Shoulder Instability

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Seung-Ho Kim

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Abstract

Traumatic anterior instability is the most common instability of the shoulder. Although Bankart and Hill-Sachs lesions are the most common pathology, capsulolabral tear can develop in other areas of the joint. While controversy remains regarding the initial first-time instability, early surgical stabilization is strongly recommended in active young patients who have a substantial high risk of recurrence. Currently, arthroscopic repair is a popular procedure and provides successful results. Suture anchors, especially bioabsorbable suture anchors, are most commonly used for capsulolabral repairs. A large bone loss at the glenoid or humeral head can be replaced with a bone graft. Distinct from multidirectional hyperlaxity, which is characterized by asymptomatic translation, multidirectional instability has symptoms related to increased translations. In asymptomatic multidirectional hyperlaxity, the increased capsular ligamentous laxity is the underlying initial pathology. However, repetitive subluxation overloads the posteroinferior glenoid labrum by excessive rim-loading of the humeral head. This excessive rim-loading eventually develops a posteroinferior labral lesion, which is an essential lesion that develops shoulder symptoms. During this stage, the shoulder pain originates from the labral lesion when the humeral head glides over the pathologic labrum. Four types of labral lesion have been reported. Kim's lesion is a concealed and incomplete tear

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of the posteroinferior labrum characterized by loss of labral height and retroversion, marginal crack, and looseness of the deep portion of the labrum. The retroversion of the glenoid labrum decreases the containment function of the glenohumeral joint, which further increases the instability.

Introduction

Instability of the shoulder joint is one of the most historic of all orthopedic diseases. It was described long ago in the Edwin Smith Papyrus and later in the descriptions of Hippocrates. A variety of methods for treating shoulder instability had been developed for acute dislocation and recurrent instability. However, much time passed, including a long plateau of uncertainty, before the modern trends of treatment methods were finally reached. Improvement in the understanding of the anatomy, biomechanics, and pathology of shoulder instability as well as advances in technology have changed operative and non-operative methods of its treatment. In this chapter, the latest knowledge in treating the shoulder instability is discussed, including its pathology, diagnosis, and operative and non-operative treatments.

It is of importance for surgeons to distinguish between laxity and instability. Laxity of the shoulder is a condition of looseness of the joint; it is most often present from birth and is not pathologic by itself. A person who has lax shoulder also demonstrates laxity in other areas of joint such as ankle, knee, and elbow joints. No matter how lax the shoulder joint is, it is not a disease that requires intensive treatment. At worst, the laxity of the shoulder can be a potential cause of development of instability in the future. However, shoulder instability is a disease and defined as symptomatic laxity of the shoulder. To diagnose shoulder instability, patients should have symptoms, usually shoulder pain in at least one direction of the laxity.

Although a person who has laxity of the shoulder may have a subtle shoulder symptom such as easy fatigability while performing heavy work or an unfamiliar activity, this symptom is not a true shoulder pain related to the underlying pathology of the instability. This condition can be easily managed with rehabilitation focusing on strengthening and balancing the musculature around the shoulder joint. Therefore, it is very important when evaluating patients to examine both the degree of laxity of the shoulder as well as to test whether the laxity is related to the shoulder symptom. For example, anterior and posterior translation tests are measures of laxity of the shoulder anteriorly and posteriorly, while the anterior apprehension and jerk test are measures of instability that evaluate symptoms related to the laxity of the shoulder joint.

One cause of confusion when classifying instability is a patient who demonstrates multidirection shoulder laxity and a traumatic anterior instability pattern. The patient may have a grade 3 sulcus sign, increased anterior and posterior translation, and positive anterior apprehension and relocation tests in the physical examination. The Hill-Sachs lesion or Bankart lesion will appear on radiographic examination. This patient can reasonably be classified as having traumatic anterior instability with multidirectional laxity as long as they do not have pain or symptoms in anywhere other than the anterior direction of the shoulder.

Traumatic Anterior Instability

Traumatic anterior dislocation is the most common form of injury in the shoulder. It accounts for about 96 % of all shoulder instability. Traumatic anterior dislocation is most commonly characterized as having Bankart and Hill-Sachs lesions. Although the Bankart lesion, which is tearing of the anterior labrum from the glenoid, is the most common form of failure of the anterior stabilizing structure in traumatic anterior dislocation, the failure can be at any area of the attachment of the inferior glenohumeral ligament. Recent studies suggest failure of the anterior stabilizing ligamentous structure alone is insufficient to simulate anterior dislocation in the cadaveric model; rather, division of the entire circumferential joint capsule resulted in a significant anterior instability. Similarly, many patients who demonstrate classic traumatic anterior instability have not only a

Bankart lesion but also capsular tearing, either in the anterior or posterior humeral insertional areas.

There is some controversy regarding the treatment of acute traumatic anterior instability. Generally, the natural course of the initial dislocation depends on the age at the initial episode of instability. Robinson et al. (2006) performed a prospective cohort study of 252 patients who sustained an anterior glenohumeral dislocation and were treated with sling immobilization followed by a physical therapy program. On survival analysis, instability developed in 55.7 % of the shoulders within the first 2 years after the primary dislocation and increased to 66.8 % by the fifth year. The younger male patients were most at risk of instability, and 86.7 % of all of the patients known to have recurrent instability had this complication develop within the first 2 years. A small but measurable degree of functional impairment was present 2 years after the initial dislocation in most patients. The authors concluded that recurrent instability and deficits of shoulder function are common after primary non-operative treatment of an anterior shoulder dislocation. There is substantial variation in the risk of instability, with younger males having the highest risk and females having a much lower risk.

