Rotator-Cuff Failure
Frederick A. Matsen III, M.D.

A 63-year-old woman presents with a 2-year history of progressive weakness and discomfort in her right shoulder, especially when she puts dishes on the top shelf in her kitchen. She is otherwise healthy and has had no injuries. Her physician diagnosed “bursitis” and gave her four subacromial corticosteroid injections; the first two seemed to relieve her symptoms temporarily, but the last two were ineffective. Physical examination reveals some atrophy of the muscles of the right shoulder and weakness when her right arm is elevated. Magnetic resonance imaging (MRI) reveals a large defect in the rotator cuff. How should her case be managed?

The rotator cuff is a synthesis of the capsule of the glenohumeral joint with the tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles (Fig. 1). The rotator-cuff mechanism precisely centers the humeral head by compressing it into the glenoid concavity. The individual muscles of the cuff help to provide strength in arm movement: the subscapularis in internal rotation, the supraspinatus in elevation, and the infraspinatus and teres minor in external rotation.

Failure of the rotator-cuff tendons due to either tear or wear is the most common clinical problem of the shoulder, accounting for more than 4.5 million physician visits per year in the United States. Failure of the cuff tendon may result from a major injury, but more commonly it results from age-related attrition of the tendons, typically starting with the undersurface of the anterior aspect of the supraspinatus (Fig. 1 and 2 of the Supplementary Appendix, available with the full text of this article at www.nejm.org). Failure of the rotator cuff may progress to involve the full thickness of the tendinous insertions of the supraspinatus and then may extend to involve the infraspinatus and the subscapularis.

The natural history of degenerative cuff-tendon failure is one of age-related progression. Imaging studies reveal that 30% of asymptomatic persons over 60 years of age and 65% of asymptomatic persons over 70 years of age have rotator-cuff defects. The rate of progression may be slow; patients with moderately symptomatic, massive rotator-cuff tears have been found to maintain satisfactory shoulder function for at least 4 years.

Cuff defects are also more frequent in obese persons. Although corticosteroid injections have not been shown to increase the risk of cuff failure, there is evidence that injection of corticosteroids in and around tendons and ligaments can alter their collagen composition, strength, and ability to heal. Nicotine also may compromise the ability of tendons to heal and attach to bone.
The clinical manifestations of full-thickness, degenerative rotator-cuff failure vary widely among patients (Table 1). Patients with acute, traumatic, full-thickness cuff tears may experience the sudden onset of weakness with elevation of the arm after an injury in which the arm has been forced to the side (e.g., during a fall while skiing with the arm out to the side or on catching a heavy falling object with the extended arm). Patients with chronic degenerative cuff defects may notice a gradual onset of shoulder weakness, often accompanied by pain and crepitus on active movement; however, many degenerative rotator-cuff defects are asymptomatic.

The examination of the shoulder should include observation for atrophy of the deltoid, supraspinatus, or infraspinatus or a combination of these muscles. Palpation at the anterior greater tuberosity may reveal a defect in the cuff–tendon attachment (Fig. 2A). Palpation below the acromion as the arm is rotated may reveal crepitance from the edges of the torn cuff (Fig. 2B). Pain or weakness on isometric testing of arm elevation suggests involvement of the supraspinatus (Fig. 2C). Pain or weakness on isometric testing of internal rotation suggests involvement of the subscapularis (Fig. 2D), and during external rotation pain or weakness suggests involvement of the infraspinatus (Fig. 2E). The range of passive motion may be limited in shoulders with cuff defects; the limitation of internal rotation on abduction is particularly common in partial-thickness rotator-cuff lesions (Fig. 2F).

Because the cuff mechanism is the primary stabilizer of the shoulder, major cuff defects may be associated with instability in the anterior, posterior, or superior direction. In a severe form of instability known as anterosuperior escape, the humeral head slides out anteriorly on attempted elevation because of wear or surgical compromise of the coracoacromial arch. When the humeral head is no longer stabilized in the glenoid concavity, contraction of the deltoid muscle is ineffective in elevating the arm away from the side, leading to a finding known as pseudo-paralysis of the shoulder.

