Ultrasound of the Shoulder: Asymptomatic Findings in Men

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OBJECTIVE. The purpose of this study was to examine the range and prevalence of asymptomatic findings at sonography of the shoulder.

MATERIALS AND METHODS. The study sample comprised 51 consecutively enrolled subjects who had no symptoms in either shoulder. Ultrasound of one shoulder per patient was performed by a musculoskeletal sonographer according to a defined protocol that included imaging of the rotator cuff, tendon of the long head of the biceps brachii muscle, subacromial-subdeltoid bursa, acromioclavicular joint, and posterior labrum. The shoulder imaged was determined at random. The 51 scans were retrospectively analyzed by three fellowship-trained musculoskeletal radiologists in consensus, and pathologic findings were recorded. Subtle or questionable findings of mild tendinosis, bursal prominence, and mild osteoarthritis were not recorded.

RESULTS. Twenty-five right and 26 left shoulders were imaged. The subject age range was 40–70 years. Ultrasound showed subacromial-subdeltoid bursal thickening in 78% (40/51) of the subjects, acromioclavicular joint osteoarthritis in 65% (33/51), supraspinatus tendinosis in 39% (20/51), subscapularis tendinosis in 25% (13/51), partial-thickness tear of the bursal side of the supraspinatus tendon in 22% (11/51), and posterior glenoid labral abnormality in 14% (7/51). All other findings had a prevalence of 10% or less.

CONCLUSION. Asymptomatic shoulder abnormalities were found in 96% of the subjects. The most common were subacromial-subdeltoid bursal thickening, acromioclavicular joint osteoarthritis, and supraspinatus tendinosis. Ultrasound findings should be interpreted closely with clinical findings to determine the cause of symptoms.

Keywords: asymptomatic findings, musculoskeletal ultrasound, shoulder

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Ultrasound of the shoulder is accepted as the investigation of choice for rotator cuff abnormality in many centers around the world [1–3]. It is also one of the most commonly performed studies among all diagnostic musculoskeletal ultrasound examinations. Study results [3, 4] have indicated that the sensitivity and specificity of ultrasound equal those of MRI in assessment of the rotator cuff. Several advantages of ultrasound are availability, cost-effectiveness, and patient preference for ultrasound evaluation over MRI [5]. Dynamic imaging and immediate patient feedback are other advantages of ultrasound. However, ultrasound is heavily operator dependent, and thorough training of the operator is essential to guarantee high sensitivity and specificity of the diagnostic information obtained.

Incidentally findings of asymptomatic rotator cuff tears have been made at MRI [6–10], ultrasound [11–17], and cadaveric studies [18–21]. A complete routine shoulder examination involves assessment of rotator cuff and surrounding structures [22]. To our knowledge, there have been no peer-reviewed reports of asymptomatic shoulder findings at ultrasound examinations that include the entire anatomy of the shoulder, that is, the rotator cuff and all nearby structures. The purpose of this study was to describe the prevalence of asymptomatic findings at shoulder ultrasound and highlight the spectrum of asymptomatic shoulder abnormalities that may be encountered at sonographic examinations. Awareness of the range of asymptomatic shoulder abnormalities is essential to gaining perspective on the clinical importance of such findings in diagnosis and patient care.

Materials and Methods

Institutional review board approval was obtained before the study, and patient consent was obtained.

The patient sample consisted of 51 consecutively registered men without symptoms who were recruited as a part of a wider study of bone density in the first half of 2009. These patients had gone to the orthopedic clinic because of knee problems. All subjects were men because women were excluded from the study to avoid postmenopausal effects on humeral bone density. All subjects included in the study reported no symptoms, trauma, or treatment involving either shoulder as determined by a sport medicine–trained orthopedic shoulder surgeon. No subject had a history of systemic inflammatory disease. Medical records, including reports of other imaging studies, were reviewed.

