Chapter 27

Multidirectional Instability

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Introduction

Multidirectional instability (MDI) of the shoulder lacks a precise definition, and that fact can cause difficulty in evaluating the published results of nonsurgical and surgical treatment. A typical patient with MDI has generalized ligamentous laxity and develops symptomatic laxity in the absence of trauma or as a result of repetitive microtrauma, such as that experienced by an overhead throwing athlete. All patients with MDI have "uncontrollable and involuntary inferior dislocation or subluxation secondary to redundancy of the ligaments and inferior capsule."[1] The direction of instability can be anterior, posterior, or both, and it always includes an inferior component. The question of whether MDI is better treated with rehabilitation or surgery remains unanswered.

Pathoanatomy

A complex balance of static and dynamic stabilizers produces a functional, stable shoulder. Instability is not synonymous with laxity. However, laxity can become symptomatic, and symptomatic laxity is probably the basis of MDI development. Unlike patients with traumatic instability, those with MDI usually do not have a Bankart lesion; instead, capsular patholaxity is present. Some patients with long-standing shoulder instability have secondary labral damage, even if the instability is atraumatic.[2]

The role of the rotator interval in MDI is well established. The rotator interval influences the amount of translation, especially inferiorly and posteriorly; conversely, imbrication of the rotator interval leads to restored inferior and posterior stability when the shoulder is flexed forward.[3] The superior glenohumeral ligament (SGHL) is important in providing stability to inferior-superior translation with the shoulder adducted. The coracohumeral ligament may be less important in providing stability than previously thought.[4]

An assessment of the possible contribution of collagen and elastin to MDI found that collagen from patients with unidirectional instability or MDI differed from that of individuals with a normal capsule, suggesting a possible systemic basis for the generalized ligamentous laxity commonly found in patients with MDI.[5] However, the biopsy samples used in this study were taken from the anterosuperior capsule and did not represent the inferior quadrant.

Loss of negative intra-articular pressure is another possible contributor to the ubiquitous inferior component of MDI. Some authors believe that the greater shoulder volume associated with a symptomatically lax shoulder reduces the negative pressure phenomenon, as in the venting of an intact joint. If negative intra-articular pressure is difficult to maintain, the ability to respond to an inferior load may be compromised. Cadaver studies found that, even after capsular imbrication and despite capsular reduction, simple venting of the capsule can lead to recurrent inferior laxity.[6]

Diminutive labral anatomy may also hinder the compression-concavity phenomenon. In symptomatic patients with a primary posteroinferior instability pattern, MRI studies revealed not only more glenoid retroversion but also a decrease in labral height, which led to diminished glenoid depth.[7]

The role of neuromuscular dysfunction continues to be questioned. Several researchers have linked shoulder instability patterns to neuromuscular dyskinesia involving the scapulothoracic articulation. A study comparing patients with normal shoulders, MDI, or multidirectional laxity discovered differences in muscle-firing patterns in the deltoid and, to a lesser extent, the rotator cuff. The delayed muscle activity and muscle imbalance were believed to contribute to asynchronous, less effective activity of the dynamic shoulder stabilizers.[8] A similar study of isolated anterior instability found activation suppression of the supraspinatus, subscapularis, biceps, and pectoralis major. The authors postulated that compromised dynamic muscular function could contribute to symptoms of persistent instability.[9] Whether these neuromuscular aberrations are the cause or the result of

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shoulder instability has yet to be established. However, treatment of associated scapular dyskinesia is an integral part of MDI rehabilitation.

The natural history of MDI is also not well established. A study that followed patients with atraumatic shoulder instability for more than 3 years found age at onset to be significant in predicting whether the instability would progress. Younger patients had a greater risk of progressive instability. Spontaneous resolution of symptoms occurred in approximately 10%, and it occurred nine times more frequently among patients who abstained from overhead throwing activities than those who did not.[10] These findings indicate that recovery with activity modification is clearly possible and that the younger a patient is at onset, the greater the risk of progressive symptoms.

Figure 1 Metacarpal hyperlaxity.

Clinical Evaluation

Patients typically develop symptoms of MDI before reaching 30 years of age. In some patients, atraumatic MDI progressively worsens until it affects basic activities, such as typing or reaching overhead. These patients sometimes have periscapular discomfort, numbness, or tingling in the hand. More frequently, patients have generalized ligamentous laxity with symptoms that worsen after participation in a forceful repetitive overhead activity, such as swimming, gymnastics, or volleyball. Infrequently, a single traumatic episode leads to development of symptomatic MDI. Evidence of significant trauma is usually not found during surgery. In contrast, a patulous capsule and interval are routinely found. A Bankart-type lesion is less common.

