Association of Sonographically Detected Subacromial/Subdeltoid Bursal Effusion and Intraarticular Fluid with Rotator Cuff Tear

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OBJECTIVE. Although an association between sonographically detected joint fluid and rotator cuff disease has been reported, the significance of sonographically detected subacromial/subdeltoid bursal effusion has not been studied. We examined a group of patients who had shoulder sonography and surgery to determine the association between bursal and joint effusion and surgically proved tears of the rotator cuff.

MATERIALS AND METHODS. We retrospectively reviewed the preoperative shoulder sonography reports of 163 patients for the presence of fluid within the subacromial/subdeltoid bursa or glenohumeral joint. Surgical reports were obtained to determine the status of the rotator cuff. The sonographic reports of 232 asymptomatic shoulders were also reviewed to determine the prevalence of fluid within the subacromial/subdeltoid bursa or the glenohumeral joint.

RESULTS. Sixty-seven (41%) of the 163 patients had a joint effusion, bursal fluid, or both. Joint effusion alone was seen in 35 patients. Fourteen of these had a normal rotator cuff at surgery, and 21 had a rotator cuff tear (sensitivity, 22%; specificity, 79%; positive predictive value, 60%). Bursal fluid alone was seen in 10 patients, seven of whom had a rotator cuff tear (sensitivity, 7%; specificity, 96%; positive predictive value, 70%). In 22 patients, fluid was seen in both the bursa and the joint; 21 had surgically proved rotator cuff tears (sensitivity, 22%; specificity, 99%; positive predictive value, 95%). Of the 232 asymptomatic shoulders, 16 (6.9%) had isolated joint effusions, eight (3.4%) had isolated bursal effusions, and four (1.7%) had both joint and bursal effusions.

CONCLUSION. The sonographic finding of intraarticular fluid alone (without bursal fluid) has both a low sensitivity and a low specificity for the diagnosis of rotator cuff tears. However, the finding of fluid in the subacromial/subdeltoid bursa, especially when combined with a joint effusion, is highly specific and has a high positive predictive value for associated rotator cuff tears. Sonographically detected fluid in both the joint and the bursa is an uncommon finding in asymptomatic shoulders. The sonographic observation of fluid in the subacromial bursa, either isolated or combined with a joint effusion, should prompt a careful evaluation of the supraspinatus tendon for tear.

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Sonography is a useful and efficient diagnostic technique for examining patients with shoulder pain [1]. In addition to allowing assessment of the rotator cuff, sonography also allows direct examination of the biceps tendon and the subacromial/subdeltoid (SA/SD) bursa. Although a small amount of fluid within the biceps tendon sheath may be a normal finding, larger quantities of fluid are abnormal and may be seen with rotator cuff tears, biceps tendinitis, and other pathologic conditions [2]. Fluid within the SA/SD bursa is also thought to be an important indirect sign of rotator cuff tear, but the finding is nonspecific and may be seen in cases of inflammatory arthropathy, trauma, and impingement [3].

The purpose of our study was to determine the association between sonographically detectable SA/SD bursal and joint fluid and surgically proved rotator cuff tears in a series of patients with shoulder pain.
Materials and Methods

We evaluated written sonographic reports and medical and surgical records resulting from 640 bilateral shoulder sonograms that were obtained at our institution over a 3-year period.

Of the 640 patients, 181 had either open or arthroscopic surgery. After exclusion of 18 patients because of incomplete medical or surgical records, our final study population included 102 men and 61 women, 29–82 years old (mean, 52 years). A total of 92 open surgical and 71 arthroscopic procedures were performed. Sonograms were obtained in all cases because of shoulder pain and a clinical suspicion of rotator cuff pathology. To determine the prevalence of joint and bursal fluid collections in a control population, we also reviewed the sonographic reports of 232 patients in whom the asymptomatic contralateral shoulder had been examined.

The shoulders were examined by one of five staff radiologists with special training in shoulder sonography and variable years of experience (1–10 years), using a technique previously reported by Mack et al. [1, 4]. With the patient seated, the biceps tendon and rotator cuff were examined in the longitudinal and axial planes using high-resolution linear-array transducers (7.0-MHz or greater) and an Acuson 128 EP or XP-10 (Mountain View, CA), ATL HDI (Bothell, WA), or Diasonics VST or VST Masters Series (Milpitas, CA) system. Shoulders were examined both with neutral positioning of the humerus and with the humerus in internal rotation and extension. The latter maneuver rotates the supraspinatus tendon out from under the acromion and, in our experience, is the best position in which small amounts of fluid may be detected within the SA/SD bursa.

For the purposes of this study, we specifically disregarded the sonographic appearance of the rotator cuff. A joint effusion was diagnosed when fluid was seen within the biceps tendon sheath (Fig. 1). The amount of intraarticular fluid was not measured. Fluid within the SA/SD bursa was seen as an anechoic layer interposed between the two thin hypechoic lines of the peribursal fat, between the deltid muscle and the supraspinatus tendon. This fluid is best seen lateral to the greater tuberosity of the humerus and often is teardrop-shaped (Fig. 2). Patients were assigned to one of four groups on the basis of the presence or absence of sonographically detected fluid collections: those with only a joint effusion, those with only a bursal effusion, those with both a joint and a bursal effusion, and those with neither a joint nor a bursal effusion. The presence or absence of joint and bursal effusions was correlated with the status of the rotator cuff at surgery.

Sensitivities, specificities, and positive predictive values (PPVs) for these sonographic findings were calculated. Data were analyzed with the Fisher exact test, using Instat software (Graft Pad, San Diego, CA).