Plain films of the shoulder may show upward displacement of the humeral head relative to the glenoid and narrowing of the interval or even contact between the acromion and the humeral head in patients with chronic cuff failure. Plain imaging may also reveal an alternative cause of shoulder pain such as degenerative arthritis of the glenohumeral joint. Both MRI (Fig. 3) and ultrasonography (Fig. 4) may be useful in directly evaluating the status of the rotator-cuff tendons. In a study comparing the results of imaging with findings at arthroscopy, ultrasonography and MRI each correctly identified approximately 90% of full-thickness and partial-thickness tears. The sensitivities and positive predictive values of both tests were high (97%), but the specificities were only modest (67%). In another study, which used open or arthroscopic operative findings as the gold standard, ultrasonography and MRI each correctly identified approximately 90% of full-thickness and partial-thickness tears. The sensitivities and positive predictive values of both tests were high (97%), but the specificities were only modest (67%). In another study, which used open or arthroscopic operative findings as the gold standard, ultrasonography and MRI each correctly identified approximately 90% of full-thickness and partial-thickness tears.
Table 1. Differential Diagnosis of Rotator-Cuff Lesions.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>History</th>
<th>Physical Examination</th>
<th>Plain-Film Radiographic Assessment</th>
<th>MRI or Ultrasonographic Examination</th>
<th>Electromyographic Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial-thickness acute tear</td>
<td>Fall or sudden attempt to lift the arm, followed by pain</td>
<td>Pain on resisted elevation of the arm</td>
<td>Normal findings</td>
<td>Thinning of tendon at insertion, with defect in the deep aspect of the tendon</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Full-thickness acute tear</td>
<td>Sudden loss of shoulder strength after a fall or sudden attempt to lift the arm</td>
<td>Weakness of the arm during elevation and possibly during external rotation, palpable defect in tendon insertion</td>
<td>Normal findings</td>
<td>Full-thickness defect in cuff tendon</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Acute fracture of tuberosity</td>
<td>Sudden loss of shoulder strength after a definite injury</td>
<td>Weakness of the arm during elevation and possibly during external rotation</td>
<td>Tuberosity fracture</td>
<td>Tuberosity fracture</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Degenerative rotator-cuff failure</td>
<td>Insidious onset of shoulder weakness without major injury</td>
<td>Weakness of the arm during elevation and possibly during external rotation, palpable defect in tendon insertion</td>
<td>Normal or narrowed space between humeral head and acromion</td>
<td>Full-thickness defect in cuff tendon or tendons; atrophy, fatty degeneration, or both of cuff musculature</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Anterosuperior escape, pseudoparesis, or both</td>
<td>Inability to raise the arm away from the side</td>
<td>Severe weakness, anterior and superior movement of humeral head on attempted elevation of the arm</td>
<td>Superior displacement of humeral head relative to glenoid and acromion</td>
<td>Supraspinatus and often infraspinatus tendons not visible</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Frozen shoulder</td>
<td>Shoulder pain and stiffness, often without an injury</td>
<td>Limited range of motion, especially in internal rotation of the abducted arm, external rotation, and when the patient reaches up the back</td>
<td>Normal findings</td>
<td>Normal findings (contrast-enhanced MRI may show obliteration of normal axillary recess)</td>
<td>Normal findings</td>
</tr>
<tr>
<td>Glenohumeral arthritis</td>
<td>Progressive onset of pain and stiffness</td>
<td>Limited range of motion, especially during external rotation and elevation; bone-on-bone crepitance</td>
<td>Joint-space narrowing, osteophytes, sclerosis</td>
<td>Cuff tendons usually intact</td>
<td>Normal findings</td>
</tr>
</tbody>
</table>
Clinical Practice