As an ailment of capsular redundancy and ligament insufficiency, MDI often has an insidious onset. Frank subluxation is found after the instability worsens. The patient's pain is frequently consistent with rotator cuff disease brought about by capsular dysfunction, and a thorough examination is required to ascertain the correct diagnosis. Age at onset, associated elbow recurvatum, metacarpal hyperlaxity (Figure 1), and a history of a repetitive overhead activity are significant factors in determining that capsular insufficiency, rather than rotator cuff disease, is the source of the patient's shoulder pain. The most important finding is generalized laxity with shoulder instability in more than one direction and, invariably, an inferior component. Patients with MDI of an atraumatic origin have global laxity in the anterior, posterior, and inferior directions. Those with a repetitive microtraumatic etiology superimposed on ligamentous laxity may have anteroinferior or posteroinferior instability. The sulcus sign (Figure 2), which is a cleft below the acromial border, is generated by axial distraction of the adducted shoulder and is consistent with inferior

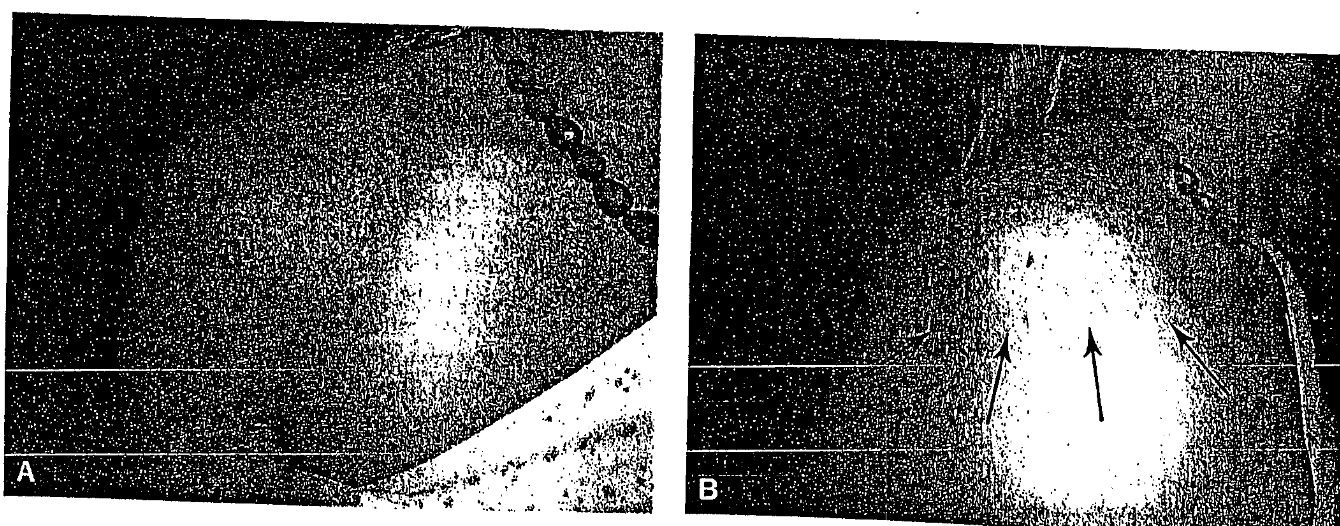

Figure 2 The sulcus sign. **A,** Shoulder without traction. **B,** Cleft (*arrows*) appears with axial loading.

translation of the joint. The sulcus sign should not appear when the shoulder is externally rotated, increasing tension within the SGHL. A persistent sulcus cleft in external rotation confirms the patulous nature of the rotator interval, including the SGHL. Some patients with this condition can voluntarily subluxate or dislocate their shoulders in multiple directions, although they may do so unwillingly. These patients should be distinguished from those whose voluntary instability is associated with behavioral or psychiatric issues; in this subgroup of patients, surgery should be avoided.

