Instability of the Shoulder: Complex Problems and Failed Repairs

PART II. FAILED REPAIRS

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Most patients who have instability of the shoulder can be well managed non-operatively. When such treatment fails, modern anatomical repairs achieve stability and function in a high proportion of patients. When these goals are not achieved, patients and surgeons are considering a revision operation with increasing frequency. A repair for instability may fail because of incorrect diagnosis, improper operative technique, or inappropriate rehabilitation. These complex situations represent both a diagnostic challenge to pinpoint the etiology of the failure of the first repair and a technical challenge to reconstruct the shoulder in the face of scarring and anatomical distortion from a previous procedure. Although there is considerable overlap, it can be helpful to broadly group these patients according to the outcome of the primary procedure. These groups consist of those who have recurrent instability, those who have a stiff or overly tight shoulder, and those who have an arthritic shoulder.

The purpose of the current paper is to describe the evaluation and management of patients who have recurrent instability or stiffness of the shoulder after a previous operation for repair of instability. Reconstruction of an arthritic shoulder with joint replacement is briefly reviewed.

Recurrent Instability

We organized this complex subject by considering the factors that may be associated with the failure of a repair for the treatment of instability. These include errors in diagnosis (for example, a missed diagnosis of multidirectional instability), a patient with impaired motivation (for example, one who has voluntary instability), incomplete correction of pathological lesions (especially Bankart lesions and capsular laxity), over-correction (for example, an overly tight repair) leading to stiffness, improper rehabilitation or a patient who does not comply with rehabilitation, new injury, complications related to the use of hardware, aberrant healing (for example, stretching of the capsule after a repair in a patient who has a collagen disorder and generalized laxity), and arthritic degeneration. A revision operation should be considered only if extensive non-operative treatment has failed to relieve the symptoms in a motivated patient. Success is most probable if an anatomical lesion that was ignored at the first procedure (for example, an unrepaired Bankart lesion) can be identified and is amenable to correction at a revision operation. In contrast, there is an increased risk of failure if a revision repair is done in a patient with atraumatic multidirectional instability who had capsular stretching despite a well performed repair that shifted the inferior portion of the capsule superiorly. In many instances, it may be better to tell a patient that no good operative option is available than to embark on a procedure without a clear chance of success.

Persistent or recurrent glenohumeral instability after a previous operative stabilization is a difficult problem. Careful evaluation of the patient's history, meticulous physical examination, and judicious use of diagnostic modalities can help to identify the reason for recurrence and to allow the formulation of a treatment plan.

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Etiology of Recurrence

Improper Previous Diagnosis

Shoulder laxity may be dramatic but asymptomatic, and other diagnoses (for example, a painful lesion in the acromioclavicular joint) may have been responsible for the symptoms. The examiner should look for other etiologies of the shoulder pain and dysfunction as well as problems in the cervical spine that may cause shoulder pain and thus simulate a lesion in the region of the shoulder.

Improper assessment of the instability, especially the failure to diagnose multidirectional instability, may have led to an improper operative procedure. All records and imaging studies from the initial evaluation should be reviewed. It is important to recall that a shoulder capsule may be both stiff and loose at the same time (for example, if a shoulder with multidirectional instability has been overtightened anteriorly). In these situations, in which the rotator interval and the anterosuperior aspect of the capsule as well as the inferior capsular pouch have not been addressed, the shoulder may continue to subluxate inferiorly despite being tight anteriorly to the point of restricted external rotation.

A particularly serious diagnostic error is the failure to recognize voluntary instability. These patients should be managed non-operatively.

Incomplete Correction of Anatomical Lesions

Even if the correct diagnosis was made, the pathological lesions still may have been inadequately repaired initially. The most common unrepaired lesions are an avulsion of the capsuloligamentous-labral complex (a Bankart lesion) (Figs. 1-A and 1-B), capsular laxity (Fig. 2), and erosion or irregularity of the glenoid rim through wear or fracture (Figs. 3-A through 3-D).

The high rate of failure of initial arthroscopic stabilization has been thought to be due to inadequate retensioning of the capsule and ligaments. It also has been proposed that these approaches tended to repair the avulsed labrum too medially, on the glenoid neck rather than on the glenoid rim, thus failing to restore the socket-containment mechanism.

Glenoid or humeral version is not usually a factor, but it may be one in the rare instance of a patient who has glenoid hypoplasia or rotational malunion after a
humeral fracture. Although humeral impression frac­
tures may be biomechanically important in chronic, un­
reduced anterior or, especially, posterior dislocations,
they are rarely of consequence in recurrent instability.

New Injury

Clearly, a new injury can disrupt even the best re­
pair. Although this can occur at any time, the great­
est risk is early in the postoperative period, before the
tissues have had a chance to mature. Trauma seems to
be related more commonly to failures of repairs per­
formed for unidirectional instability. In one study of re­
current instability after stabilization procedures, twelve
of the twenty-three failures that occurred after a repair
for unidirectional instability were associated with a
new traumatic event compared with only two of the
twenty that occurred after a repair for multidirectional
instability.44

Improper Rehabilitation and Abnormal Healing

A common cause of failure of a repair of a loose
shoulder with multidirectional instability is overly in­
tensive rehabilitation. Although stiffness is possible, it
typically occurs in patients who have acquired laxity
that is due to repetitive microtrauma. Patients who have
inherited generalized ligamentous laxity rarely have
stiff shoulders; rather, the repair tends to fail because of
gradual stretching of the capsule. This type of failure
can be prevented by tailoring the rehabilitation of the
shoulder to regain motion slowly over a period of a full
year, with avoidance of early intensive range-of-motion
exercises.