It was believed that immobilization after the reduction of initial dislocation does not substantially decrease the risk of recurrent instability. However, recent studies suggest that immobilization of external rotation can reduce the risk of recurrence of the anterior instability. Itoi et al. (2007) determined the benefit of immobilization in external rotation in a randomized controlled trial. One hundred and ninety-eight patients with an initial anterior dislocation of the shoulder were randomly assigned to be treated with immobilization in either internal rotation (94 shoulders) or external rotation (104 shoulders) for 3 weeks. The follow-up rate was 74 (79 %) of 94 in the internal rotation group and 85 (82 %) of 104 in the external rotation group. In a minimum follow-up period of 2 years, the intention-to-treat analysis revealed that the recurrence rate in the external rotation group (22 of 85; 26 %) was significantly lower than that in the internal rotation group (31 of 74; 42 %) ($p = 0.033$), with a relative risk reduction of 38.2 %. In the subgroup of patients who were 30 years of age or younger, the relative risk reduction was 46.1 %. The authors concluded that immobilization in external rotation after an initial shoulder dislocation reduces the risk of recurrence compared with that associated with the conventional method of immobilization in internal rotation. This treatment method appears to be particularly beneficial for patients who are 30 years of age or younger.

The recurrence rate after first-time instability in the dominant arm of young and active male patients is as high as 94 %. Early surgical stabilization is strongly recommended in this group of patients who have a substantially higher risk of recurrence (Arciero et al. 1994; Arciero and Pierre 1995; DeBerardino et al. 1996, 2001; Arciero and Taylor 1998; Bottoni et al. 2002, 2006).

Arciero et al. (1994) undertook a prospective study evaluating non-operative treatment versus arthroscopic Bankart suture repair for acute, initial dislocation of the shoulder in young athletes. Thirty-six athletes with an average age of 20 years were divided into two groups. Group I patients were immobilized for 1 month followed by rehabilitation; they were allowed full activity at 4 months. Group II patients underwent arthroscopic Bankart repair followed by the same protocol as Group I. Group I consisted of 15 athletes. Twelve patients (80 %) developed recurrent instability; 7 of the 12 required open Bankart repair for recurrent instability. Group II consisted of 21 patients: 18 patients (86 %) had no recurrent instability at last follow-up (average 32 months; range 15–45 months) ($p = 0.001$). One patient in Group II has required a subsequent open Bankart repair to treat symptomatic recurrence ($p = 0.005$). In this study, arthroscopic Bankart repair significantly reduced the recurrence rate in young athletes who sustained an acute, initial anterior dislocation of the shoulder.

Surgical treatment of traumatic anterior instability has adapted from the classic open Bankart repair to the modern arthroscopic repair. Compared with the open Bankart repair, early techniques for arthroscopic repair of the Bankart lesion had a higher recurrence rate. However, advances in arthroscopic

techniques and development of instrumentation now allow equivalent or superior outcomes of arthroscopic repair compared with the traditional open Bankart repair. Kim and Ha (2002) compared the results of open and arthroscopic Bankart repair using suture anchors. At an average of 39 months, 26 (86.6 %) of 30 shoulders with the open repair and 54 (91.5 %) of 59 shoulders with arthroscopic repair showed excellent or good results. The arthroscopic group revealed slightly higher Rowe ($p = 0.041$) and UCLA (University of California at Los Angeles) ($p = 0.026$) scores. Two patients (6.7 %) in the open repair group and two (3.4 %) in the arthroscopic repair group experienced at least one episode of redislocation after the surgery. One patient (3.3 %) in the open repair group and four (6.8 %) in the arthroscopic repair group demonstrated mild apprehension. The overall residual instability was 10 % in the open repair group and 10.2 % in the arthroscopic repair group. There were no significant differences in the loss of external rotation and return to prior activity between the two groups ($p > 0.05$). Kim and Ha concluded that arthroscopic suture anchor capsulorrhaphy showed similar results to the open Bankart procedure. (Bottoni et al. 2002, 2006) reported that clinical outcomes after arthroscopic and open stabilization were comparable in a randomized controlled trial.

Current arthroscopic repair of anterior instability utilizes suture anchors and the outcomes are excellent (Kim et al. 2002, 2003a; Carreira et al. 2006; Marquardt et al. 2006; Sedeek et al. 2008). Recently, bioabsorbable suture anchors have become available that have an excellent pullout stability. At the Madi Hospital in Seoul, Korea, this author uses small suture tack-type anchors (3.0 mm Bio-SutureTak®, Arthrex, Naples, FL, USA). The basic principle of the repair includes a complete mobilization of the Bankart lesion from the glenoid, insertion of a suture anchor as inferior as possible, and appropriate balancing of the capsuloligamentous tension. Optimal visualization and approach angle are of importance for the successful arthroscopic repair. In this author and others' experience, a significant number of shoulders with traumatic anterior instability have not only a Bankart lesion but also humeral avulsion of the glenohumeral ligaments (HAGL), posterior HAGL, or capsular tears (Fig. 1; Richards and Burkhart 2004; Mizuno et al. 2005; Kim et al. 2009). Also, many Bankart lesions are extended to the inferior and posterior labrum to form a so-called extended Bankart lesion (Fig. 2). With a standard posterior portal, it is often difficult to properly repair the posterior labral tear in the extended Bankart lesion.