All scans were performed according to a routine shoulder protocol with a 12-MHz linear-array high-frequency transducer (model iU-22, Philips Healthcare). Scans were performed by one of two musculoskeletal sonographers (each with more than 5 years of musculoskeletal scanning experience), and both static images and cine clips were recorded. The sonographer who performed the scan was blinded to the subject's dominant side, and a single randomly determined shoulder was scanned per patient. The routine shoulder ultrasound protocol at our institution included evaluation of the rotator cuff and the tendon of the long head of the biceps brachii muscle in the long and short axes and of the subacromial-subdeltoid bursa, acromioclavicular joint, and posterior labrum. Dynamic assessment for subacromial impingement and subluxation and dislocation of the long head of the biceps brachii was also performed.

Shoulder ultrasound static images and cine clips were retrospectively reviewed by three musculoskeletal radiologists fellowship trained in obtaining and evaluating musculoskeletal ultrasound images; each had more than 5 years of musculoskeletal scanning experience. Only definitive sonographic abnormalities agreed on by the three musculoskeletal radiologists in consensus were included in the study.

The ultrasound diagnoses of pathologic findings were based on the following criteria. Full-thickness tear was defined as discontinuity of the tendon fibers resulting in communication between the articular and bursal surfaces appearing as a hypoechoic or anechoic defect. Supraspinatus tears extending 2.5 cm or more posterior to the biceps tendon in the transverse view were regarded as tears extending into the infraspinatus. Partial-thickness tear was defined as partial tear of the tendon fibers involving either the bursal or the articular surface that appeared as a focal hypoechoic or anechoic defect not traversing the entire tendon thickness. Tendinosis was defined as tendon thickening associated with abnormal echogenicity and loss of the normal fibrillar echotexture of the tendon evaluated subjectively by consensus. Atrophy was defined as increased muscle echogenicity and decreased size. Calcification was defined as echogenic focus with or without posterior acoustic shadowing. Biceps brachii long head subluxation was defined as biceps partially medial to the bicipital groove location. Biceps brachii long head dislocation was defined as biceps tendon completely out of the bicipital groove. Biceps brachii long head tendon tear was defined as discontinuity and absence of biceps tendon in the bicipital groove. Distention of the biceps brachii tendon sheath was defined as hypoechoic or anechoic fluid or hypoechoic soft tissue surrounding the biceps tendon. Subacromial-subdeltoid bursal thickening was defined as focal or diffuse bursal thickening of more than 2-mm transverse thickness with associated hypoechogenicity with or without bursal fluid [23]. Subacromial impingement was defined as pooling of subacromial-subdeltoid bursal content just lateral to the acromion at dynamic shoulder abduction evaluation [24]. Acromioclavicular osteoarthritis was defined as the presence of osteophytes with associated articular surface irregularity with or without joint effusion or capsular thickening. Posterior glenoid labral abnormality was defined as abnormal hypoechogenicity or anechoic cleft.

TABLE 1: Prevalence of Asymptomatic Shoulder Ultrasound Findings (*n* = 51)

Finding	Prevalence (%)
Supraspinatus	
Full-thickness tear	10 (5)
Partial-thickness tear, articular	4 (2)
Partial-thickness tear, bursal	22 (11)
Tendinosis	39 (20)
Calcification	4 (2)
Infraspinatus	
Full-thickness tear	4 (2)
Tendinosis	10 (5)
Subscapularis	
Tendinosis	25 (13)
Partial-thickness tear	10 (5)
Calcification	4 (2)
Teres minor atrophy	8 (4)
Biceps brachii	
Tendinosis	4 (2)
Full-thickness tear	2 (1)
Fluid distention of sheath	2 (1)
Subluxation or dislocation	6 (3)
Subacromial-subdeltoid bursal thickening	78 (40)
Subacromial impingement	6 (3)
Acromioclavicular osteoarthritis	65 (33)
Posterior labrum abnormality	14 (7)

Note—Values in parentheses are number of cases.

In an attempt to increase specificity and eliminate false-positive diagnoses, questionable or mild cases of tendinosis, osteoarthritis, bursal surface or articular surface fraying, possible bursal thickening, and partial-thickness tears of the biceps brachii long head tendon were excluded from analysis.

Results

The study group consisted of 51 men (average age, 56 years; range, 40–70 years) who did not have shoulder symptoms. Twenty-five ultrasound examinations were performed on the right shoulder and 26 on the left. Of these examinations, 25 were performed on the dominant side and 22 on the nondominant side; four subjects were ambidextrous. Abnormalities were found at ultrasound in 96% (49/51) of the subjects. Of the two studies with normal findings, one was performed on the dominant side and the other on the nondominant side. The prevalence of the findings is shown in Table 1.