Treatment Outcomes

MDI is initially treated through a rehabilitation program emphasizing correct scapulothoracic mechanics in conjunction with strengthening. Although the reported efficacy of nonsurgical treatment varies, it can be an effective alternative to surgery. In one study, 80% of all patients with atraumatic instability and 88% of the subgroup with MDI were successfully treated using only rehabilitation.[11] A long-term evaluation of nonsurgical treatment for MDI found that 33% of the patients required surgery; of the remaining patients, almost half had a satisfactory outcome based on shoulder instability scores.[12]

The goal of surgery for recalcitrant MDI, whether the surgery is open or arthroscopic, is to reduce capsular volume without significantly compromising the patient's range of motion or function. Neer's seminal work on a laterally based capsular shift[1] was a turning point in the ability to offer effective surgical treatment of MDI, although concerns have been raised as to the correctness of the presurgical diagnoses in this study. (More than half of the patients reported their symptoms after significant trauma.) A study of 43 shoulders more than 2 years after an inferior capsular shift procedure found that 9% had recurrent subluxation, and an additional 24% had continued apprehension correlated with residual inferior and posterior translation.[13] This study is compelling because more than two thirds of the patients had generalized ligamentous laxity without a history of significant trauma and only seven shoulders had a Bankart lesion; these findings are consistent with a diagnosis of MDI. In another study, 96% of the patients had an excellent or good result at an average 5-year follow-up of 52 shoulders treated for MDI with an inferior capsular shift procedure. Almost 90% had returned to sports activity, although not at their preinjury level.[14] Other studies confirmed the efficacy of surgical management of MDI using an open inferior capsular shift procedure; the reported success rates routinely approached 90%. However, the study populations were not uniform, and the diagnosis of MDI tended to be overly inclusive.

Several cadaver studies found that an arthroscopic approach can be successful in achieving adequate volume reduction. In one study, anteroinferior capsular suture plication using 10-mm plication sutures effectively reduced anterior translation and external rotation in cadaver specimens; in addition, anterior capsular labral height was improved almost 3.5 mm.[15] Another cadaver study used progressively larger plication distances to calculate the volume reduction achieved with an arthroscopic plication technique. The authors concluded that arthroscopic plication methods reliably reduced volume and that a definite relationship existed between the amount of tissue captured and the extent of volume reduction.[16] Researchers compared open, laterally based inferior shifting to arthroscopic capsular plication to determine capsular volume reduction, finding a 50% reduction with an open approach. In contrast, an arthroscopic approach using three plication sutures, based anteriorly, inferiorly, and posteriorly, reduced volume approximately 23%. The authors concluded that an open approach was preferable for patients requiring significant tissue shifting, although additional plication sutures might improve the volume reduction.[17]

The clinical results of arthroscopic treatment of MDI have been encouraging. At a minimum 2-year follow-up of 19 consecutive shoulders treated for MDI with arthroscopic capsular plication, 13 excellent and 5 good outcomes were recorded, with no complications. However, the primary pathology at surgery was excessive capsular laxity in 9 patients and Bankart pathology in 7 patients.[18] A study evaluating 47 patients with MDI treated with an arthroscopic capsular shift found a 93% success rate at 3-year follow-up. Twenty-six patients had not reported a traumatic episode, and only 10 Bankart lesions were noted at surgery.[19]

Several studies investigated the effectiveness of volume reduction after arthroscopic thermal capsulorrhaphy. One study compared an open capsular shift and thermal capsulorrhaphy; capsular volume was reduced 50% after an open capsular shift and 30% after thermal shrinkage.[20] Although thermal treatment of MDI was once popular because of its simplicity and ease of application, diminished longer term results and the significant risk of complications, including capsular necrosis, chondrolysis, and neurovascular injury, have caused it to fall out of favor. A 2-year follow-up of 19 patients found a 47% failure rate and a 21% rate of iatrogenic transient axillary nerve dysesthesia.[21] A similar study of 53 patients with MDI found that 41% had an unsatisfactory outcome and 14% had transient axillary nerve injury.[22]

Nonsurgical and Surgical Treatment

Rehabilitation

The initial treatment of a patient with MDI should focus on rehabilitation and strengthening. Scapulothoracic articulation and core strengthening should be the foundations of treatment, although the rotator cuff musculature also deserves attention. Gentle, slowly progressive