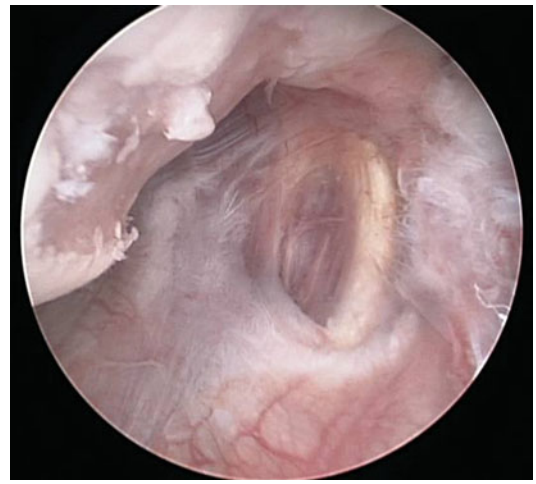

Fig. 1 The posterior humeral avulsion of the glenohumeral ligaments (HAGL) lesion and Hill-Sachs lesion. The posterior capsular attachment is detached from the humeral insertion

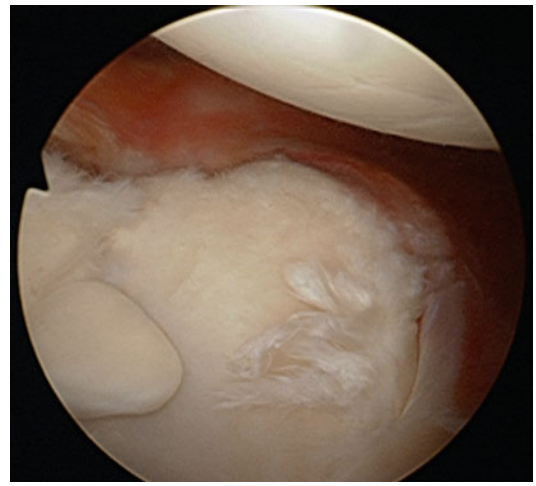

Fig. 2 Extended Bankart lesion. The anterior labral tear extends to inferior and posterior area

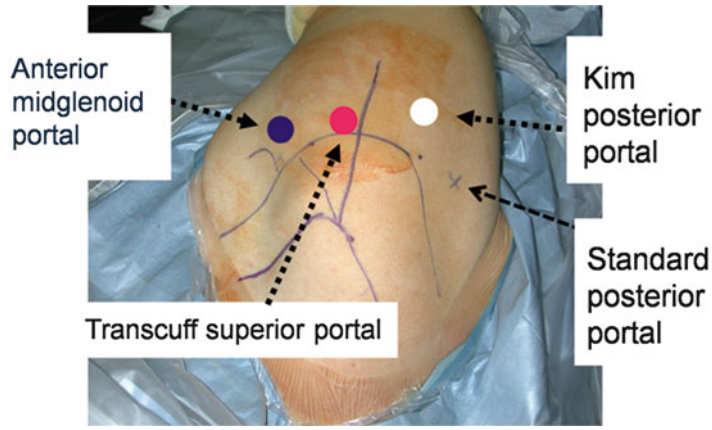

Fig. 3 The triple instability portal. All three portals are located high-riding from the glenoid surface, which allows relatively vertical access to the entire area of the glenoid rim

By placing the posterior portal more anteriorly, visualization and the access angle can be optimized in these situations. The author developed the triple instability portal, which was initially developed for repair of the posterior or posteroinferior multidirectional instability. The triple instability portal is also useful for the traumatic anterior instability with an extended Bankart lesion (Fig. 3).

Bone defects in the glenoid or humeral head predispose to repair failure. The incidence of bone loss ranges from 5.4 % to 78.8 % of patients with anterior instability (Rowe et al. 1978; Bigliani et al. 1998; Burkhart and De Beer 2000; Edwards et al. 2003; Lo et al. 2004). Rowe et al. (1978) reported that open repair had a good result if the bone defect is less than 30 % of the glenoid surface. Itoi et al. 2000 found in a cadaver study that a glenoid defect greater than 21 % of the glenoid results in a significant instability of the soft tissue repair. Burkhart and De Beer reported a 67 % recurrence rate for instability repair in patients with more than 25 % of glenoid defect. An inverted pear shape of the glenoid suggests significant bone loss in the arthroscopic evaluation. Replacement or supplement of the glenoid defect has become more and more popular. The most common bone graft comes from the coracoid process. Recently, a modified Latarjet procedure has been reported to provide excellent outcomes for those with a significant glenoid defect (Fig. 4; Burkhart et al. 2007).

Arthroscopic bone graft for the glenoid defect has been attempted recently (Boileau et al. 2007; Lafosse et al. 2007; Mochizuki et al. 2007). Future studies are needed to evaluate the efficacy of the arthroscopic bone graft in treating the glenoid defect.

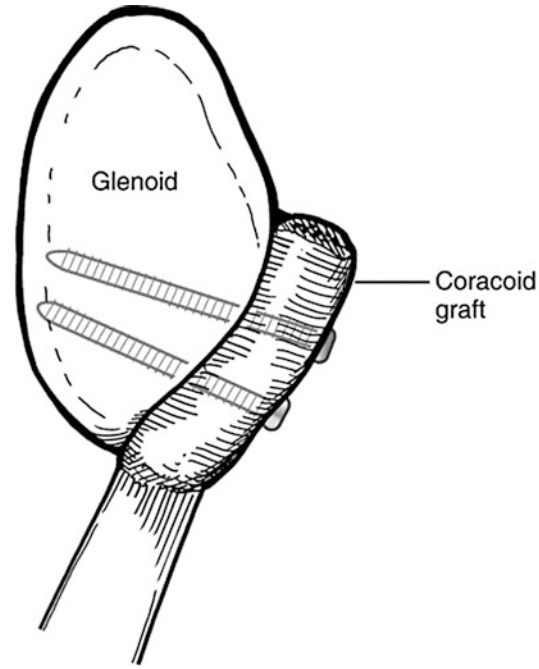

Fig. 4 The modified Latarjet procedure. The coracoid graft restores the width of the glenoid (from Burkhart et al. 2007)

A large humeral head defect such as a Hill-Sachs lesion may also be related to the recurrence of instability or failure of soft tissue repair. The Hill-Sachs defect often engages the glenoid rim, especially when there is also a glenoid defect.