Rotator Cuff

Asymptomatic rotator cuff (supraspinatus, infraspinatus, subscapularis, and teres minor)

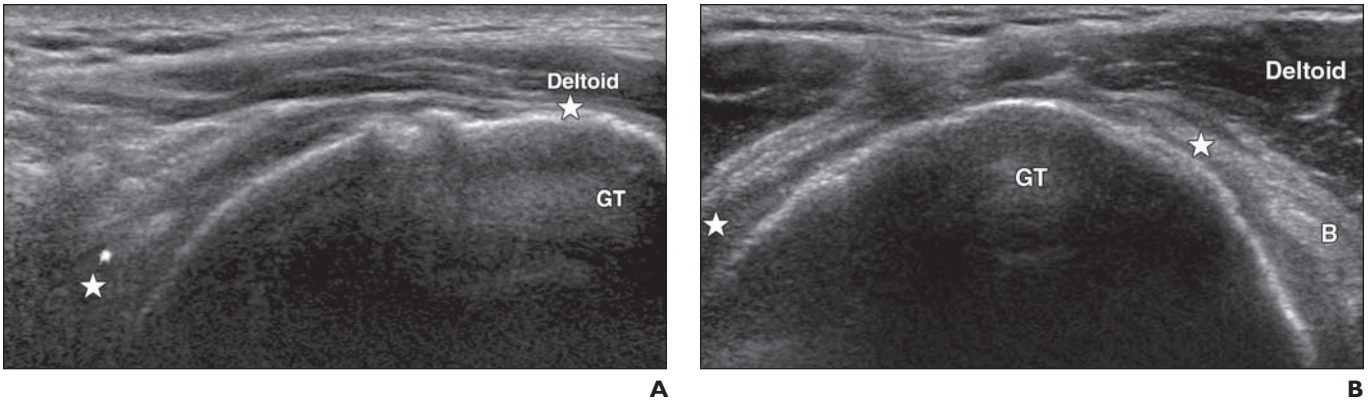


Fig. 1—61-year-old man with asymptomatic full-thickness supraspinatus tear.
A and **B,** Long-axis (**A**) and short-axis (**B**) ultrasound images in expected location of supraspinatus tendon show complete full-thickness tear of supraspinatus tendon (between *stars*). GT = greater tuberosity, B = tendon of long head of biceps brachii muscle.

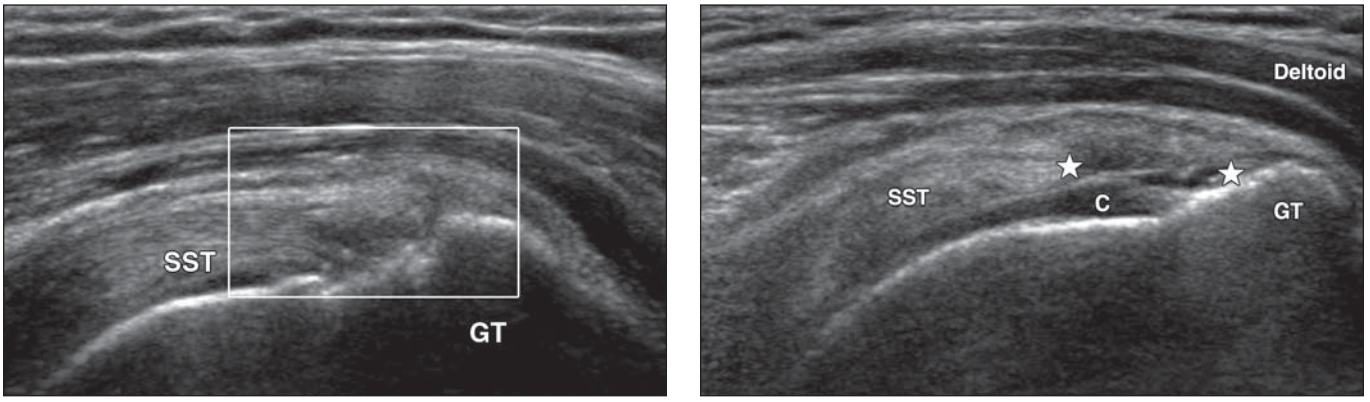


Fig. 2—59-year-old man with asymptomatic partial-thickness tear of bursal surface of supraspinatus tendon. Long-axis ultrasound image of supraspinatus tendon shows predominately hypoechoic bursal surface tear (*box*). Articular fibers deep to bursal surface tear are intact. SST = supraspinatus tendon, GT = greater tuberosity.