Treatment of Recurrent Instability

Non-Operative Treatment

Recurrent instability should be classified with regard
to the frequency of recurrence, the degree of trauma
involved, and the direction and degree of instability32.
The initial treatment should always be non-operative.
New traumatic lesions may heal if the shoulder is pro­
tected, and laxity may be better tolerated if muscle
strength and control are improved33. In a series of thirty­
ine shoulders that had recurrent instability after pre­
vious stabilization attempts, Rowe et al.37 used specific
resistive exercises to treat seven shoulders. The result was
excellent in one shoulder, good in four, fair in one, and
poor in one.

Treatment with a Revision Operation

The operative approach varies according to the type
of previous procedure and the degree of contracture
associated with the instability. When the skin incision is
made, generally previous scar tissue must be excised and,
in some instances, the incision must be placed in a
more correct position.

The anatomical planes should be identified and the
cephalic vein, if it is present, should be preserved. Often
there is considerable scar tissue between the clavipe­
toral fascia and the subscapularis. An incision lateral to
the short head of the biceps up to the coracoacromial
ligament, as well as rotation of the humeral head, facil­
itates identification of the proper plane. A periosteal
elevator allows separation of the conjoined tendon and
the deltoid from the cuff and the humeral head. The axillary nerve must be preserved medially and laterally. The subscapularis muscle then is released from the capsule to allow a capsular advancement and repair to be performed medially or laterally as needed. An elevator can be used to separate the muscle from the capsule; then this dissection is carried out superiorly and inferiorly. The anterosuperior portion of the capsule should be inspected. This region has been termed the cleft between the superior and middle glenohumeral ligaments, and it is referred to as the rotator interval as well, although that term also is used to describe the gap between the tendons of the subscapularis and the supraspinatus. If it is enlarged, the cleft may be closed or incorporated in the capsulorrhaphy.

If there is a Bankart lesion and little or minor uni-directional capsular laxity, a variety of capsular repairs, performed either medially or laterally, can be effective. The Bankart lesion should be repaired to freshened bone at the glenoid rim. Suture anchors, if they are used, should be placed at the margin of the glenoid and not along the neck. When substantial capsular laxity is present, especially when the inferior pouch is enlarged, an inferior capsular shift is performed. This is one of the rare situations in which anterior and posterior incisions may be necessary, as adhesions from the initial repair may make it impossible to mobilize the inferior portion of the capsule sufficiently to tension both sides from one approach. Although the ligaments and the capsule should be attached medially and laterally without slack, overtightening should be avoided, as contracture may lead to humeral subluxation in the opposite direction with subsequent arthritis.

A capsular release may be necessary in shoulders that have a capsular contracture, especially of the anterior part of the capsule and the middle glenohumeral ligament. If the contracture includes the subscapularis, that structure also has to be released or lengthened. If stiffness seems to be the dominant factor, it may be preferable to do only a release and then wait to see if renewed rehabilitation can control any remaining laxity. When anterior tightness is combined with major inferior or posterior instability, or both, a release combined with the appropriate capsulorrhaphy generally is used.

At times, the subscapularis has avulsed and contracted medially, which necessitates dissection along the glenoid neck. The brachial plexus must be identified. In some patients, scarring prevents reattachment. In these instances, one of us (R. F. W.) prefers to fill the defect with an Achilles tendon allograft attached to the glenoid and the humeral head. Alternatively, reconstruction may include the use of a hamstring or plantaris graft or the transfer of the pectoralis minor or the sternal head of the pectoralis major.

Rehabilitation after a revision operation is the same as that after a primary repair for instability and is tailored to the ligamentous laxity and healing response of the patient. It is best to have the patient regain motion gradually, over a period of many months, and to monitor the progress and to adjust the exercises accordingly.

Results of Revision Repairs

Few reports in the literature document the outcome of revision operations for treatment of instability of the shoulder. Furthermore, although most of those reports concern failed repairs of traumatic unidirectional anterior instability, some do not clearly delineate the etiology or classify the type of instability. This makes comparisons difficult.

Rowe et al. reported on a series of thirty-nine shoulders that had recurrent anterior dislocation after a failed initial operative repair. The previous operations included a Bankart procedure (nineteen shoulders), a
Putti-Platt procedure (seven), a Magnuson procedure (five), a DuToit procedure (three), a Bristow procedure (two), and a Nicola procedure (three). Thirty-two shoulders had a revision operation. The most common lesions found and corrected were Bankart lesions and excessive laxity of the capsule. Twenty-four of the thirty-two shoulders were followed for at least two years; there were ten excellent results, twelve good, and two poor results. Recurrent instability developed after only two of the revision procedures.