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Imaging Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute calcific tendinitis</td>
<td>Severe pain at rest, difficulty moving the arm</td>
<td>Calcific density in supraspinatus tendon near insertion</td>
<td></td>
</tr>
<tr>
<td>Cervical radiculopathy</td>
<td>Pain above the shoulder, hand numbness, dysesthesia</td>
<td>Normal findings, cervical spondylosis</td>
<td></td>
</tr>
<tr>
<td>Brachial neuritis (Parsonage–Turner syndrome)</td>
<td>Atraumatic onset of pain in nerve distribution, followed by weakness</td>
<td>Normal findings, Peripheral neuropathy</td>
<td></td>
</tr>
<tr>
<td>Spinoglenoid notch cyst (ganglion)</td>
<td>Onset of weakness in suprascapular nerve distribution</td>
<td>Weakness of supraspinatus, infraspinatus, or both</td>
<td></td>
</tr>
</tbody>
</table>

**TREATMENT**

The treatment of various types of rotator-cuff lesions is summarized in Table 2. Few randomized trials have compared the effectiveness of different approaches to the management of rotator-cuff lesions, and none have directly compared surgical with nonsurgical intervention. A Cochrane review of various common interventions for rotator-cuff lesions concluded that there were insufficient data to provide support for or refute their use. Most studies have been limited by the lack of a control group, the types of outcome data reported (which have rarely included assessment of both the subjective benefits to the patient and the objective assessment of the integrity of the cuff), follow-up of all prospectively enrolled patients, and the questionable generalizability of studies performed by expert surgeons in major centers. Therefore, the approach to the management of cuff lesions is largely based on clinical experience, an understanding of the anatomy, and the management of other sites, such as the hand and knee.

In contrast to acute full-thickness cuff tears, patients with acute partial-thickness or chronic partial-thickness cuff defects, 70% of partial-thickness cuff defects, and 80% of normal tendons.

Decisions regarding the need for imaging should be based on whether the results are likely to affect treatment. For example, because of the need for prompt repair of an acute full-thickness tear, an expedited ultrasound or MRI study is warranted in a patient who cannot raise his or her arm after a fall. However, imaging of the cuff tendon is unlikely to change the initial care of an elderly patient who has no history of an injury and who reports long-standing weakness, pain, and stiffness in the shoulder, that suggests degenerative cuff failure.
A Palpating cuff defect

B Crepitance

C Supraspinatus

D Subscapularis

E Infraspinatus

F Limited internal rotation in abduction

Physician resistance

Patient motion

Limited internal rotation
Chronic, Full-Thickness, Degenerative Tendon Defects

Most chronic, full-thickness, degenerative tendon defects are best managed without surgery. Non-
surgical approaches include treatment with non-
steroidal antiinflammatory drugs (NSAIDs) or
acetaminophen for discomfort, activity modifi-
cation, and gentle stretching and strengthening
exercises for the muscles that remain intact. Al-
though data are lacking from randomized trials
assessing the benefits of exercise therapy for full-
thickness, degenerative defects, case series and
case reports have shown improvement in comfort
and function with exercise.\(^{36}\)

In a Cochrane review of placebo-controlled,
randomized trials of the use of subacromial in-
jection of corticosteroids for rotator-cuff disease,
some trials showed a modest benefit with this intervention; however, pooled results of three trials comparing subacromial corticosteroid injection with NSAIDs showed no significant benefit of injection. Overall, the authors concluded that the effects of subacromial corticosteroid injection for rotator-cuff disease appeared to be slight and not sustained. Another Cochrane review showed no evidence of a significant benefit of corticosteroid injection in patients with rotator-cuff tears. Because corticosteroid injections may adversely affect tendon quality and their benefit is uncertain, repeated use of injections is discouraged, except in cases in which surgery is not considered an option, the response to other nonsurgical interventions is inadequate, and there is a perceived improvement in symptoms with injection. Other approaches, such as electrotherapy, therapeutic ultrasonography, acupuncture, injection of hyaluronic acid, and shock-wave therapy, have also been used in patients with rotator-cuff failure, but these methods have not been rigorously studied, and the indications and benefits are unclear.