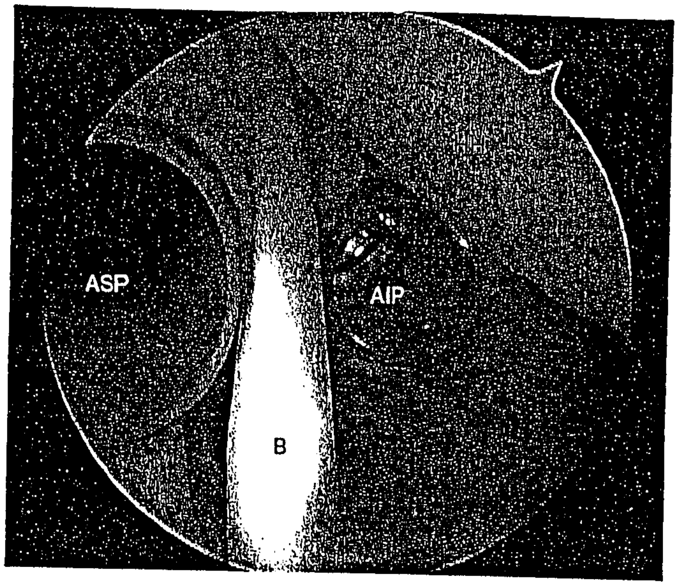

Figure 3 Intrasurgical photograph showing the anterosuperior portal (ASP) for viewing and the anteroinferior portal (AIP) for instrumentation. B = biceps, HH = humeral head.

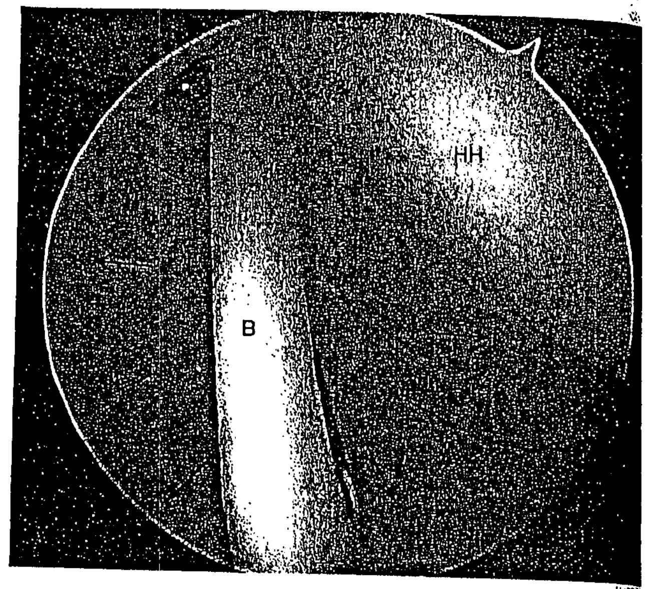

Figure 4 Intrasurgical photograph showing the patulous rotator interval (arro
B = biceps, HH = humeral head.

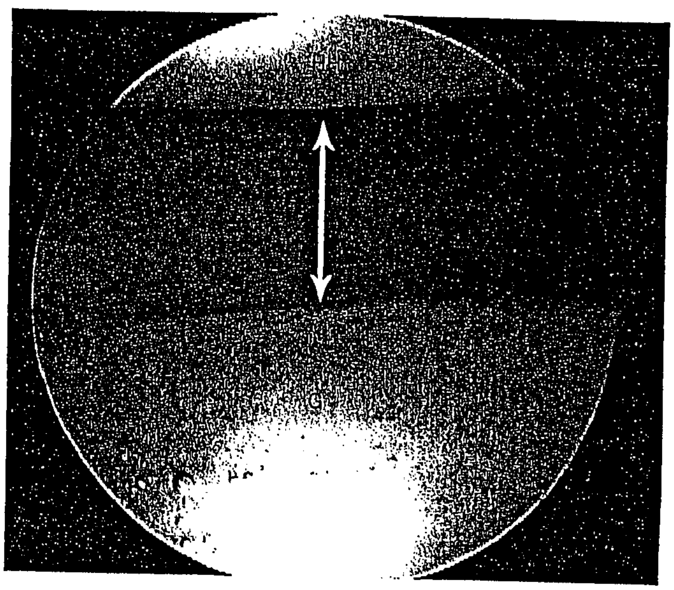

Figure 5 Intrasurgical photograph showing a positive drive-through sign (*arrow*). G = glenoid, HH = humeral head.

Figure 6 Intrasurgical photograph taken from the anterosuperior portal, showin ligaments carefully rasped to generate a healing response. G = glenoid, IGHL = inferio glenohumeral ligament, L = labrum.

exercises, in conjunction with significant activity modification, must be performed for at least 3 months before the efficacy of the regimen is determined.

Arthroscopic Surgery

Surgery can be performed with the patient in either the supine or the lateral decubitus position. A thorough examination is performed under anesthesia, and the findings are compared with the contralateral extremity. Confirming the primary direction of instability as anterior or posterior is of paramount importance for surgical planning. (The inferior component is always present.)