The Hill-Sachs lesion, which is located more medially over the glenoid tract, has a risk of engagement (Yamamoto et al. 2007). Wolf et al. (2007) reported the arthroscopic Remplissage procedure, which includes infraspinatus tenodesis to the Hill-Sachs defect, which was originally described as an open procedure by Connolly (1972). The current author commonly uses posterior capsulodesis to the Hill-Sachs defect using one or two suture anchors, which includes posterior capsule without infraspinatus tendon.

Atraumatic Instability

Atraumatic instability usually presents as posterior or multidirectional instability. There has been no universal agreement in the classification, terminology, and treatment options. The clinical presentation of the atraumatic instability is not as clear as traumatic anterior instability and many patients with posterior instability are easily overlooked or treated under another diagnosis. Recent advances in the concept of posterior instability have provided us reasonable insight into the pathology, pathogenesis, diagnostic examinations, and treatment options. Posterior instability very often presents as bidirectional posteroinferior instability, which has various degrees of inferior components of instability. Also, posterior instability overlaps with multidirectional instability in its diagnosis, clinical presentation, and management.

Pathogenesis

Several anatomic structures have been implicated in the pathogenesis of atraumatic instability, including bony and soft tissue abnormalities. Bony abnormalities include increased humeral retroversion, glenoid retroversion, and glenoid hypoplasia. Although several studies on the glenoid version have focused on the bony glenoid measured, the stability of the glenohumeral joint is an integral function of both bone and soft tissue stabilizer. Lazarus et al. (1996) showed a 65 % decrease in the mechanical stability ratio and an 80 % reduction in the height of the glenoid associated with the creation of an anteroinferior chondrolabral defect. Accordingly, the measurement of the glenoid version would be more ideal when the articular cartilage and labrum are considered as a whole. Soft tissue abnormality of the atraumatic instability has been considered an excessive capsular laxity. However, increased capsular ligamentous laxity alone cannot entirely explain the whole pathogenesis of the atraumatic instability, which often occurs in the mid-range of motion where the capsular ligaments normally become loose.

Kim et al. (2005a) emphasized that loss of chondrolabral containment is a consistent finding in shoulders with atraumatic posteroinferior instability and is principally due to the loss of posterior labral height. Kim et al. (2004a, b, c, 2005a) suggest that the loss of chondrolabral containment is a result of cumulative microtrauma to the posteroinferior glenoid labrum, which initially has normal height and undergoes gradual change to retroversion by the rim-loading mechanism. With the loss of chondrolabral containment, the static restraint loses its function and the dynamic stabilizer of the shoulder becomes less effective in maintaining concavity compression of the glenohumeral joint. Bradley et al. (2006) similarly measured the posterior inferior chondrolabral version and bony glenoid version for each magnetic resonance (MR) arthrography at the inferior one-third of the glenoid rim. In this study, there was increased bony and chondrolabral retroversion in the symptomatic group, which suggests that loss of anatomical containment predisposes to atraumatic instability (Fig. 5).

The concept of chondrolabral lesion in atraumatic instability provides further insight into the cause of symptom development. Although there are two groups of people, one of which is asymptomatic and the other symptomatic, it is interesting to know that the amount of increased translation either in the posterior, inferior, or anterior direction is the same. Also, asymptomatic people often become symptomatic over time. Although the shoulder is loose in all three directions, concurrent production of symptoms is in one

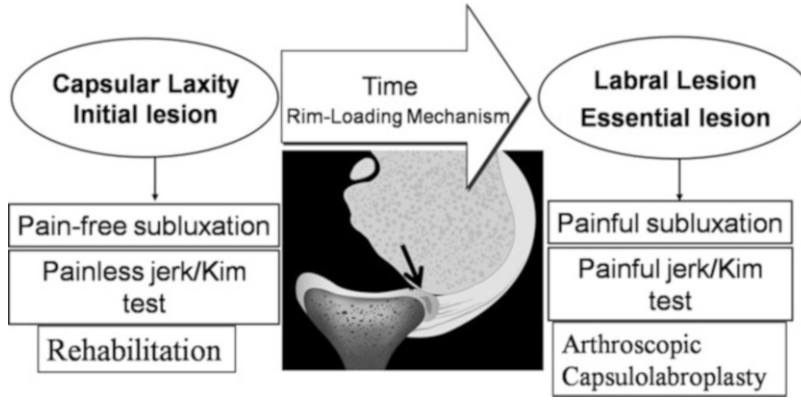

Fig. 5 Capsular laxity is the initial lesion of the posteroinferior instability. Shoulders with capsular laxity are asymptomatic or minimally symptomatic and attempted tests present painless clunk. However, the rim-loading mechanism during the repetitive subluxation eventually develops a posteroinferior labral lesion, which is the essential lesion responsible for the shoulder symptom and painful clunk in the jerk or Kim test

or multiple directions. There is evidence that the amount of translation is not fundamentally different between healthy subjects who have asymptomatic laxity and those who need surgical intervention (Lintner et al. 1996; McFarland et al. 1996). Given these facts, there may be other pathology responsible for the shoulder symptom, rather than just an increased joint volume. The author found that the majority of patients with an asymptomatic jerk test in the posterior instability, represented by a painless posterior clunk, were successfully treated non-operatively. However, patients with a symptomatic jerk test, represented by sharp pain with posterior clunk, did not respond to rehabilitation and invariably had a posteroinferior labral lesion in the arthroscopic finding (Kim et al. 2004c). The author concluded that the jerk test was a hallmark for predicting the failure of non-operative treatment in posteroinferior instability. Shoulders with a painful jerk test have a posteroinferior labral lesion (Kim et al. 2004c).