If symptoms persist in spite of nonsurgical measures and the clinical evaluation suggests that the cuff is reparable, surgical repair can be considered. Factors that favor durable surgical reattachment of a detached rotator-cuff tendon include an age of less than 60 years, a traumatic onset of weakness, a short duration of symptoms (e.g., <2 months), no history of smoking, good general health, receipt of only a few (e.g., <4) cortisone injections, no previous shoulder surgery, no detection of atrophy of the muscles on physical examination, stability of the shoulder, a good range of motion in the shoulder, and MRI or ultrasound findings that show minimal retraction, good tendon quality, and minimal muscle atrophy. Reports on the results of surgery for rotator-cuff repair indicate that more than 75% of repairs of defects that involve only the supraspinatus remain intact at 5 years and are associated with improved comfort and function, whereas less than 50% of repairs of defects that involve the supraspinatus and infraspinatus remain intact at 5 years. Improved comfort may be achieved even if the repair does not remain intact. Outcomes have been reported to be best when the repair is performed by a surgeon who is experienced in rotator-cuff reconstruction.

The risks associated with surgery for rotator-cuff repair include infection, postsurgical adhesions with loss of motion, damage to the deltoid from the surgical approach, injury to the axillary nerve, prominent sutures or fixation devices causing roughness in the humeroscapular motion interface (resulting in pain and reduced range of motion), and damage to the coracoacromial arch from acromial resection, leading to anterosuperior escape. These complications are rare in centers with experience in this type of surgery. The risk of a retear after a repair varies substantially with the quality of the tendon and the size of the tear.

The approach to and duration of rehabilitation after rotator-cuff repair depend on the quality of the tendon that was sutured back to the bone and the security of fixation. Rotator-cuff tendons

### Table 2. Treatment of Rotator-Cuff Lesions.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Nonsurgical Management</th>
<th>Surgical Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute rotator-cuff tear</td>
<td>Usually not recommended in active persons</td>
<td>Prompt surgical repair in active persons</td>
</tr>
<tr>
<td>Partial-thickness rotator-cuff lesion</td>
<td>Flexibility exercises to eliminate shoulder tightness, especially of the posterior capsule</td>
<td>Surgical repair often not needed; smoothing of humeroscapular motion interface, cuff curettage, or both may be considered</td>
</tr>
<tr>
<td>Degenerative rotator-cuff failure</td>
<td>Flexibility exercises to restore range of motion, gentle progressive strengthening exercises to increase shoulder function</td>
<td>Surgical repair often not possible; surgical repair may be considered if quality and quantity of tissue are sufficient for durable repair — otherwise, smoothing of humeroscapular motion interface is considered</td>
</tr>
<tr>
<td>Arthritis of humeral head</td>
<td>Flexibility exercises to restore range of motion, gentle progressive strengthening exercises to increase shoulder function</td>
<td>Humeral hemiarthroplasty with careful preservation of coracoacromial arch</td>
</tr>
<tr>
<td>and chronic, massive rotator-cuff defect</td>
<td></td>
<td>Reverse total shoulder arthroplasty to provide necessary glenohumeral stability</td>
</tr>
<tr>
<td>Anterosuperior escape, pseudoparesis,</td>
<td>Flexibility exercises to restore range of motion, gentle progressive strengthening exercises to increase shoulder function</td>
<td></td>
</tr>
</tbody>
</table>

The risk of a retear after a repair varies substantially with the quality of the tendon and the size of the tear.
that failed with minimal injury are at high risk for repeat failure after surgical repair. Two to six sutures are generally used to attach the tendon to the bone; any of these sutures may pull through the tendon with tension overload. All positions and motions of the shoulder apply some load to the repaired cuff. For all these reasons, the surgically repaired cuff must be protected from active use and from falls for at least 3 months after repair, allowing the bone the opportunity to attach to the tendon. The total period of rehabilitation after rotator-cuff repair is often as long as 1 year, during which time the use of the arm remains limited. The recovery period may be shorter with secure repair of acute rotator-cuff defects with good-quality tissue.

