The case:

A 56-year-old man presented with ongoing right shoulder weakness of 4 years’ duration. While skiing, the patient landed on his right shoulder and felt a sharp pain, but was able to ski for the next 3 days with only minimal pain. At the time of injury, the patient had an area of ecchymosis along the superolateral aspect of the shoulder. He reported weakness primarily when exercising with weights. The affected shoulder demonstrated mild weakness with abduction (Figures 1-4).

Figure 1: AP radiograph of the right shoulder. Figure 2: Coronal T-1 weighted MRI of the shoulder. Figure 3: Sagittal T-1 weighted MRI of the shoulder medial to the glenoid. Figure 4: Sagittal MRI of the shoulder lateral to the glenoid.

Your diagnosis?

For answer see page 1114
Shoulder pain and weakness with rotator cuff tearing is common. The etiology of a tear in young patients usually is a fall of sufficient force onto the shoulder, resulting in an acute avulsion of the rotator cuff from the greater tuberosity. Although similar injury patterns in older patients may result in rotator cuff tearing, an occult shoulder dislocation and proximal humerus fracture should also be suspected.1,2

Isolated greater tuberosity fractures can occur as the result of impaction- or avulsion-type injuries. With impaction, direct force to the shoulder occurs such as with a fall or with hyperabduction and impaction of the greater tuberosity against the acromion or superior glenoid. Avulsion injuries commonly occur in association with anterior glenohumeral dislocation, which did not occur in this described case. In this circumstance, the tuberosity is sheared off by contact against the glenoid as the humeral head dislocates.

Most patients present with pain, swelling, tenderness, and limitation of active and passive range of motion. Significant soft-tissue swelling and ecchymosis may be noted. This injury is commonly associated with an anterior shoulder dislocation and should be ruled out with adequate radiographs. Neurovascular injuries are not uncommon, and a thorough neurologic and vascular examination is necessary to rule out injury.

**IMAGING**

Radiographic evaluation of the injured shoulder should always include a shoulder trauma series with a minimum of three views—anteroposterior (AP), lateral scapula (supraspinatus outlet), and axillary view. The axillary view is necessary to assess a posteriorly displaced greater tuberosity fragment and to rule out posterior fracture-dislocation. Additional AP views in internal and external rotation can provide more details about a fracture of the greater tuberosity and help identify an occult nondisplaced surgical neck fracture.

Determining the amount of tolerable displacement is critical when considering operative treatment of a greater tuberosity fracture. In some cases, computed tomography helps further define the extent of fracture displacement. Coronal and three-dimensional reconstruction images can be used to define the extent of superior displacement of the greater tuberosity. Magnetic resonance imaging (MRI) usually is not indicated for routine evaluation of acute greater tuberosity fractures. However, if radiographs fail to reveal a fracture, and the clinical course is not progressing satisfactorily, MRI can be used to identify occult fractures or rotator cuff tears.2,3 In chronic greater tuberosity fracture, MRI helps assess the extent of rotator cuff injury, including retraction, and the extent of muscle fatty degeneration.

Radiographs in this patient demonstrated a centered humeral head with no evidence of proximal humeral migration (Figure 1). Avulsion of a portion of the greater tuberosity was noted with lucency at its insertion site with a large bony fragment (24 mm) just lateral to the glenoid rim. Magnetic resonance imaging also demonstrated the bony avulsion with retraction of the attached supraspinatus tendon demonstrated on the coronal views (Figure 2). The supraspinatus had moderate fatty infiltration on the medial sagittal images, with tearing of the rotator cuff iden-
TREATMENT

Nonoperative

Nondisplaced greater tuberosity fractures should be treated nonoperatively with close radiographic follow-up. Impacted fractures can be treated with a short period of immobilization, followed by gentle passive motion exercises. Active assisted range of motion can begin after the early healing period (usually 3-6 weeks), with active assisted motion and isometric strengthening after healing is documented radiographically.

Greater tuberosity fractures associated with glenohumeral dislocation usually reduce to an acceptable position and can be treated conservatively. Great care should be taken whenever a fracture-dislocation is reduced manually. If any difficulty presents, a reduction with the patient under anesthesia (general or interscalene nerve block) should be considered to avoid converting a greater tuberosity fracture-dislocation into a three- or four-part fracture. In reduced fracture-dislocations, the shoulder may be immobilized for 2 weeks, followed by passive motion. At 6 weeks, active assisted range of motion and progressive strengthening exercises are begun once healing is identified radiographically. These patients should be carefully followed in the early injury period with at least weekly radiographs to assess for any displacement.

Operative

Operative intervention is warranted for acute tuberosity fractures that are displaced or hinder shoulder abduction. As little as 5 mm of displacement has been associated with sub-
acromial impingement and higher rates of unsatisfactory results when treated nonoperatively.\(^7\) Careful examination of the radiographs in multiple planes may be necessary to properly assess the injury. Surgical treatment with reduction of the fracture fragments and secure internal fixation is recommended. Careful assessment of the rotator cuff is warranted to rule out associated rotator cuff tearing.

Visualization of the rotator cuff and fractured tuberosity can be obtained with a deltoïd-splitting or deltopectoral approach.\(^6\) Techniques using arthroscopic reduction are being developed.\(^8\) An image intensifier is used to verify anatomic reduction. Care should be taken to avoid “over-reduction” of the fragments, thus, placing excess tension on the rotator cuff. Large fragments can be fixed securely with screws and a washer, if necessary. However, smaller fragments may best be secured with suture tension-band fixation.

**DISCUSSION**

Isolated greater tuberosity fractures represent a small percentage of proximal humeral fractures (<2%) and can present as rotator cuff insufficiency if diagnosed late. Recognition of this injury pattern in the acute phase is critical to obtain the best functional outcome.

Treatment of chronic fractures with rotator cuff tearing involves mobilization of the scarred and torn rotator cuff tendons with less predictable results.\(^9\) Early recognition of these injuries is necessary to avoid the late sequela of rotator cuff insufficiency including shoulder weakness and pain. Although the indications for operative treatment are not well-defined, in that the extent of displacement that can be tolerated has not been clearly established, a current trend exists toward operative treatment when the greater tuberosity displacement is >5 mm.

In this case, the patient had only mild to moderate weakness, pain only with heavy activities, and no evidence of impingement from the displaced fragment. Based on the physical findings and minimal limitations, the patient continues with a nonoperative program of gentle therapy and strengthening and will be followed for any worsening of symptoms.

**REFERENCES**


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