Hawkins and Hawkins reviewed a series of forty-six shoulders that had failure of an initial repair for anterior instability. Thirty-one shoulders had a recurrence of instability. Twenty of these patients had a revision operation, and about 80% of them were satisfied with the result.

In 1986, Walch et al. reported seventy-nine recurrences after operations to treat recurrent dislocation. Most of the initial stabilization procedures had consisted of distal displacement or lengthening of the coracoid process. Of the twenty-three shoulders that had a revision repair, only seventeen (74 per cent) were stabilized.

Young and Rockwood reported on forty shoulders in thirty-nine patients who had continuing symptoms after a failed Bristow procedure. Failure of the initial repair was related to recurrent anterior instability (primarily due to capsular laxity), posterior instability, damage of the articular cartilage, coracoid non-union, loosening of the screw, and neurovascular injury. Multidirectional instability was identified in twenty-three (59 per cent) of the thirty-nine patients, and an untreated Bankart lesion was identified in four (20 per cent) of twenty patients who had had a capsular shift or capsular release for treatment of chronic painful anterior instability. A revision capsulorrhaphy was performed in fifteen shoulders because of recurrent instability. Of the thirteen shoulders followed for at least two years, only eight had a good or excellent result.

Zabinski and Warren evaluated the results of revision stabilization in forty-four shoulders. Twenty-three shoulders had had an initial repair for treatment of unidirectional anterior instability, and twenty-one shoulders had had reconstruction for treatment of multidirectional instability. At the revision operation, a Bankart lesion was identified in nineteen of the twenty-three shoulders that had unidirectional instability and in only five of the twenty-one shoulders that had multidirectional instability. Major capsular laxity was present in nineteen of the twenty-three shoulders with unidirectional instability and in all twenty-one shoulders with multidirectional instability. At an average of sixty-two months, two shoulders had an excellent result; four, a good result; two, a fair result; and thirteen, a poor result. Eleven of the thirteen shoulders that had a poor result had a total of twenty-four additional revision operations, including four glenohumeral arthrodeses.

Levine et al. reviewed the results in fifty-four shoulders in fifty-three patients who had had a revision stabilization procedure after an operation for treatment of anterior glenohumeral instability that had failed. Patients who needed a revision procedure for treatment of postoperative stiffness, posterior instability, or arthrosis were excluded. The initial procedure failed following a new traumatic event in only seventeen shoulders. At the revision operation, all patients demonstrated anteroinferior instability when they were examined under anesthesia. Forty-six shoulders had excessive capsular laxity, and twenty-five had either a recurrent or a persistent Bankart lesion. Eleven shoulders had tight anterosuperior structures (the coracohumeral ligament, rotator interval, or superior aspect of the subscapularis) that tended to push the humeral head inferiorly into a large, redundant capsular pouch. The revision repair in fifty-three shoulders included an anterior-inferior capsular shift procedure; twenty-five also had repair of a Bankart lesion. One shoulder had a coracoid transfer for repair of a large fracture of the anterior aspect of the glenoid rim. At an average of 4.5 years, there were forty excellent and three good results. Eleven shoulders were considered to have an unsatisfactory result because of recurrent subluxations (two shoulders) or dislocations (nine shoulders). Seven of the eleven patients were later diagnosed as voluntary dislocators. All seventeen patients who had failure of the index procedure after substantial trauma had an excellent result after the revision operation compared with only twenty-three (62 per cent) of the thirty-seven patients in whom the failure after the initial repair was not associated with trauma. Interestingly, all of the patients who had had a failed arthroscopic stabilization procedure had an excellent result after the revision operation. Four of the nine shoulders that had had multiple previous stabilization attempts had recurrent instability after the revision procedure compared with only seven of the forty-five shoulders that had had only one previous stabilization procedure.

Overview

Recurrent instability of the shoulder after a stabilization procedure may be related to a missed diagnosis; a new injury; a missed anatomical lesion (especially a Bankart lesion); or capsular laxity that was inadequately addressed at the initial procedure, was treated with an improper rehabilitation program postoperatively, or healed unsatisfactorily because of an underlying collagen disorder. Non-operative treatment options should be exhausted before operative intervention is
TABLE I

OPERATIVE PROCEDURES FOR RECURRENT ANTERIOR AND ANTEROINFERIOR INSTABILITY OF THE SHOULDER

| Procedure        | Operative Correction                           |
|------------------|-----------------------------------------------|
| Motion-sparing   | Open or arthroscopic capsuloligamentous release |
| Bankart repair   | in both procedures                            |
| Horizontal       |                                               |
| capsulorrhaphy   |                                               |
| Motion-restricting| Open or arthroscopic capsuloligamentous release |
| Vertical         | in both procedures                            |
| capsulorrhaphy   |                                               |
| Putti-Platt      | Open subscapularis release or capsuloligamentous release, or both |
| Magnuson-Stack   | Open subscapularis release or capsuloligamentous release, or both |
| Bristow          | Open release of the subscapularis-conjoined tendon interval or subscapularis-lengthening, or both |

performed. Range of motion, function, and glenohumeral stability can be restored by a revision repair in a high percentage of patients. However, the results are not as predictable as those after a primary procedure.