Fig. 3—55-year-old man with asymptomatic partial-thickness tear of articular surface of supraspinatus tendon. Long-axis ultrasound image of supraspinatus tendon shows hypoechoic articular surface tear (between *stars*) and intact bursal fibers overlying articular surface tear. SST = supraspinatus tendon, C = cartilage, GT = greater tuberosity.

abnormality (tear, tendinosis, calcification, atrophy) was noted in 75% (38/51) of the shoulders. Supraspinatus tendon abnormality was found in 65% (33/51) of the subjects; 10% (5/51) of these men had a full-thickness tear (Fig. 1). All the full-thickness tears were located at the distal attachment site of the tendon and involved the anterior fibers. Two of the tears extended posteriorly to involve the posterior fibers of the supraspinatus tendon. Three of the full-thickness tears of the supraspinatus tendon were found on the dominant side and two on the nondominant side. The supraspinatus tendon had partial-thickness tears in 24% (12/51) of subjects, and nearly all (92%, 11/12) were partial-thickness tears of the bursal surface (Fig. 2). One subject had tears of both the bursal and articular surfaces, which did not communicate. One subject had a partial-thickness tear involving only the articular surface (Fig. 3). All but one of the supraspinatus tendon tears were associated with subacromial-subdeltoid bursal thickening. Thirty-nine percent (20/51) of the subjects had supraspinatus tendinosis (Fig. 4). Calcification was seen in 4% (2/51) of supraspinatus tendons (Fig. 5).

Infraspinatus tendon abnormality was found in a small minority of the cases and was always associated with supraspinatus abnormalities in this study. Ten percent (5/51) of subjects had tendinosis, and 4% (2/51) had full-thickness tears. Both of these cases of full- thickness infraspinatus tendon tears were associated with full-thickness tears of the adjacent supraspinatus tendon.

With regard to the subscapularis tendon, no full-thickness tears were encountered. Ten percent (5/51) of subjects had a partial-thickness tear of the subscapularis. Twenty-five percent (13/51) of subjects had subscapularis tendinosis (Fig. 6). Tendon calcification was seen in 4% (2/51) of subjects.

Teres minor atrophy was found in 8% (4/51) of the subjects (Fig. 7) and was independent of adjacent infraspinatus abnormalities. No teres minor tendon tears, tendinosis, or calcification were identified.

Biceps Brachii Long Head

Tendinosis of the biceps brachii long head was found in 4% (2/51) and full-thickness complete tendon tear in 2% (1/51) of subjects (Fig. 8). The only full-thickness tear of the biceps tendon was in a nondominant shoulder. Fluid and soft-tissue distention of the biceps brachii tendon sheath was found in 2% (1/51) of subjects. Medial subluxation of the biceps brachii long head tendon was found in 4% (2/51) (Fig. 9) and medial dislocation with an empty bicipital groove in 2% (1/51) of the men. All cases of medial subluxation of the biceps brachii long head tendon were associated with an adjacent partial-thickness tear of the subscapularis tendon involving the superior fibers of the subscapularis. Supraspinatus tendon tear was seen in the one case of full-thickness biceps brachii