When the degree and direction of instability have been determined, a posterior portal is established. A slightly inferior and lateral placement, compared with the usual location, facilitates posterior instrumentation for both capsular and labral surgery. Dual anterior portals are established at the superior and inferior extent of the rotator interval (Figure 3). The glenohumeral space is carefully inspected, as are the rotator interval, which is usually patulous (Figure 4), and the labrum and its attachment, which may be roughened but rarely detached. Occasionally, Bankart-type labral separations are found and must be addressed. The biceps anchor is usually intact. An articular-sided partial rotator cuff tear is sometimes found. Axial and lateral traction on the humeral

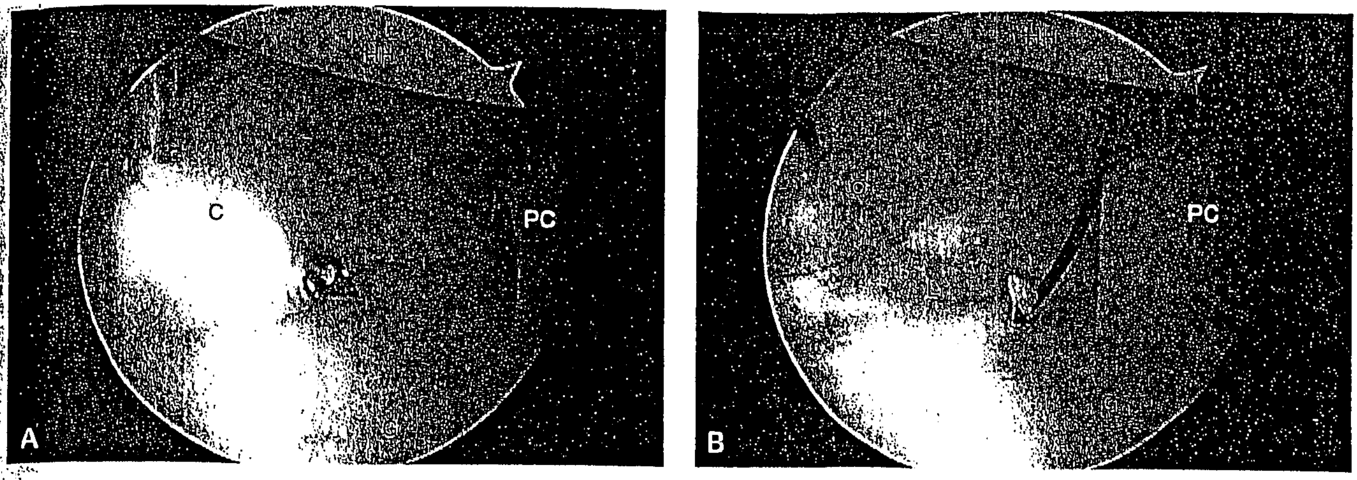

Figure 7 Intrasurgical photographs showing capsular tissue captured with first pass and shifted superiorly before the labrum is engaged (A) and suture hook passing through the labrum as the second step, with passage of absorbable suture (B). C = capsular tissue, G = glenoid, HH = humeral head, L = labrum, PC = posterior cannula.