The factors associated with a poor result after a revision operation include a diagnosis of multidirectional instability, failure of the initial repair without a new traumatic event, avulsion of the subscapularis, voluntary instability, and multiple previous stabilization attempts. An open revision repair for instability after a failed arthroscopic stabilization appears to yield good results. The reason may be that there is less scarring and soft-tissue disruption from an arthroscopic procedure or that failure of an arthroscopic procedure is related more commonly to incompletely repaired anatomical lesions (a technical failure) than to poor collagen (a biological failure).

**Stiffness**

The major goals in the treatment of recurrent glenohumeral instability (subluxation and dislocation) are the restoration of stability and the maintenance of pain-free motion. When non-operative modalities fail, numerous operations to reconstruct the static (osseous and capsuloligamentous) and dynamic (rotator cuff) stabilizers of the shoulder have been used. The success rate of most procedures in the prevention of recurrent dislocation is more than 90 per cent. Although many of these procedures restore stability, they have resulted in loss of mobility and function. Furthermore, excessive loss of motion (principally external rotation) after operative intervention has been implicated as a cause of degenerative arthropathy. Indeed, many early repairs were designed explicitly to restrict motion to avoid the positions in which the shoulder was at risk for instability. These repairs were often extra-articular and did not deal with intra-articular abnormalities such as labral detachments and capsular laxity. Reconstructions for repair of instability thus can be classified into two categories: those that restrict motion and those that spare motion (Table I). Motion-restricting procedures reduce external rotation, thus preventing the patient from placing the arm in a vulnerable position (abduction and external rotation). This objective is achieved by means of medial-lateral tightening of either the capsuloligamentous complex (a vertical capsulorrhaphy) or the subscapularis (a Magnuson-Stack or Bristow procedure), or both (a Putti-Platt procedure) (Fig. 4). In contrast, motion-sparing operations correct capsuloligamentous laxity, emphasizing a superior-inferior (Neer or Jobe-type) capsulorrhaphy. Both types of procedures have been combined with a simultaneous repair of a detached anterior capsulolabral complex (a Bankart lesion).

Loss of motion after stabilization of the shoulder can occur as a result of the type of procedure, technical errors in the performance of the procedure, or inadequate postoperative therapy. The management of a patient who has disabling loss of motion and pain after stabilization requires a clear understanding of the available operative procedures and their potential pitfalls as well as a systematic clinical and radiographic evaluation in order to implement an effective treatment protocol.

**Etiology and Prevention of Stiffness after Repair of Instability**

**Procedures Involving the Capsulolabral Complex**

The traditional Bankart repair was directed solely at the capsuloligamentous and labral detachment from the anterior aspect of the glenoid rim, and tightening of the anterior aspect of the capsule was not a specific goal. The repair involves the separation of the subscapularis from the underlying capsule followed by a vertical capsulotomy five to ten millimeters lateral to the glen-
The lateral capsular flap then is advanced to the glenoid rim and repaired through drill-holes in bone followed by suturing of the medial flap in a double-breasted fashion over the top.

Several technical points are relevant to the prevention of postoperative stiffness when this procedure is used. As the capsuloligamentous complex is tightened to a small degree with this procedure, care must be taken not to make the capsulotomy too far lateral from the glenoid rim in order to avoid excessive medial advancement of the lateral portion of the capsule and loss of external rotation. The site of attachment of the capsulolabral complex on the glenoid rim also is critical to anterior tensioning, which may restrict postoperative motion. The traditional Bankart repair should be performed on the edge of the articular surface of the glenoid. However, newer techniques such as suture anchors and biodegradable tacks used in either an open or an arthroscopic procedure often result in attachment of the capsulolabral complex to the anterior part of the glenoid neck. If the capsule is placed too medially, the lateral portion of the capsule and the potential loss of external rotation. However, other authors have expressed concern that this approach may not adequately correct the variable degrees of capsular laxity often seen in combination with Bankart lesions.

**Procedures for Capsuloligamentous Laxity**

Capsuloligamentous laxity is unidirectional (usually anterior), bidirectional (usually anterior-inferior), or multidirectional. Although a history of traumatic injury of the shoulder usually is associated with unidirectional instability and a history of atraumatic injury, with multidirectional instability, this dichotomy does not always hold true. Frequently, a patient who has laxity of the shoulder that initially was due to a traumatic etiology can acquire, over time and with repeated episodes of instability, capsuloligamentous laxity. Therefore, a capsulorrhaphy alone or in combination with a modified Bankart repair often is necessary. If there is excessive capsular laxity at the time of a Bankart repair, medial advancement of the lateral portion of the capsule has been advocated by some investigators. However, as has been mentioned, this may result in a restriction of external rotation. One method for avoiding a severe loss of motion is to tension and close the capsulorrhaphy with the arm in at least 30 degrees of external rotation.