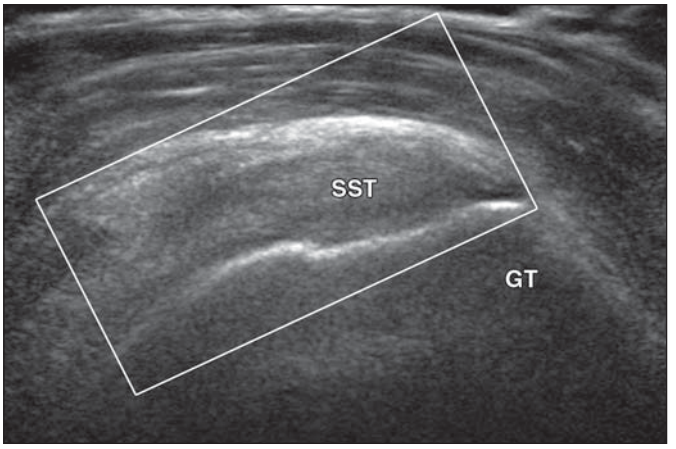


Fig. 4—62-year-old man with supraspinatus tendinosis. Long-axis ultrasound image of supraspinatus tendon shows thickening and hypoechogenicity of tendon with loss of normal fibrillar echotexture. SST = supraspinatus tendon, GT = greater tuberosity.

tendon tear (100%) and the two cases of medial biceps subluxation (50%).

Subacromial-Subdeltoid Bursa

Ultrasound images showed thickening of the subacromial-subdeltoid bursa in 78% (40/51) of subjects (Fig. 10). Seven of these men had associated fluid in the bursa. Subacromial impingement was found in 6% (3/51) of subjects (Fig. 11). Supraspinatus tendon tears were seen in 40% (16/40) of subjects with subacromial-subdeltoid bursal thickening.

Acromioclavicular Joint

Sixty-five percent (33/51) of the shoulders imaged had osteoarthritis of the acromioclavicular joint (Fig. 12).

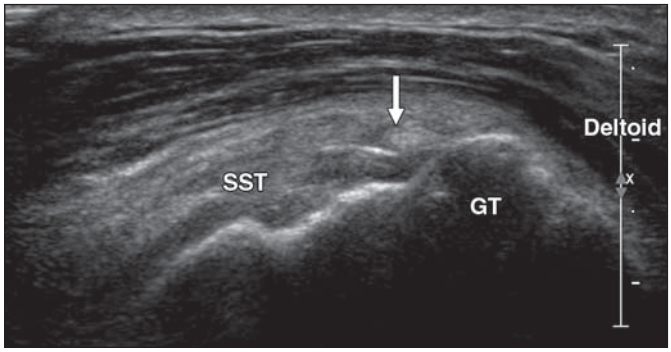
Posterior Glenoid Labrum

The posterior glenoid labrum was found to be abnormal in 14% (7/51) of subjects.

Discussion

Our study results show the variety of incidental asymptomatic abnormal findings in the shoulder on ultrasound scans. Asymptomatic shoulder abnormalities were found in 96% of subjects. The most common were subacromial-subdeltoid bursal thickening (78%), acromioclavicular joint osteoarthritis (65%), and supraspinatus (39%) and subscapularis (25%) tendinosis.

With regard to asymptomatic rotator cuff abnormalities, we found the rate of full-thickness tears of the supraspinatus tendon in our study to be 9.8%, slightly higher than the



A

B

Fig. 5—70-year-old man with asymptomatic supraspinatus tendon calcification.
A and **B,** Long-axis ultrasound image of supraspinatus tendon (SST) (**A**) and anteroposterior external rotation radiograph (**B**) obtained as part of original bone density study show calcification (*arrow*) within tendon. GT = greater tuberosity.

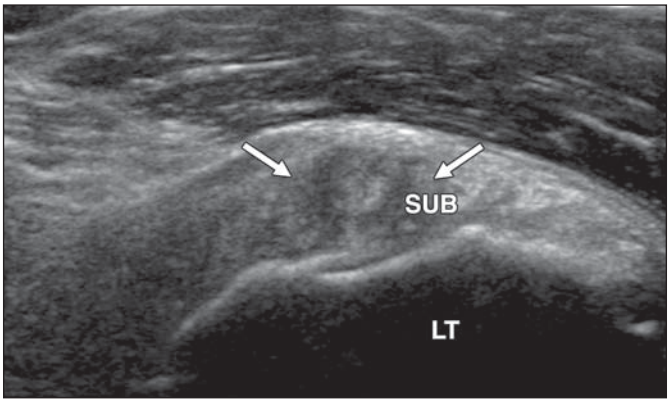


Fig. 6—62-year-old man with asymptomatic subscapularis tendinosis. Short-axis ultrasound image of subscapularis tendon (SUB) shows heterogeneity and hypoechoic thickening (*arrows*) of superior fibers of subscapularis tendon. LT = lesser tuberosity.