In patients in whom the cuff appears to be irreparable but who are bothered by painful crepitance or stiffness, surgery to smooth the humeroscapular motion interface and remove restricting adhesions and scar tissue has been shown to decrease pain and increase range of motion, but it has not been shown to increase strength. When such smoothing procedures are performed, preservation of the integrity of the coracoacromial arch is critical in order to avoid the complication of anterosuperior escape. Because degeneration of the long head of the biceps tendon is frequently associated with cuff failure and may contribute to shoulder pain, surgical intervention may include biceps tenotomy (in which the tendon is cut) or tenodesis (in which the tendon is cut in the joint and secured to the humerus) along with the smoothing procedure.

### AREAS OF UNCERTAINTY

It is unclear why some persons with rotator-cuff failure are symptomatic, whereas others with seemingly identical patterns of failure are asymptomatic. The optimal management of chronic degenerative rotator-cuff lesions remains uncertain, including the approach to exercise programs and the role of complementary therapies. It is unclear when surgical intervention is warranted; a survey of 539 orthopedic surgeons showed remarkable inconsistency in perceptions about the indications for rotator-cuff surgery. Randomized trials are needed to assess and compare nonsurgical with surgical interventions and to assess different surgical procedures for these conditions.

### GUIDELINES

Professional guidelines have been published for the evaluation and management of shoulder conditions, including rotator-cuff lesions; one guideline specifically addresses the imaging of rotator-cuff lesions. The Washington State Department of Labor and Industries and the New Zealand Group have published official recommendations for the treatment of rotator-cuff conditions. These recommendations are consistent with the recommendations in this article.

### CONCLUSIONS AND RECOMMENDATIONS

The diagnosis of rotator-cuff failure is suggested by a history of acute traumatic or progressive, insidious loss of shoulder strength, as described by the patient in the vignette. The physical examination of a shoulder with a rotator-cuff lesion should assess stiffness, pain on resisted motion, weakness, palpable tendon defects, crepitance, atrophy, and instability. Plain radiographs may help rule out other diagnoses that may underlie shoulder pain (e.g., degenerative arthritis of the glenohumeral joint) and may help determine the degree to which the humeral head is aligned with the glenoid. Ultrasonography or MRI is useful for evaluating the integrity of rotator-cuff tendons in patients when this information is needed to help guide treatment, but these imaging examinations may reveal tendon abnormalities even when the shoulder is asymptomatic. When an acute injury results in an abrupt loss of shoulder function, the evaluation of the rotator cuff should be expedited so that a traumatic rotator-cuff tear, if present, can be repaired before muscle and tendon atrophy occur.

With chronic cuff failure, such as in the patient in the vignette, I would recommend initially the use of mild analgesics and exercises to attempt to restore comfort, flexibility, and the strength of the shoulder muscles that remain intact. Exercises performed by the patient with or without the supervision of a therapist should be tried for 6 to 12 weeks to see whether they help. If pain, stiffness, and crepitance remain after the trial of nonsurgical management, I would discuss the potential risks, limitations, and benefits of surgery with the patient. If the patient continued to have bothersome symptoms, I would consider attempting a durable repair if there were minimal muscle atro-
phy and a sufficient quantity and quality of rotator-cuff tendon; if the patient was a poor candidate for repair, a smoothing procedure might be tried to reduce pain and improve range of motion.

No potential conflict of interest relevant to this article was reported.

An audio version of this article is available at www.nejm.org.

REFERENCES


Copyright © 2008 Massachusetts Medical Society.