Table II

| Study                        | Samilson and Prieto6    | Hawkins and Hawkins13 | Hawkins and Angelo6 | MacDonald et al.22 | Lusardi et al.21 |
|------------------------------|-------------------------|-----------------------|---------------------|-------------------|-----------------|
| Total†‡                       | 74 (45 ops.)            | 10                    | 11                  | 10                | 20              |
| Bankart repair†               | 2                       |                       |                     |                   |                 |
| Capsulorrhaphy†               | 9                       | 9                     | 11                  | 7                 | 4               |
| Putti-Platt procedure†        | 6                       | 1                     | 1                   | 10                | 18              |
| Magnuson-Stack procedure†     | 17                      | 1                     | 2                   | 7                 | 27 (28%)        |
| Bristow procedure†            | 11                      |                       |                     |                   |                 |
| Other procedures‡             | 0                       |                       |                     |                   |                 |
| Range of motion               | 0-30 (n = 27),          | -5 (-30-25)‡         | -8 (-30-5)‡         | -11 (-50-10)‡     | 13 (14%)        |
| (degrees)                     | 31-50 (n = 16),         | 32 (31-50)‡          | 32 (31-50)‡         |                   |                 |
|                              | 51-70 (n = 12),         |                      |                     |                   |                 |
|                              | >70 (n = 19)            |                      |                     |                   |                 |
| Osteoarthrosis†               | 32                      | 6                     | 5                   | 2                 | 9               |
| Mild                         | 3                       | 3                     | 3                   | 5                 |                 |
| Moderate                     | 8                       | 4                     | 1                   | 2                 |                 |
| Severe                       | 5                       | 4                     | 6                   |                   |                 |

*Some shoulders had more than one procedure at a single or multiple operations. Forty-five of the shoulders in the report of Samilson and Prieto had loss of motion after an operative procedure.

†The values are expressed as the number of shoulders.
‡The values are expressed as the average with the range in parentheses.
the capsule but not shortening the medial-lateral dimension. This is mandatory when inferior instability plays a role. Variations include a T-type inferior capsular shift on the humeral\textsuperscript{11} or the glenoid side\textsuperscript{24}; both allow for adequate exposure for repair of a Bankart lesion through an inside-out approach, if necessary, and a reduction in capsule-ligamentous volume in a superior-inferior direction. T-type capsulorrhaphies also allow for more precision and individualization, as the superior-inferior and medial-lateral tension may be independently adjusted to suit the degree of capsular laxity present in each shoulder\textsuperscript{4}. Although the risk of inadvertent tightening of the anterior aspect of the capsule is far less than that with a purely medial-lateral capsulorrhaphy, the humerus should be placed in at least 30 degrees of external rotation and care must be taken to avoid overtightening. When performing the procedure on athletes who throw, the surgeon must allow for far more external rotation as the flaps are set\textsuperscript{24}. It also has been suggested that, as different parts of the capsule are tensioned by specific positions, the inferior flap in a T-type repair should be positioned with the arm in abduction and external rotation and the superior flap, with the arm in external rotation and at the side\textsuperscript{43}.

The arthroscopic capsular shift procedure reduces capsular volume, but it may result in decreased motion if the stabilizing sutures are placed too laterally in the capsule-ligamentous complex or secured too far medially on the anterior portion of the glenoid neck. With use of suture techniques\textsuperscript{26}, the ability of the surgeon to place the anchoring site for the transglenoid sutures at the junction of the articular surface may be better than that with use of suture anchors and biodegradable devices. The accurate placement of this anchoring site can be achieved only by disregarding the commercially available drill-guide placement and manually using the guide to place the drill site at the articular margin, exactly as was done in the original open Bankart procedure.

\textit{Bone Procedures}

The most common bone abnormalities found at an operation on the shoulder are Hill-Sachs lesions and, less frequently, variable erosion of the anteroinferior portion of the glenoid\textsuperscript{27}. Reconstruction of these defects is rarely necessary to achieve stability. The Bristow procedure, as originally described by Helfet\textsuperscript{17} (transfer of the coracoid process with the attached conjoined tendon to the anterior surface of the glenoid process), was designed to function, in part, as an osseous block to anterior movement of the humeral head. However, the Bristow procedure may function more as a dynamic musculotendinous sling, holding the humeral head in the joint when the arm is abducted and externally rotated. The modified Bristow procedure described by May\textsuperscript{24} reaps the subscapularis and places the coracoid transfer through a split between the superior and inferior portions of this muscle. Thus, this modified procedure probably confers stability by tethering the distal portion of the subscapularis and by preventing it from migrating superiorly with abduction and external rotation.

Helfet\textsuperscript{17} reported only a slight limitation in external rotation after the Bristow procedure, and May\textsuperscript{24} found, a limitation of less than 15 degrees in most patients. Lombardo et al.\textsuperscript{20} reported an average loss of 11 degrees (range, 0 to 30 degrees) of external rotation and an inability of the patients to return to sports activities involving overhead motion. Seven of the twenty shoulders that had disabling loss of external rotation in the study by Lusardi et al.\textsuperscript{21} had a Bristow procedure. Anatomically, the loss of rotation probably resulted from the tethering of the subscapularis and excessive scarring between the conjoined tendon and the subscapularis. Clancy\textsuperscript{19} suggested that the amount of internal rotation contracture related to the Bristow procedure could be minimized by positioning the humerus in 90 degrees of abduction and maximum external rotation before closure of the defect in the subscapularis created by the coracoid graft. This would shift the site of tethering of the subscapularis more medially.