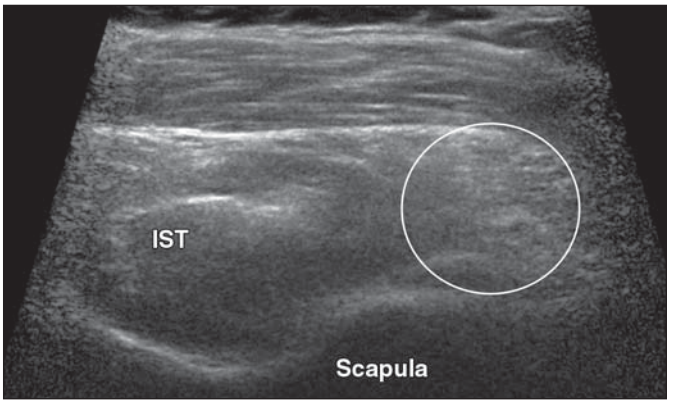


Fig. 7—49-year-old man with asymptomatic teres minor muscle atrophy. Short-axis ultrasound image of teres minor and infraspinatus (IST) musculature shows loss of volume and increase in echogenicity of teres minor (*circle*) in keeping with teres minor atrophy.

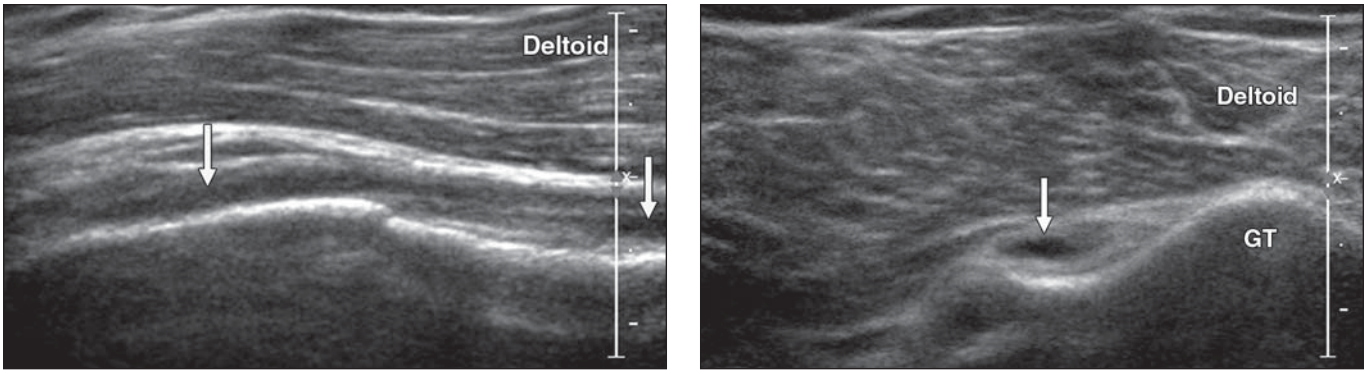


Fig. 8—54-year-old man with asymptomatic full-thickness tear of tendon of long head biceps brachii muscle.
A and **B,** Long-axis (**A**) and short-axis (**B**) ultrasound images (in relation to bicipital groove) show complete absence of biceps brachii long head tendon with residual fluid (*arrows*) in bicipital groove. GT = greater tuberosity.

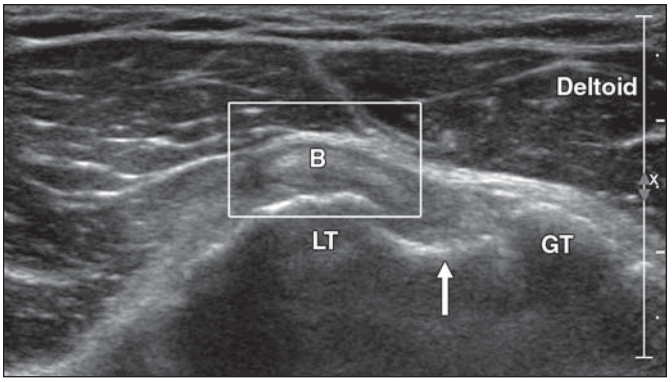


Fig. 9—51-year-old man with asymptomatic medial subluxation of biceps brachii tendon. Short-axis ultrasound image of long head of biceps brachii tendon shows medial subluxation of biceps tendon (B) from bicipital groove (*arrow*) overlying lesser tuberosity (LT). GT = greater tuberosity.