Kim et al. previously reported that all patients who underwent arthroscopic surgery for posterior instability had a variable degree of labral lesions in the posterior and inferior portion of the glenoid (Kim et al. 2003b, 2004a, b). These labral lesions were classified into four types. Type I labral lesion is an incomplete detachment, in which the posteroinferior labrum is separated from the glenoid margin but not medially displaced. This type is more common in traumatic posterior instability than multidirectional instability. Type II lesion is a marginal crack, so-called Kim's lesion, which is an incomplete and concealed avulsion of posteroinferior labrum. Type III lesion is a chondrolabral erosion, and type IV lesion is a flap tear of the labrum (Fig. 6; Kim et al. 2003b, 2004a, b).

Kim's lesion refers to a superficial tearing between the posteroinferior labrum and the glenoid articular cartilage without a complete detachment of the labrum (marginal crack). The posteroinferior labrum loses its normal height and becomes a flat labrum, with subsequent retroversion of the chondrolabral glenoid. Probing the lesion demonstrates fluctuation of the posteroinferior labrum and reveals a loose attachment. These labral lesions are limited to the posteroinferior quadrant of the glenoid for shoulders with a pure posterior instability, typically present in a 6–9 o'clock position for the right shoulder and 3–6 o'clock position for the left shoulder. However, the lesion is extended to the entire inferior glenoid labrum from 4 or 5–9 o'clock in shoulders with posteroinferior multidirectional instability. When the superficial portion is incised with an arthroscopic knife, for 1–2 mm in depth, the lesion reveals detachment in the deep portion of the labrum from the medial surface of the glenoid (Kim et al. 2003b, 2004a, b). Kim's lesion is quite similar to the intratendinous tear of the rotator cuff tendon, which is often overlooked and unrecognized at the initial arthroscopic evaluation. Therefore, the surgeon's insight into this hidden

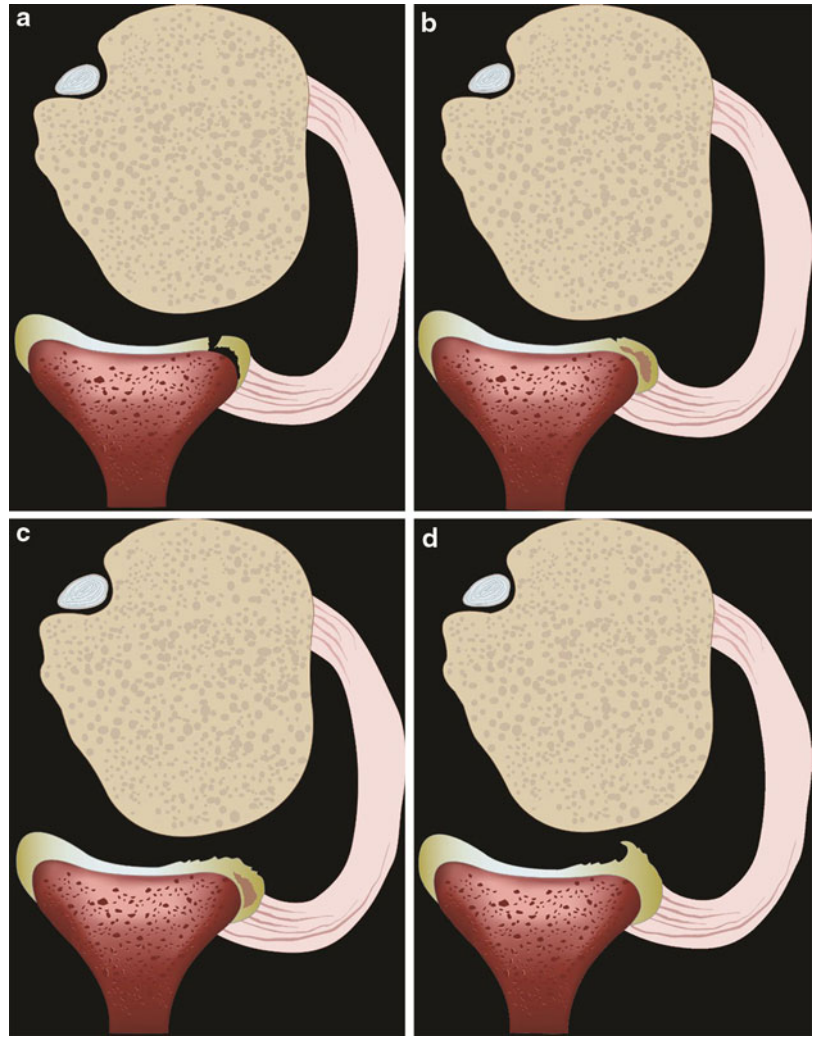

Fig. 6 Diagram of arthroscopic classification of the posterior and inferior labral lesion. (**a**) Type I: incomplete detachment. The posteroinferior labrum is detached from the glenoid but not displaced. (**b**) Type II: marginal crack or Kim's lesion. The labrum has marginal crack and retroversion, and the deep portion is loose. (**c**) Type III: chondrolabral erosion. The labral surface has fraying and the deep portion is loose. (**d**) Type IV: flap tear. The labrum has a flap tear or multiple buck handle tear

lesion is of paramount importance for the diagnosis of the pathology. The four types of labral lesions are a spectrum of severity of the instability. Kim's lesion may, perhaps, over time be converted into type I incomplete detachment when the marginal crack is extended to the deep portion tear.