\textit{Motion-Restricting Procedures}

Although loss of external rotation is a complication of the procedures just described, it is the stated goal of the Putti-Platt and Magnuson-Stack procedures. The Magnuson-Stack operation rarely is used alone and often is performed in conjunction with a capsulorrhaphy\textsuperscript{25}. It involves the lateral and distal advancement of the subscapularis tendon, which is intended to decrease external rotation and inferior subluxation, respectively. Lusardi et al.\textsuperscript{21} found that ten of twenty shoulders that had disabling loss of external rotation had a Magnuson-Stack procedure. Until the current time, the most widely used operation for repair of anterior instability was the one described by Putti in 1923 and by Platt in 1925 and later termed the Putti-Platt procedure by Osmond-Clarke\textsuperscript{29}. The operation involves a vertical incision directly through the subscapularis and the capsuloligamentous complex into the joint followed by attachment of the lateral flap to the anterior rim of the glenoid or the periosteal tissue of the glenoid neck. The medial stump is then overlapped (double-breasted) over this repair and attached to the lesser tuberosity or to the bicipital groove\textsuperscript{25}.

The Putti-Platt procedure has been implicated more frequently in the loss of external rotation and subsequent degenerative osteoarthrosis than any other stabilization procedure. Hawkins and Hawkins\textsuperscript{30} found that nine of ten patients who had been seen because of substantial loss of motion had a Putti-Platt repair, and six of these nine had osteoarthrosis. Hawkins and Angelo\textsuperscript{30} described eleven shoulders that had become stiff and arthrotic after the Putti-Platt procedure. MacDonald et al.\textsuperscript{22} reported on ten patients who had an
anterior release for treatment of severe loss of motion after an anterior repair; seven had had a Putti-Platt repair originally, and five of the seven demonstrated severe osteoarthrosis. Lusardi et al. found that four of twenty patients who had loss of external rotation after stabilization had been managed with a Putti-Platt operation; all of them needed an anterior soft-tissue release, and two needed an arthroplasty.

TREATMENT OF A STIFF SHOULDER

The treatment of a stiff shoulder after a stabilization procedure requires the systematic recording of a history and physical examination of the patient, followed by radiographic evaluation. It is necessary to rule out other causes of the pain in the neck, shoulder, and arm as well as the loss of motion. These possible etiologies include abnormality of the cervical cord and nerve roots, reflex sympathetic dystrophy, rotator-cuff tendinitis, primary intra-articular abnormality (adhesive capsulitis, infection, osteoarthrosis, inflammatory and crystalline arthropathy, and avascular necrosis), secondary gain, and psychological dysfunction. Details of the operation, postoperative rehabilitation, and the patient's motivation as well as whether the patient is receiving or has applied for Workers' Compensation and whether legal issues are involved, should be determined. If the patient has pain, it should be noted if it is constant or intermittent; if it occurs at night; if it is related to activity; and, if so, in what position of motion it occurs. The type and amount of analgesics used should be documented.

Physical examination should include subjective and objective measurement techniques, as described by the Society of Shoulder and Elbow Surgeons. In addition, evidence of shoulder atrophy, areas of tenderness, contractures, and signs of other shoulder abnormalities should be documented. Standard shoulder radiographs should include anteroposterior, transscapular lateral outlet, and axillary lateral radiographs.

On the basis of the history as well as the physical and radiographic findings, the cause or causes of the loss of motion can be attributed to an anatomical site. Capsuloligamentous causes include generalized adhesive capsulitis or anterior contracture due to either overzealous medial-lateral capsulorrhaphy, inadequate postoperative physiotherapy, idiosyncratic scar contracture, or a combination of these conditions. Extracapsular causes can be related to specific operations (the Bristow, Magnuson-Stack, or Putti-Platt procedure), scarring along anatomical tissue planes used for exposure during reconstruction, inadequate postoperative physiotherapy, or primary or secondary rotator-cuff tendinitis. Anatomically, loss of motion can be related to scarring and contractures within any of the rotator cuff tendons and the pectoralis major, long head of the biceps, teres major, and latissimus dorsi muscles; around the coracobrachial and clavicepolar fascia as well as the coracohumeral and coracoacromial ligaments; and between the conjoined tendon and the subscapularis, subacromial space, and subdeltoid space.

Pain associated with reduced motion (principally external rotation) may be due to impingement, osteoarthrosis, capsular contracture, posterior instability, or muscle spasm. Capsuloligamentous contractures can alter the dynamic pressures within the glenohumeral joint and may be partly responsible for pain-induced spasms in the muscles surrounding the shoulder. In a series of forty-six shoulders in which a repair that had been performed because of instability had failed, Hawkins and Hawkins found that pain was the major problem in twenty shoulders; nine shoulders had subacromial impingement syndrome, seven (six of which had had a tight anterior repair) had osteoarthrosis, and four had pain caused by the hardware.

