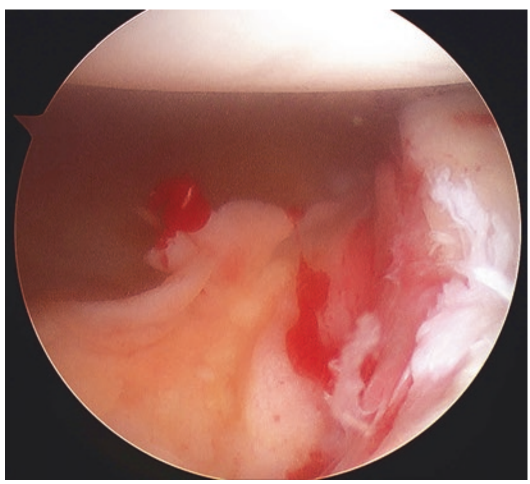

Fig. 1.3 Right shoulder. Arthroscopic view from the anterosuperior portal: ALPSA lesion

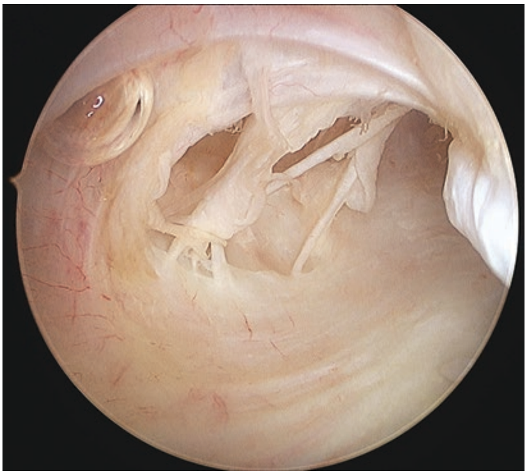

Fig. 1.4 Right shoulder. Arthroscopic view from the posterior portal: HAGL lesion

metal or biodegradable devices [46]. However, a significant difference was found between patients in whom knot-tying and knotless suture anchors were used, with higher rate of recurrence using knotless anchors [47].

One of the most commonly known mistakes includes failure to recognize and address capsular laxity during arthroscopic repair [12, 15, 37, 38]. Hyperlaxity and instability may be coexisting conditions. The difference between instability and hyperlaxity needs to be assessed preoperatively and influences the therapeutic decision. After multiple shoulder dislocations, anterior capsular tissue may be stretched and becomes redundant [12, 28]. Bigliani et al. [48] demonstrated that anterior capsular stretching can occur with or without labral detachment. Rowe et al. [37] showed that 83% of patients with recurrent dislocations after surgical repair had significant capsular laxity.

It is known that the recurrence of instability is significantly higher in patients with anterior glenoid bone defects [21, 23]. Imaging studies are essential for the evaluation of patients with recurrent instability, since it allows the identification and quantification of glenoid bone loss and other possible articular abnormalities. While CR is considered important for bone loss assessment and many different radiographic views have been proposed, CT scan is considered the ideal method to quantify both glenoid and humeral head bone defects. Several authors [49–51] described the glenoid osseous defect as being located anteriorly at approximately the 3 o'clock position (in the right shoulder) and extending toward inferiorly. 3D CT scan with humeral head subtraction facilitates quantification of glenoid bone defect related to the total area and depth of the defect. Glenoid bone defect over 20% have been strongly associated with high risk of recurrence of instability after Bankart repair [45, 52], but Calvo et al. [21] demonstrated that a glenoid bone defect involving 15% of the articular surface represented a higher risk of postoperative failure. Yamamoto et al. [53] introduced the concept of the "glenoid track" determining whether a bipolar lesion was significant. The "glenoid track" concept offers the surgeon the possibility to predict engagement, based on size and morphology lesions [49]. The critical size of a Hill-Sachs lesion is thought to be a volume over 250 mm^3, defined as "large Hill-Sachs lesion" [54]. Recent clinical evidence supports the "on-track" versus "off-track" model in predicting failure of isolated Bankart repair in shoulders with bipolar bone loss [55, 56].