It is believed that increased translation by the increased capsular laxity is the initial lesion and underlying pathology of the posterior and posteroinferior multidirectional instability. This increased capsular laxity can be in-born or developmental and asymptomatic or minimally symptomatic initially. In this stage, attempted translation does not produce symptoms. Also, jerk and Kim tests reveal posterior clunk without shoulder pain (Kim et al. 2004c, 2005b). However, repetitive subluxation over time overloads the posteroinferior glenoid labrum by the excessive rim-loading of the humeral head. This excessive rim-loading eventually develops a posteroinferior labral lesion varying from simple retroversion to incomplete detachment. During this stage, the patient's symptom, which is shoulder pain, originates from the labral lesion when the humeral head glides over the pathologic labrum. The compressive force on the torn labrum in the jerk and Kim tests generates shoulder pain (Kim et al. 2004c, 2005b). The labral lesion is now the essential lesion responsible for the true shoulder symptom of the posterior and posteroinferior instability. Therefore, an intact

labrum does not produce shoulder pain no matter how lax the glenohumeral joint is. Increased translation alone produces asymptomatic posterior clunk until the repetitive rim-loading eventually develops a posteroinferior labral lesion.

Physical Examination

The shoulder examinations should include both laxity and instability evaluations. Laxity evaluation simply tests how loose the shoulder joint is in anteroposterior and inferior directions. Translations in anterior and posterior direction are tested by the load and shift test. Anteroposterior humeral translation is rated as grade 0 (no translation), grade 1+ (translation less than the margin of glenoid), grade 2+ (translation beyond the margin of glenoid with spontaneous reduction), or grade 3+ (translation beyond the glenoid without spontaneous reduction). Inferior translation is evaluated by the sulcus sign (Neer and Welsh 1977). A downward traction force is applied to the adducted shoulder and the inferior translation of the humerus is measured by estimating the distance between the inferior margin of lateral acromion and the humeral head. 0+ is equivalent to no movement; 1+ is less than 1 cm; 2+ is 1–2 cm; and 3+ is more than 2 cm.

Instability Tests

Instability tests should involve testing for symptoms related to the specific pathology relevant to the posterior instability. The posterior apprehension test may reproduce the patient's symptom but is seldom positive in posterior instability. Two sensitive and specific physical tests are the jerk and Kim tests. Like the McMurray test for evaluation of meniscal injury in the knee joint, the basic principle of the jerk and Kim tests is pain provocation by compressing the labral lesion.

The jerk test has been used for a long time but the significance of the test has recently been validated (Kim et al. 2004c). The jerk test is performed in a sitting position. While stabilizing the patient's scapula with one hand and holding the affected arm at 90° abduction and neutral rotation, the examiner grasps the elbow and axially loads the humerus in a proximal direction. The arm is moved horizontally across the body. A positive result is indicated by a sudden clunk as the humeral head slides off the back of the glenoid. When the arm is returned to the original position, a second jerk may be produced by the humeral head returning to the glenoid (Fig. 7). In this test, firm axial compression is very important. The painless jerk group includes patients with posterior clunk but without any significant pain provocation, while the painful jerk group includes patients who show abrupt pain in accordance with posterior clunk. The author found that painful clunk in the jerk test is invariably associated with structural defect: a posteroinferior labral lesion.

Kim et al. (2004c) reported that the painful jerk group had a higher failure rate with non-operative treatment. In the painless jerk group, 50 shoulders (93 %) responded to the rehabilitation program after a mean of 4 months. Four shoulders (7 %)

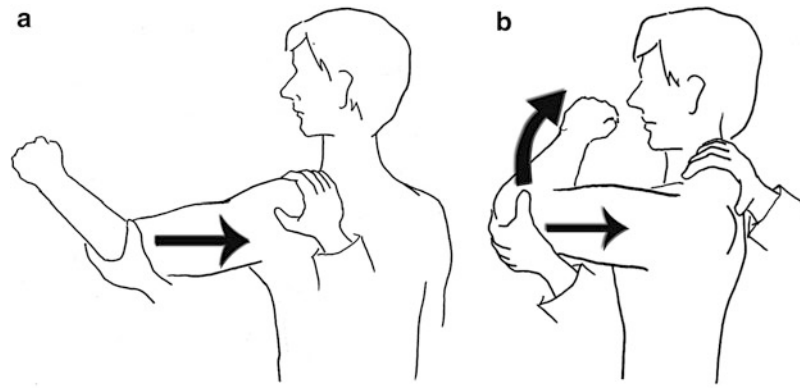

Fig. 7 The jerk test. (**a**) Stabilizing the scapula with one hand, the other hand holds the elbow with the arm in 90° abduction and internal rotation. Firm axial compression force is applied on the glenohumeral joint. (**b**) The arm is horizontally adducted while maintaining the firm axial load

were unresponsive to the rehabilitation. In the painful jerk group, five shoulders (16 %) were successfully treated with rehabilitation, whereas the other 30 shoulders (84 %) failed to respond. All 34 shoulders that were unresponsive to rehabilitation had a variable degree of posteroinferior labral lesions. The jerk test is a hallmark for predicting the prognosis of non-operative treatment for posteroinferior instability. Shoulders with symptomatic posteroinferior instability and a painful jerk test have posteroinferior labral lesions (Kim et al. 2004c). Arthroscopic findings supported that the abrupt pain during the jerk test may be elicited from a rim-loading of the humeral head over the pathologic posteroinferior labral lesion.

Kim et al. (2005b) also developed a new test for the posteroinferior labral lesion in posteroinferior instability. The Kim test is performed in a sitting position with the arm in 90° abduction. With the examiner holding the elbow and lateral aspect of the proximal arm, a simultaneous axial loading force and 45° diagonal elevation is applied on the distal arm, while downward and backward force is applied on the proximal arm. A sudden onset of posterior shoulder pain indicates a positive test regardless of accompanying posterior clunk of the humeral head. During the test, it is important to apply a firm axial compression force on the glenoid surface by the humeral head. Therefore, sitting against the back of a chair rather than a stool provides a good counter-support for the axial loading in the arm being examined (Fig. 8).