Treatment of a shoulder that is stiff or painful, or both, should be individualized and based on the patient's lifestyle, the demands on the shoulder, and the level of pain. Treatment should begin with non-operative measures, including modification of activity, periodic use of analgesics, non-steroidal anti-inflammatory medication, gentle range-of-motion exercises, and strengthening exercises for the rotator cuff. Hawkins and Angelo managed seven of eleven patients who had osteoarthrosis and painful internal rotation contractures in this manner. Operative release is warranted when pain or dysfunction, or both, do not improve after an adequate course of non-operative treatment. Operative release also may be advisable for a patient who has early osteoarthrosis and reduced motion because, in addition to pain relief and increased motion, the progression of osteoarthrosis may be delayed. The value of a release before arthrosis develops in a stiff but pain-free shoulder is unclear. Many surgeons, wishing to avoid the dilemma of how to treat arthritis of the shoulder in a young active patient, would consider a release for a shoulder with substantial loss of external rotation, even if the shoulder was not painful at that time. However, the precise guidelines for such an approach, as well as clinical data to support them, are not available. Our current approach is to consider a release when external rotation is less than 0 degrees, to accept a loss of more than 30 degrees of external rotation (if there is no pain or sign of osteoarthrosis) in most patients, and to individualize the decision when external rotation is between 0 and 30 degrees. Functional considerations also are very important; in particular, athletes who throw cannot function with almost any loss of external rotation, especially at 90 degrees of elevation. Most athletes who throw have more than 90 degrees of external rotation at 90 degrees of elevation, and if external rotation is less than 90 degrees in this position a release may need to be considered. Whatever the final decision, it is important to counsel a patient on the reasons to consider a release, with respect to both the current function and the risk of later osteoarthrotic degeneration, so that he or she may participate in the choice of treatment.

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Preoperative assessment helps to direct the planning of the operative procedure. If the previous operation or operations involved only a capsuloligamentous or labral procedure, then the shoulder release often may be performed arthroscopically, as no lengthening of the subscapularis is necessary. However, even a purely capsular procedure may lead to extra-articular adhesions, and an open release may sometimes be needed. If the previous operation was extracapsular (a Bristow or Magnuson-Stack procedure) or capsular and extracapsular (a Putti-Platt procedure), then usually only an open procedure is effective. Although several methods of open release have been suggested, all are based on release, lengthening, or medial transfer of the subscapularis musculotendinous unit and release or medial-lateral lengthening of the capsuloligamentous complex. Recurrent instability after release is rare.

As discussed already, patients may have a loss of external rotation but continue to have instability inferiorly; in these situations, a capsulorrhaphy in addition to an anterior release may be needed. The precise indications are unclear. When the stiffness predominates, it may be better to release the tight side so that asymmetrical stiffness is eliminated. If this is done, the patient must be warned that a later capsular procedure may be needed if the instability cannot be treated with rehabilitation. However, once the soft tissues are balanced, mild laxity is often well tolerated. This approach avoids the difficulties of designing a postoperative rehabilitation program to follow a combined procedure that includes a release, which normally is followed by early and vigorous motion, and a capsulorrhaphy, which is followed by a program of more gradual motion. When the inferior instability is extreme, however, a combined anterior release and appropriate capsular repair generally is used.

**Operative Procedure**

It is important to assess the shoulder for loss of motion in all planes and at various positions. In particular, external and internal rotation should be measured at 90 degrees of elevation as well as with the upper extremity at the side. An arthroscopic evaluation can be helpful if an open release is planned, as the entire joint may be inspected for arthrosis or another abnormality. A capsular release may be easily performed arthroscopically. The subscapularis may be freed from the glenoid margin, and the rotator interval and the coracohumeral ligament may be released if necessary. It seems paradoxical to consider a capsular release when instability was the initial problem, but instability after a release is almost never a problem unless it was present.
FIG. 7-A
Figs. 7-A through 7-G: A female patient with secondary arthrosis after a Bristow procedure who had a very stiff shoulder, constant pain, and very little use of the upper extremity.
Fig. 7-A: Anteroposterior radiograph of the shoulder.

The incision then continues down the anterior portion of the capsule just lateral to the labrum in a superior-to-inferior direction. The muscular fibers of the subscapularis are exposed, and care must be taken to liberate this muscle fully. The arthroscope then is repositioned through the anterior portal, and, if internal rotation is restricted, the posterior portion of the capsule may be released through the posterior portal. If the inferior capsular pouch is tight, some surgeons, to avoid injury of the axillary nerve, remove the arthroscope and instruments at this point and perform a gentle manipulation. Other surgeons continue arthroscopically and carefully release the inferior aspect of the capsule, tak-

FIG. 7-B
Axillary radiograph showing posterior subluxation of the humerus with eccentric posterior wear of the glenoid.

before the release. As already discussed, when a shoulder is tight on one side and loose on another, the release is focused on the tight structures, usually the anteroinferior and anterior portions of the capsule and ligaments.

Typically, the arthroscope is placed through a standard posterior portal and a high anterior working portal is created. A transverse cut superior to the biceps with the cautery or laser releases the rotator interval.

FIG. 7-C
Anteroposterior radiograph made after a total shoulder replacement. The washer was embedded in the bone and was not removed.

FIG. 7-D
Axillary radiograph, made after the total shoulder replacement, showing proper positioning of the component and partial restoration of normal glenoid version.
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Fig. 7-E

Figs. 7-E, 7-F, and 7-G: Photographs made one year after the shoulder replacement and soft-tissue rebalancing. The patient had little pain and full use of the upper extremity.