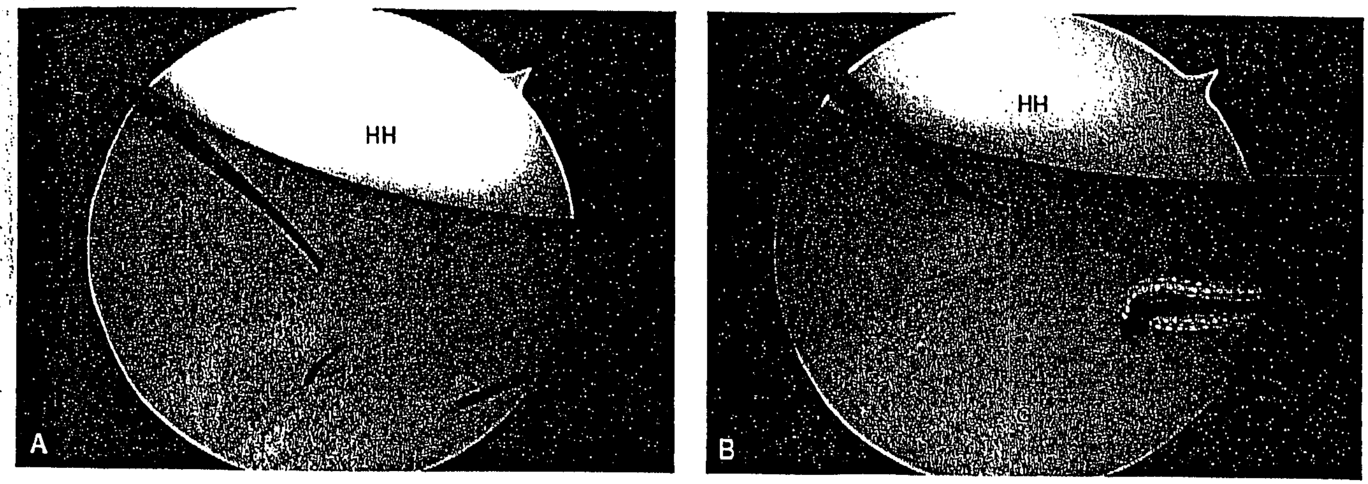

Figure 8 Intrasurgical photographs taken from the anterosuperior portal, showing pinch-tuck suture in place (A) and retrograde shuttling of permanent suture through the capsular tissue (B). C = capsular tissue, G = glenoid, HH = humeral head, L = labrum.

head leads to a positive drive-through sign, in which the humeral head separates from the glenoid (Figure 5). The arthroscope can be easily driven across the joint from posterior to anteroinferior; this maneuver is usually not possible in a stable shoulder. Although a drive-through sign is not pathognomonic for MDI, its presence, in conjunction with a consistent history and a finding of instability on the examination under anesthesia, serves to confirm the diagnosis.

The primary direction of pathologic translation, which usually is anteroinferior, is addressed first. The ligaments are carefully roughened with a rasp to avoid thinning the already-compromised capsular tissue (Figure 6). A suture hook is then passed in a pinch-tuck fashion, in which capsular tissue is captured lateral to the glenoid and reapproximated to the labrum. To help prevent overtightening of the joint, the capsular tissue is penetrated inferiorly, 1 to 2 cm from the labral rim and at or below the level of the glenoid (Figure 7). Placing the arm in 40° to 50° of abduction can also prevent overtightening. The axillary nerve is at risk, although careful attention to positioning in abduction and slight forward flexion can minimize the likelihood of complications. After the capsular layer is captured, the hook is passed through the labrum, which is usually intact. An absorbable suture is passed and retrieved, then used as a shuttling device to carry nonabsorbable suture through the capsule (Figure 8). This sequence is repeated to achieve a horizontal mattress configuration. Tying the knot on the labral side of the sutures pushes the capsular tissue and labrum onto the glenoid face, re-creating labral height and increasing the depth of the glenoid (Figure 9). This procedure can be repeated as necessary to ablate the inferior capsular pouch, effectively shifting tissue from inferior to superior.

After the primary direction of instability has been treated, the opposite side is shifted to balance the capsule and avoid creating iatrogenic instability in the opposite direction (Figure 10). Finally, the rotator interval is closed to diminish the inferior pouch. Several techniques can be used. Passing sutures through the SGHL and retrieving them through the middle glenohumeral ligament allows a simple, satisfactory closure (Figure 11). Careful arm positioning in 25% of external rotation helps prevent motion loss.

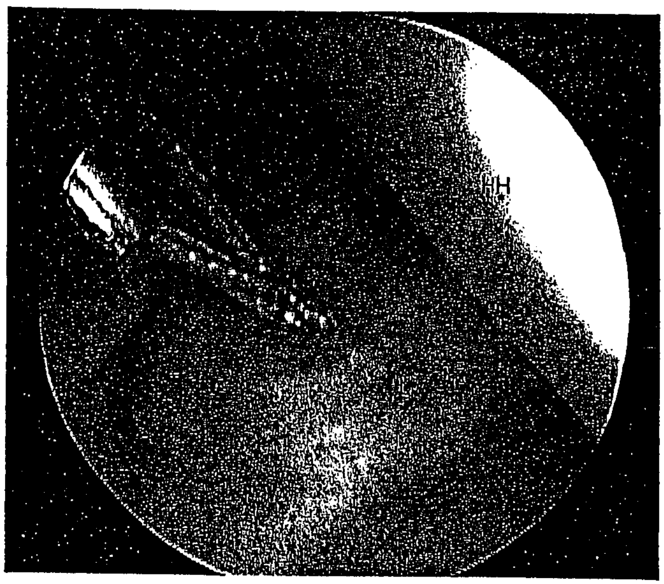

Figure 9 Intrasurgical photograph showing reconstitution and widening of labral dimensions. C = capsular tissue, G = glenoid, HH = humeral head, L = labrum.