Bone augmentation procedures are preferred to address bone defects, and Latarjet is regarded as the gold standard technique for this condition [57, 58]. Walch et al. [9] conducted a study of 68 shoulders after open Latarjet and reported a recurrence rate of 5.9% after a mean 20-year follow-up. Young and Rockwood [59] studied a population of 39 patients with painful instability after shoulder stabilization performed with an open Bristow procedure and attributed the recurrences to the presence of capsular redundancy in 23 (59%) cases. Other investigations have also found labral defects and capsular elongation at arthroscopic revision of recurrent instability in patients previously operated with bone block procedures [60, 61]. Arthroscopic examination was considered extremely useful in identifying these abnormalities, and labral re-fixation with capsular plication was recommended to stabilize the shoulder [61]. However, other authors have attributed postoperative instability after Latarjet to complications related to the coracoid graft, either due to malposition, malunion, or nonunion [62]. Gasbarro et al. [63] analyzed the reasons for failure after coracoid transfer procedures in a cohort of 83 patients and considered too inferior or too medial graft placement to be a risk factor for recurrence, as well as single screw fixation of the coracoid graft. Nonunion is a well-known complication after Latarjet procedure that can involve over 9% of the patients, but it has not been clearly associated with a higher risk of recurrence [64]. The coracoid graft can also show osteolysis at its upper half, but this complication does not seem to be correlated with postoperative recurrence either [65–67].

Eden-Hybinette, either open or arthroscopic, has been regarded as the elective technique for failed Latarjet, especially in patients with bone defects [68, 69]. Lunn et al. [70] reported the first series of the Eden-Hybinette revision procedure in a cohort of 46 patients with failed Latarjet and found different risk factors for recurrence such as malposition, lysis, or avulsion of the coracoid graft. Interestingly, the authors identified that ligamentous laxity was present in 14 patients and for the first time incriminated subscapularis weakness as a reason for failure 10 patients (5 patients had a complete rupture of the subscapularis tendon). Calvo et al. [71] reported a series of 11 patients who underwent revision surgery for recurrent instability after Latarjet stabilization. The technique used was based on the specific anatomic abnormalities found at arthroscopy: the coracoid graft inadequately positioned was repositioned with open surgery in three cases; extraarticular capsular reinforcement was performed in four shoulders that showed hyperlaxity or poor capsulolabral tissue and no severe bone defect, while arthroscopic Eden-Hybinette was used in four shoulders with humeral or glenoid bone defects and a nonviable coracoid graft.

Boileau et al. [44] pointed out the role of certain Hill-Sachs defects in the recurrence following surgical stabilization. Recently, Locher et al. [72] assessed the impact of "off-track" Hill-Sachs lesions in a study of 254 patients with anterior instability managed with a Bankart repair. The authors demonstrated that Hill-Sachs "off-track" lesions constitute an important risk factor for recurrence of instability after arthroscopic Bankart repair and need of revision surgery compared to "on-track" defects. "Remplissage" is regarded as the procedure of choice for those patients with "off-track" defects, albeit Latarjet procedure could be a valid alterative in shoulders with "off-track" Hill-Sachs lesions by increasing the articular surface area. However, Millet et al. [11] demonstrated that the presence of "off-track" Hill-Sachs lesions increases the risk for persistent engagement after surgery also after stabilization with the Latarjet technique.

Based on the few comparative studies reported, there is no evidence on the superiority of open or arthroscopic stabilization in terms of recurrence, and the fact that arthroscopic stabilization represents an independent risk for recurrence cannot be sustained. Mohtadi et al. [73] carried out a prospective study of 196 patients randomized to undergo open or arthroscopic soft tissue stabilization and concluded that although there were no differences concerning postoperative quality of life, the recurrence rate was superior after arthroscopic surgery. However, Fabbriciani et al. [74], in a study with a similar design, failed to find differences between the two therapeutic approaches and noticed that the group treated arthroscopically showed superior postoperative mobility over the open group. Moreover, Archetti Netto et al. [75] reported lower failure rates, higher mobility, and fewer complications after arthroscopic Bankart stabilization. With regard to coracoid transfer procedures, there are not published studies on the superiority of the arthroscopic versus the traditional open approach. Arthroscopic surgery is very helpful in identifying articular abnormalities to be amended, and arthroscopic revision stabilization provides satisfactory results [62]. The technique allows direct visualization of the pathology that may be responsible for recurrence, including unexpected causes that can be corrected during the same procedure, such as loose bodies, rotator cuff tears, or chondral lesions [76, 77].

1.1.4 New Trauma

Traumatic injuries to the surgically repaired shoulder are one of the biggest contributors to recurrence. As the majority of those affected are young with initial injuries often due to athletic activities, return to collision sport or overhead throwing sports predisposes this population to reinjury. Tauber et al. [38] reviewed 41 patients and found that 85% of initial shoulder dislocations and 59% of re-dislocations after surgical stabilization were traumatic.

Conclusion

Key factors for successful surgical shoulder stabilization are adequate patient selection, precise surgical technique selection and fulfillment, identification and correction of all joint abnormalities, and integration of patient and surgeon expectations. For this purpose, we must be able to correctly answer the following questions: what are the characteristics of the patient? Which shoulder injuries should be treated? Did the patient have a new trauma responsible for recurrence? Despite all known risk factors for recurrence of instability, there are cases in which it is not possible to establish the cause of primary repair failure.

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