Fig. 7-E: Full active elevation.

When care to avoid the nerve, especially posteriorly where it crosses just inferior to the capsule. It may be advantageous to use the laser in this situation as the energy is less deeply transmitted (to the nerve). If there is still a loss of full external rotation, most surgeons convert to an open release, which may include a lengthening of the subscapularis if it has been previously shortened (for example, during a Putti-Platt procedure). One of us (R. F. W.) has, on occasion, arthroscopically sectioned the internal two-thirds of the thickness of the tendon of the subscapularis obliquely and then stretched the remaining tendon thickness with manipulation to gain external rotation.

When an open release is planned or if the arthroscopic release cannot achieve full motion, the shoulder is exposed through a deltopectoral approach and the origin of the conjoined tendon and the insertions of the subscapularis, pectoralis major, and deltoid muscles are identified. First, scar tissue along interfascial planes is resected by blunt dissection if possible and by sharp dissection if necessary. The clavipectoral and coraco-brachial fasciae are released. The subdeltoid and sub-acromial spaces are freed, and the conjoined tendon is bluntly separated from the underlying subscapularis, taking care not to injure the musculocutaneous or axillary nerve.

External rotation of the humerus allows the remain-
humerus externally rotated at least 30 degrees. This type of formal subscapularis-lengthening generally is reserved for situations in which the subscapularis has been previously shortened (as in a Putti-Platt procedure). Otherwise, circumferential release of the subscapularis usually is adequate.

If any necessary capsular releases were not performed during an initial arthroscopic procedure, they are performed at this time. Full motion should be achieved, especially external rotation with the upper extremity at the side and at 90 degrees of elevation. A standard closure is performed, and a drain is placed.

Postoperatively, passive-assisted range-of-motion exercises, including terminal stretching, are begun immediately under the supervision of the surgeon and a physical therapist. When the pain is severe, perioperative scalene blocks or an intermittent regional block by injection through an indwelling interscalene catheter can be used to help to relieve the pain and to facilitate early motion.

The results of a release for stiffness after an operation for repair of instability have been gratifying, even when early osteoarthrotic changes are already present. Whether the long-term progression of arthrosis is altered is still unknown.

Overview

Prevention is the best method of treatment for loss of motion associated with shoulder reconstruction for instability. A clear understanding of the goals and potential pitfalls of the chosen operative procedure is essential. Operations that emphasize medial-lateral tightening of the capsule (a vertical capsulorrhaphy), the subscapularis (a Magnuson-Stack or Bristow procedure), or both (a Putti-Platt procedure), are not recommended because of the loss of motion and the subsequent dysfunction with overhead activities and the potential for degenerative osteoarthrosis. However, when a patient has loss of motion despite an appropriately chosen and executed procedure, a systematic approach to the diagnosis and treatment can provide satisfactory relief of pain and increased function.

Arthrosis

Patients who have severe arthrosis after a repair for instability generally need prosthetic replacement and soft-tissue rebalancing. Long-standing anterior contracture tends to drive the humeral head posteriorly, resulting in a fixed posterior subluxation, altered contact stresses, arthritic degeneration, and wear of the posterior aspect of the glenoid. In addition, damage of the articular surface may result from loose or misplaced hardware (Fig. 5). A complete description of the technical steps of shoulder replacement is outside the scope of the current paper. However, it is helpful to review briefly the issues involved.

A release for arthrosis is performed in the same general fashion as already described. Rather than attempting to lengthen the subscapularis, the surgeon usually gains length by releasing adhesions, removing osteophytes, and repairing the subscapularis more medially, at the anatomical neck (Figs. 6-A and 6-B).

When a joint has been replaced because of arthrosis after a repair for anterior instability, recurrent anterior instability is extremely rare. If any instability occurs, it is likely to be posterior subluxation. This can occur for two major reasons. First, chronic posterior subluxation of the humerus (due to anterior tightness) tends to leave a recess in the posterior aspect of the capsule. Second, wear of the posterior part of the glenoid leads to a tendency to resurface the glenoid in excessive retroversion. Soft-tissue rebalancing, especially an anterior release, combined with appropriate sizing of the humeral head component, usually takes care of the posterior recess, although in rare instances imbricating sutures may be necessary in the posterior portion of the capsule. Excessive glenoid retroversion is generally reduced by reaming down the anterior aspect of the glenoid rim, although usually not by the same amount that the posterior aspect of the glenoid has been lowered by wear. The remaining degree of increased retroversion of the glenoid component may, in most instances, be accepted and compensated for by reducing the retroversion of the humeral component. Bone grafts are almost never used.

The results of shoulder replacement and soft-tissue rebalancing are generally good (Figs. 7-A through 7-G). However, as many of these patients are quite young, the long-term issues with respect to the longevity of the implant are a source of concern.

Overview

Although operative repair for shoulder instability is usually successful, failures do occur. Careful evaluation, a long trial of non-operative management, and, when indicated, an appropriate revision operation can be successful in a high proportion of these difficult situations. However, the results of a revision operation are rarely as successful as those of a well performed primary repair.

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