There is no consensus as to whether absorbable or nonabsorbable suture material is preferable. The optimal number of sutures and the exact amount of volume reduction required for successful arthroscopic stabilization of MDI also have not been determined. Undercorrection can fail to relieve the symptoms of instability, but overconstraint of the joint can lead to early arthrosis and disabling functional limitations.

Postsurgical Immobilization

Postsurgical treatment is facilitated by using an external rotation brace with the arm in 10° to 15° of abduction and external rotation. In patients treated for primary posteroinferior instability, the brace should be externally rotated 20° to 30°, with 10° to 15° of abduction. This position is maintained for 6 weeks before motion exercises are initiated. The goal is to achieve a full range of motion 5 to 6 months after surgery; a more rapid return to full motion can compromise the desired stability. Despite the prolonged postsurgical immobilization, arthroscopic plication for MDI rarely leads to permanent stiffness because the patient usually has an underlying generalized ligamentous laxity.

Summary

Patients with MDI typically do not have a history of trauma. They have generalized ligamentous laxity that has become pathologic, frequently as a result of repetitive overhead activities. In addition, asynchronous dynamic shoulder function can contribute to instability symptoms. Bankart lesions are found infrequently.

The initial treatment consists of a well-supervised rehabilitation program. More than 50% of patients with

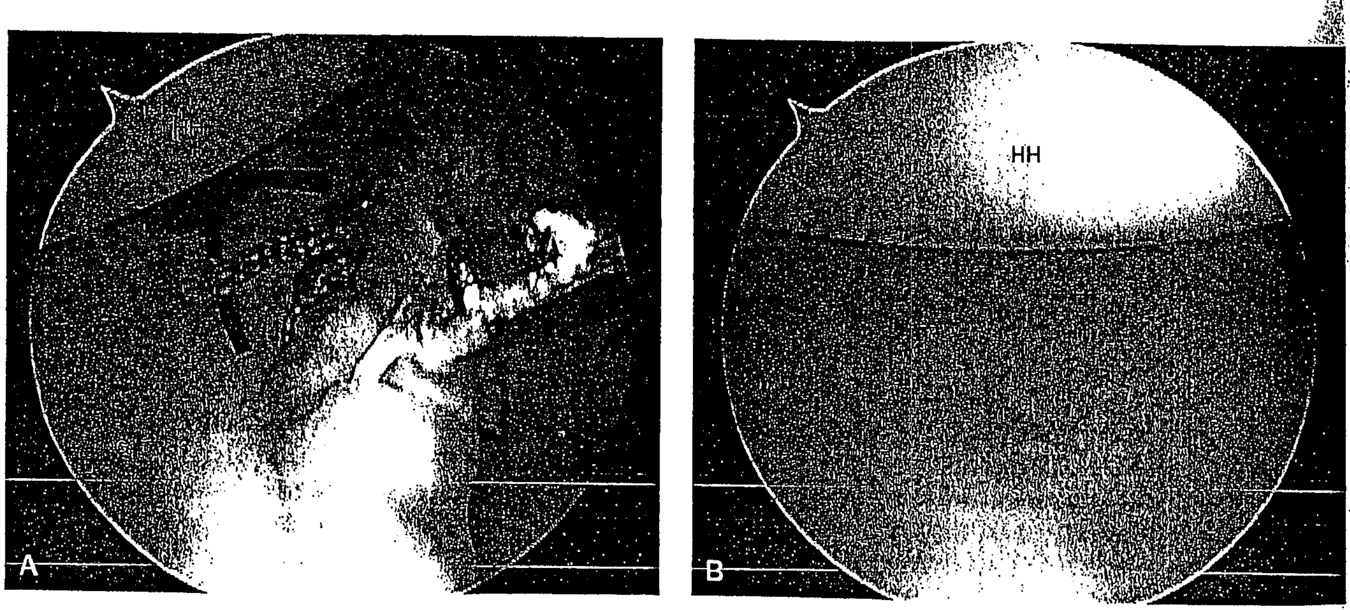

Figure 10 A, Posterior capsular shifting after the anteroinferior component was addressed. B, As seen from the anterosuperior portal, the humeral head is balanced and well centered on the glenoid face after panscapular plication. G = glenoid, HH = humeral head.