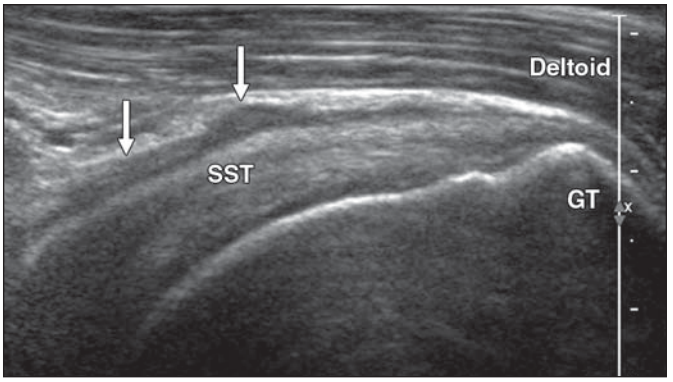


Fig. 10—54-year-old man with asymptomatic subacromial-subdeltoid bursal thickening. Long-axis ultrasound image of supraspinatus tendon (SST) in shows subacromial-subdeltoid bursal thickening (*arrows*) between supraspinatus and deltoid muscles. GT = greater tuberosity.

7.6% reported by Moosmayer et al. [25] and 6% reported by Schibany et al. [14] and lower than the 21.7% reported in a meta-analysis of cadaveric studies by Reilly et al. [26]. Other authors, such as Sher et al. [10], found a higher rate of full-thickness tears, close to 15%, likely because of an older population. Their sample included subjects as old as 88 years, and 90% of the tears were found in subjects older than 60 years. None of our subjects was older than 70 years, and the mean age was 56 years. We did not identify any full-thickness supraspinatus tendon tears in the 40- to 50-year-old group. Two (4%) full-thickness tears supraspinatus were in the 51- to 60-year-old group. Three full-thickness tears (6%) were found in the 61- to 70-year-old group, in keeping with the findings noted by Moosmayer et al. in the same age group. This increase in prevalence of tears with increasing age is consistent with findings in other studies [13, 16, 27].

The literature on the presence and quantification of asymptomatic partial-thickness rotator cuff tears is scant. Milgrom et al. [11] documented a 17.2% frequency of partial-thickness supraspinatus tears. We found partial-thickness supraspinatus tears in 24% of the subjects, a rate slightly higher possibly owing to patient selection or improved technology and use of high-frequency transducers. Partial-thickness supraspinatus tears were overwhelmingly more common on the bursal surface, 85% of partial-thickness tears having bursal surface involvement. We did not find any reports of comprehensive evaluations of partial-thickness tears with which to compare our data.

We found that asymptomatic full-thickness tears were uncommonly found outside the supraspinatus tendon; this findings is consistent with those of other studies [14, 15, 25]. Two of our subjects had full-thickness tears of the infraspinatus tendon, both of which were associated with a supraspinatus tear. No subject had a full-thickness tear of the subscapularis tendon. Another finding in the rotator cuff was four cases (8%) of teres minor atrophy. Friend et al. [28] found teres minor atrophy in 3% of cases and theorized that this asymptomatic finding may be due to variations in teres minor innervation.

With regard to the long head of the biceps brachii tendon, one full-thickness tear was identified in this study. We did not find documentation of this type of asymptomatic tear in the peer-reviewed literature. The supraspinatus tendon was also torn in this subject.