The Kim test is more sensitive in the predominant inferior labral lesion, while the jerk test is more sensitive for the predominant posterior labral lesion. Correlation of the symptom with the physical examination is also mandatory in making a diagnosis. Patients with mild shoulder symptoms usually have asymptomatic jerk and Kim tests. The Kim and jerk tests have three components: pain, clunk, and click. Pain without clunk suggests a posterior labral lesion, whereas pain with clunk indicates posterior instability with a labral lesion. Although the Kim and jerk tests are most commonly used to diagnose posteroinferior instability, the test results are also positive for any pathologic posteroinferior labral lesions in other conditions. For instance, a positive Kim test result in a shoulder with proven traumatic anterior instability with a Bankart lesion suggests that the Bankart lesion extends all the way to the posteroinferior aspect of the glenoid. Also, it is worthwhile to note that the Kim test result can be infrequently positive for a labral lesion associated with a rotator cuff tear and that such a labral lesion may be considered insignificant (Kim et al. 2005b).

Radiographic Evaluation

Plane radiographs include an anteroposterior, axillary lateral, and Stryker-Notch view to evaluate any bony abnormality suggesting anterior instability. A Hill-Sachs lesion in the

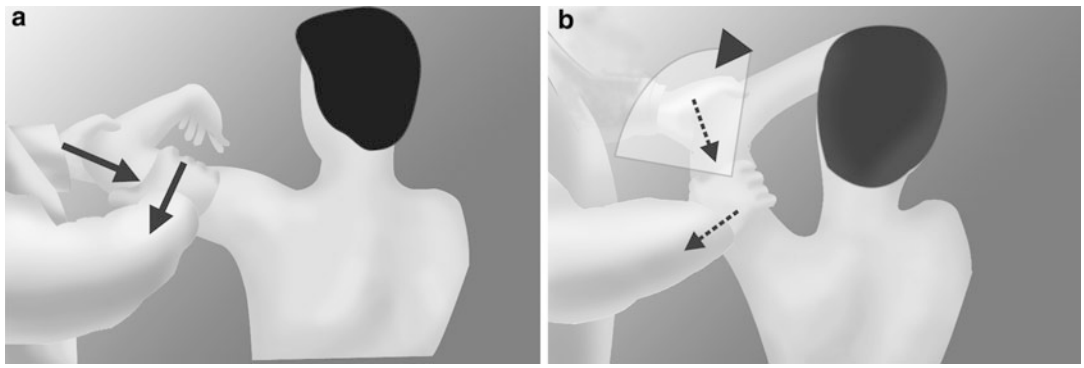

Fig. 8 The Kim test was performed in a sitting position with the arm in 90° abduction. (**a**) With the examiner holding the elbow and lateral aspect of the proximal arm, firm axial loading force is applied. (**b**) Simultaneous 45° diagonal elevation is applied on the distal arm, while downward and backward force is applied on the proximal arm

Table 1 Kim classification of the posteroinferior labral lesion based on arthroscopic findings and magnetic resonance imaging (MRI)-arthrogram

Type	Finding	MRI-arthrogram finding
I	Incomplete stripping	Type I: Separation without displacement
II	Marginal crack	Type II: Incomplete avulsion
III	Chondrolabral erosion	Type III: Loss of contour
IV	Flap tear	Type III: Loss of contour

Stryker-Notch view indicates traumatic anterior instability. Usually, plane radiographs do not provide any useful sign in the posterior instability. Inferior stress anteroposterior radiographs are obtained in the standing position with a 10-lb weight applied downward on both arms (Neer and Foster 1980). Asymmetric inferior translation between both shoulders may suggest superimposed traumatic instability in multidirectional instability. However, the significance of the inferior stress radiograph is unclear and is not indicated for patients with posterior instability.

An MR-arthrogram using intra-articular contrast improves visualization of the labral lesion as well as capsular redundancy on the T1- and T2-weighted axial and coronal images. A high index of suspicion is needed when evaluating the labral lesion noted on an MR-arthrogram as the lesion is often very subtle or negative. Capsular volume is increased in the posterior and axillary recess in the oblique coronal images. A posteroinferior labral lesion can be classified using the classification system of Kim et al. (2003b, 2004a; Table 1). The MR type I lesion is a separation without displacement, type II is incomplete avulsion (cystic lesion), and type III is loss of contour. The surgeon should be aware that the MR finding of the posteroinferior labral lesion is not always distinctive in the posterior instability compared to the anterior labral lesion in the traumatic anterior instability.

Treatment Options

In patients with a painless jerk or Kim test, the initial treatment is supervised rehabilitation including restoration of the scapulothoracic and glenohumeral kinematics. Although strengthening exercises do not decrease hyperlaxity of the shoulder, they improve overall control and function of the shoulder joint. Non-operative treatment consists of extensive rehabilitation including strengthening exercises of the rotator cuff, deltoid, and scapular stabilizer muscles. In the author's experience, young females with hyperlaxity and spontaneous onset of mild symptoms tend to respond well to non-operative treatments. Despite persistent hyperlaxity, these patients show improved symptoms and return to their normal activities.

Operative treatment is indicated in patients with a painful jerk or Kim test, and patients who have failed to respond to non-operative treatments (Kim et al. 2004b, c, 2005b). Historically, open surgical treatment for posterior instability included bony and soft tissue procedures. Bony procedures that address geometric abnormality include rotational osteotomy of the humerus, glenoid osteotomy, or bone block procedures. Soft tissue procedures are the reverse Putti-Platt, reverse Bankart repair, and Boyd-Sisk procedure. Overall, the outcome of the surgical procedures has not been consistent compared to the results for the anterior instability.