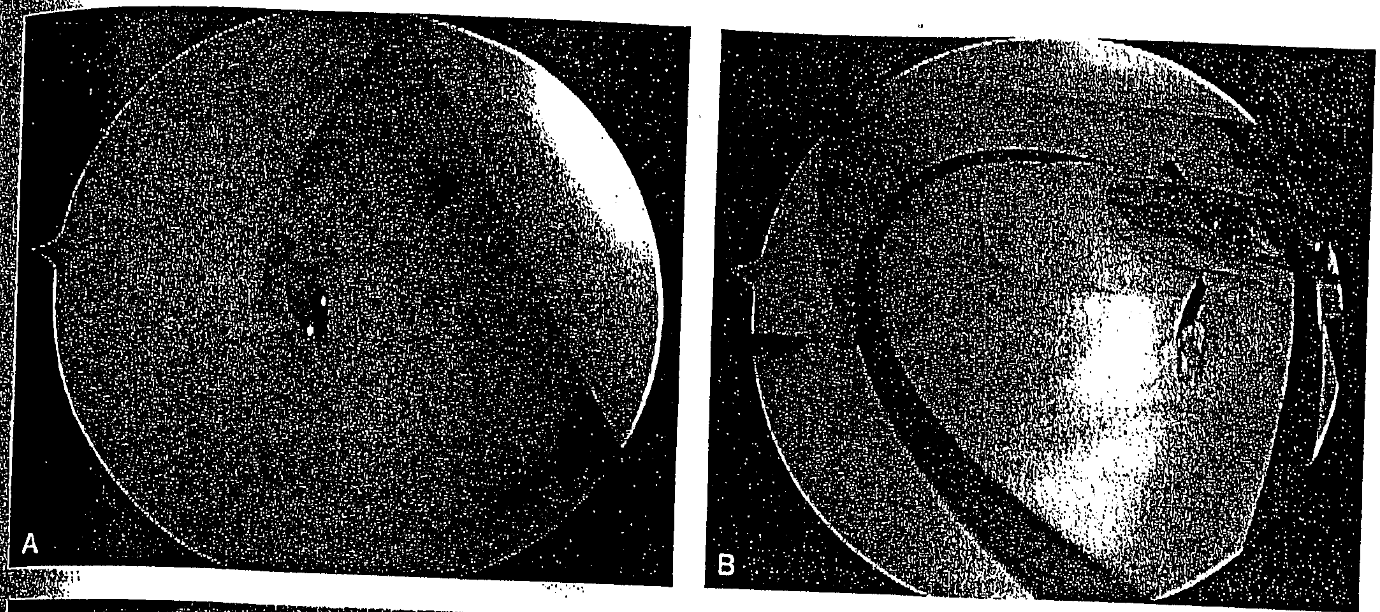

Figure 11 Intrasurgical photographs showing rotator interval closure technique. **A,** Passing the suture through the SGHL. **B,** Retrieving the suture with a grasper through the middle glenohumeral ligament. **C,** Closing the interval with an approximation of the SGHL and the middle glenohumeral ligament. B = biceps, G = glenoid, HH = humeral head, L = labrum, MGHL = middle glenohumeral ligament, SGHL = superior glenohumeral ligament.

MDI have improvement if activity modification is pursued concomitantly. For those with persistent instability and pain, surgical stabilization is warranted. Both the open and arthroscopic techniques must reduce capsular volume to be successful. Numerous studies have concluded that either approach is effective, although neither the precise amount of tissue shifting nor a standardized surgical technique has yet been elucidated.

Annotated References

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   In this prospective case series, the authors detail arthroscopic findings in atraumatic shoulder instability. Classic Bankart lesions were noted in 30%, non-Bankart pathology in 44%, articular-sided partial cuff tears in 7%, and superior labral anterior and posterior pathology in 12%. Level of evidence: IV.

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In this cadaver study, intra-articular pressure was measured after imbricating and venting the capsule to assess the role of negative intra-articular pressure on stability. Imbrication facilitated favorable intra-articular pressure, but venting led to recurrent instability, despite the prior imbrication.

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This long-term study evaluated the results of treatment of MDI with rehabilitation exercises. At an average 8-year follow-up, 21 of the 57 patients had undergone surgical treatment. Of the nonsurgical patients, 17 were rated as having excellent or good results, and the remaining 19 were rated as having poor results. Level of evidence: III.

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In this cadaver study, joint volume reduction was measured using open and arthroscopic plication techniques. Although the open shift led to a 50% reduction, compared with 23% achieved arthroscopically, the authors concluded that additional arthroscopic suture placement might have permitted a greater reduction in capsular volume. Level of evidence: IV.

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50%, compared with 30% achieved using the thermal technique.

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