We found subacromial-subdeltoid bursal thickening in 78% of subjects; only 14% of thickened areas contained bursal fluid. This result suggests that an isolated finding of subacromial-subdeltoid bursal abnormality is not an indicator of symptomatic subacromial external impingement. A study by Oschman et al. [13] showed that 4% of subjects who had no symptoms had the changes of subacromial-subdeltoid bursitis, although asymptomatic effusion was seen in 36% of overhead-throwing athletes [12]. Among the cases of full-thickness

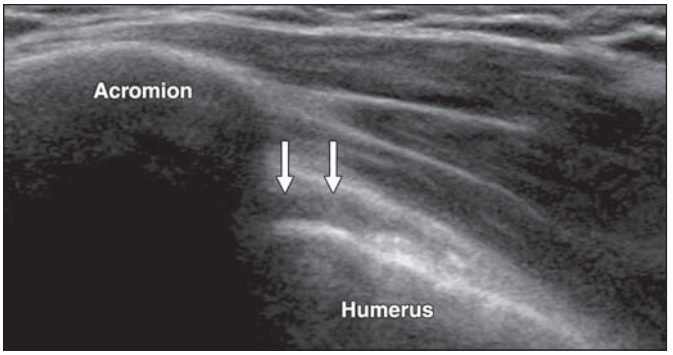


Fig. 11—59-year-old man with asymptomatic subacromial impingement. Ultrasound image over lateral acromion in coronal plane with shoulder in active abduction shows pooling of fluid in subacromial-subdeltoid bursa (*arrows*) between acromion and greater tuberosity.

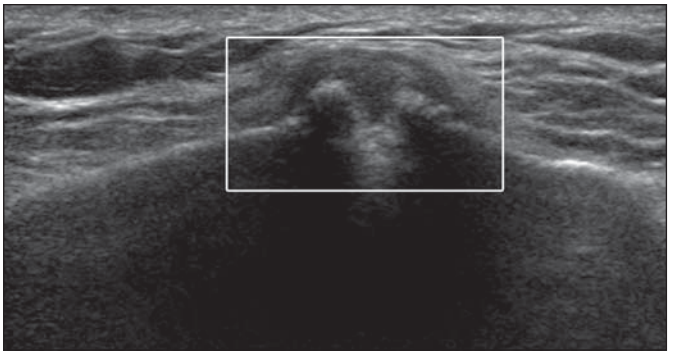


Fig. 12—53-year-old man with asymptomatic acromioclavicular osteoarthritis. Ultrasound image of acromioclavicular joint (*box*) shows osteophyte formation and cortical irregularity of articular surface. Clavicle is on left side of image and acromion on right.

tear of the supraspinatus tendon in our study, we found that 40% were associated with subacromial-subdeltoid bursal effusion. The presence of bursal effusion in a similar population ranged from none reported by Tempelhof et al. [15] through 34.3% in a study by Moosmayer et al. [25] to 100% reported by Needell et al. [8]. Of our cases of bursal thickening or fluid accumulation, 40% were associated with supraspinatus tear. We also found three cases (6%) of impingement, all of which were asymptomatic.

The high rate of osteoarthritis of the acromioclavicular joint (65%) in our study is not unexpected because of the age of our subjects. Fialka et al. [27] found that the acromioclavicular joint often has degenerative changes by the third decade of life. Because ultrasound is sensitive to cortical irregularity, detection of early asymptomatic degenerative change is likely.

We acknowledge several possible limitations of this study. The sample was not representative of the general population because all of the subjects were men recruited at a sports medicine clinic and had problems remote to the shoulder. However, the subjects were recruited into the study by a shoulder surgeon after a careful history and clinical examination of both shoulders, and shoulders exhibiting any symptoms were excluded. Because the cases were asymptomatic, there was no surgical confirmation or clinical follow-up. To compensate for this limitation, only obvious abnormal ultrasound findings interpreted in consensus by all three radiologists were included. We understand that there is also the possibility of recall bias of the patient sample with regard to the absence of previous symptoms. A current absence of symptoms does not exclude the development of symptoms at a later date. Radiographs were not available in all cases. When radiographs were available, only an anteroposterior view was obtained. Consensus reading of the images was performed, but because specificity was believed most important, we believe this method was reasonable.

Conclusion

Asymptomatic shoulder abnormalities were found in 96% of subjects 40–70 years old. The most common abnormalities were subacromial-subdeltoid bursal thickening, acromioclavicular joint osteoarthritis, and supraspinatus tendinosis. Our results in the absence of symptoms suggest that when symptoms are present, ultrasound findings should be interpreted closely with clinical findings to determine the cause.

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