In 1980, Neer and Foster introduced a new type of capsular procedure, a laterally based posterior capsular shift to tighten a patulous posterior inferior capsule, which they termed inferior capsular shift (Neer and Foster 1980). Recently, Rhee et al. (2005) reported the outcome of 30 shoulders with the open posterior capsulolabral reconstruction with a posterior deltoid-saving approach in posterior shoulder instability. Posterior capsular redundancy was observed in all cases, but a posteroinferior labral tear was found in only five shoulders. Posterior capsular thinning developed in six patients. The recurrence of instability was observed in four cases, including three of voluntary instability. The overall recurrence rate was 13.3 %, but the success rate was 92.6 % when cases of voluntary instability were excluded. Wolf et al. (2005) recently reported the results of an open posterior capsular shift procedure in 44 shoulders. Recurrence occurred in eight

shoulders (19 %). Of all of the patients, 84 % were satisfied with the current status of their shoulder. No progressive radiographic signs of glenohumeral arthritis were seen up to 22 years after surgery. A limited number of studies have been reported for arthroscopic treatment of posteroinferior instability in the peer-reviewed literature. Duncan and Savoie (1993) reported their preliminary results of ten patients who were treated with arthroscopic modification of the inferior capsular shift procedure. In 1–3 years of follow-up, all patients had satisfactory results according to the Neer system.

Kim et al. (2004b) reported on an arthroscopic procedure for posteroinferior instability, which emphasizes the concept of restoring the loss of the chondrolabral containment and capsular laxity. Arthroscopic capsulolabroplasty was performed in 31 patients with posteroinferior multidirectional instability. All patients had a labral lesion and variable capsular stretching in the posteroinferior aspect. Thirty patients had stable shoulders, and one had recurrent instability. They concluded that symptomatic patients with posteroinferior instability had posteroinferior labral lesions, including retroversion of the posteroinferior labrum, which were previously unrecognized. Restoration of the labral buttress and capsular tension by arthroscopic capsulolabroplasty successfully stabilized shoulders with posteroinferior multidirectional instability.

Provencher et al. (2005) reported the results of 33 patients who received an arthroscopic treatment for posterior shoulder instability. The procedures include posterior arthroscopic shoulder stabilization with suture anchors or suture capsulolabral plication, or both. There were seven treatment failures: four for recurrent instability and three for symptoms of pain. Patients with voluntary instability demonstrated worse outcomes, and those with prior surgery of the shoulder also did worse. More recently, Radkowski et al. (2008) reported on 107 shoulders in 98 athletes with unidirectional posterior shoulder instability who underwent arthroscopic capsulolabral repair or plication. Results for 27 dominant shoulders in throwing athletes (25 %) were compared with those for 80 shoulders in non-throwing athletes (75 %). Throwing athletes were less likely to return to their pre-injury levels of sport (55 %) than non-throwing athletes (71 %). There were a higher percentage of patients with atraumatic onset of injury in the thrower group. This is likely a result of microtrauma from repetitive high stresses placed on the shoulder associated with throwing. Savoie et al. (2008) treated 92 shoulders with a diagnosis of primary posterior instability who failed to respond to 6 months of rehabilitation by operative stabilization. At an average follow-up of 28 months, 97 % of the shoulders were stable. Posterior pathology varied, and a reverse Bankart lesion alone was found 51 % of the time, a stretched posterior capsule 67 % of the time, and a combination of a reverse Bankart lesion and capsular stretching 16 % of the time. The rotator interval was obviously damaged in 61 % of cases.

Operative treatment should not only address the loose joint capsule but also restore the containment function of the glenoid labrum. The arthroscopic capsulolabroplasty procedure includes complete mobilization of the incomplete labral lesion from the glenoid, removal of a rim of articular cartilage and insertion of suture anchors on the surface of glenoid, posteroinferior labroplasty, superior shift of the posteroinferior and anteroinferior capsule, and closure of the Kim posterior portal. During our extended experiences with arthroscopic treatment, we recognized that rotator interval closure is seldom indicated in most posterior instability. The basic rationale of the posteroinferior labroplasty is both restoration of the posteroinferior labral height and capsular tension.

We use a triple instability portal that includes a Kim posterior portal, transcuff superior portal, and midglenoid anterior portal. The Kim posterior portal is placed at least 1 cm anterior from the standard posterior portal. It usually lies about 2–3 cm distal and just anterior to the posterolateral corner of the acromion. The transcuff superior portal is located just posterior to the anterolateral corner of the acromion. The transcuff superior portal trespasses musculotendinous junction of the rotator cuff when a blunt trocher is inserted, and lies far posterior from the biceps tendon when

it is visualized inside. The midglenoid portal is placed just lateral to the coracoids process and lies just superior to the leading edge of the subscapularis tendon. All three portals are high-riding and vertical from the glenoid surface, which allows a proper access angle to the inferior aspect of glenoid.

Conclusion

Traumatic anterior instability has a higher success rate using current arthroscopic procedures, except for in a select group of patients with complicated pathology such as large glenoid or humeral bone loss. A glenoid defect requires a bone graft procedure such as a modified Latarjet procedure while a Hill-Sachs defect needs arthroscopic remplissage or posterior capsulodesis. Atraumatic instability not only has capsular laxity but also a variable degree of labral lesion. The initial pathology is capsular laxity, which gradually develops a labral lesion via a repetitive rim-loading mechanism. Pain comes from the labral lesion. Painful jerk and Kim tests suggest a labral lesion, which requires arthroscopic stabilization. Arthroscopic capsulolabroplasty addresses not only capsular laxity but also labral pathology.

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