Results

Sixty-seven (41%) preoperative patients had either a joint effusion, bursal fluid, or both. Forty-nine (52%) of the 95 patients with surgically proved rotator cuff tears had sonographically detected fluid in either the joint, the bursa, or both. Joint effusion alone was seen in 35 patients. Fourteen (40%) of these had a normal rotator cuff at surgery, and 21 (60%) had a rotator cuff tear (16 full-thickness, five partial-thickness). SA/SD bursal fluid alone was seen in 10 patients, seven (70%) of whom had a surgically proved rotator cuff tear (five full-thickness, two partial-thickness). Twenty-two patients had sonographically detected fluid in both the joint and the bursa. Twenty-one (95%) of these patients had rotator cuff tears at surgery (16 full-thickness, five partial-thickness). In comparison, when we examined 232 asymptomatic shoulders, we found 16 (6.9%) subjects with isolated joint effusions, eight (3.4%) with isolated bursal effusions, and only four (1.7%) with both joint and bursal effusions.

The sonographic finding of an isolated intraarticular effusion, independent of its size, has a sensitivity of 22%, a specificity of 79%, and a PPV of 60% for the diagnosis of
rotator cuff tear. In contrast, for the finding of bursal fluid alone, the sensitivity is 7%, the specificity is 96%, and the PPV is 70%; for the finding of both a bursal and a joint effusion, the sensitivity is 22%, the specificity is 99%, and the PPV is 95%. No statistically significant association was found between rotator cuff tear and the sonographic presence of bursal or joint effusion \( p = .5 \) and \( p = 1.0 \), respectively; however, the association between rotator cuff tear and fluid in both the joint and the bursa was statistically significant \( p < .0001 \).

**Discussion**

Rotator cuff tears are a frequent cause of shoulder pain and are often difficult to diagnose clinically. Sonography has been advocated as a quick, efficient, and accurate imaging examination to evaluate the rotator cuff for tears [4]. However, the reported sensitivity and specificity of sonography for the detection of rotator cuff tears vary, ranging from 58% to 93% and 25% to 98%, respectively [2, 5–10]. In addition, the accuracy of shoulder sonography has been questioned by some authors [5, 6]. Because sonography can easily identify collections of intraarticular and bursal fluid [3, 11], we sought to determine whether the presence of such fluid collections could improve our ability to diagnose rotator cuff tears.

The significance of intraarticular fluid, shown sonographically as fluid within the biceps tendon sheath, has been previously studied [2]. Eighteen (90%) of 20 patients with an effusion extending into the biceps tendon sheath had a variety of pathologic conditions of the shoulder, including impingement syndrome, adhesive capsulitis, glenoid fracture, and loose bodies. Eleven patients (55%) had a frank rotator cuff tear. These findings led the authors to conclude that when fluid is detected sonographically in the biceps tendon sheath, the rotator cuff should be evaluated carefully for a tear [2]. Our findings confirm those reported by Middleton et al. [2], as 21 (60%) of our 35 patients with fluid in the biceps tendon sheath had a surgically proved rotator cuff tear.

To our knowledge, the significance of sonographically detected fluid in the SA/SD bursa has not been specifically studied. Nevertheless, the sonographic presence of such fluid is thought to be an important secondary sign of rotator cuff tear [3, 12]. While evaluating a group of 381 patients for impingement syndrome, Farin et al. [13] found sonographic abnormalities (bursal fluid or thickening) of the SA/SD bursa in 68 patients, 38 (56%) of whom had rotator cuff tears. van Holsbeeck et al. [3] incidentally observed that more than 90% of patients with SA/SD bursal effusions had an associated rotator cuff tear. Moreover, the specificity of this finding appears to be high. Although bursal fluid certainly may be seen in the absence of rotator cuff disorders (i.e., primary bursitis from a number of different origins), we found the sonographic presence of bursal fluid to have a specificity of 96% for the diagnosis of rotator cuff tears. Analysis of the data reported by Farin et al. [13] shows a similar high specificity of 87%. Moreover, in a group of patients with painful shoulders, we found that the detection of both a joint effusion and a bursal effusion improved the specificity for the diagnosis of rotator cuff tear to 99%, making this an extremely important sonographic finding. The pathologic basis of fluid within both the bursa and the joint in patients with a full-thickness rotator cuff tear can be explained by the communication of these two spaces through the defect. It is more difficult, however, to explain the presence of such fluid when there is only a partial-thickness rotator cuff tear. We suggest that the findings may be related to severe chronic repetitive stress (impingement), which also weakens the rotator cuff and ultimately causes it to tear. Another possible explanation is that there may be fenestrations within the partially torn rotator cuff that allow fluid from the joint to communicate with the bursa.

The prevalence of bursal and joint effusions on shoulder sonograms of otherwise healthy subjects has not been previously determined. Our results, gathered from examination of the contralateral asymptomatic shoulder of patients with unilateral shoulder pain, suggest that the sonographic finding of an isolated joint or bursal effusion is uncommon and the finding of combined joint and bursal effusions more uncommon still in an asymptomatic subject. Indeed, these results could be an overestimation of the true prevalence of these fluid collections, because it may be argued that abnormal stresses may be placed on these normal shoulders because of the pathologic changes in the contralateral shoulder. These data conflict, however, with the published MR imaging studies in which small quantities of fluid are routinely seen within the SA/SD bursa and biceps tendon sheath of healthy volunteers [14, 15]. In one study, fluid was detected within the SA/SD bursa of 20% of healthy subjects [14]. This discrepancy between sonography and MR imaging may be due to several factors, including differences in patient population, the higher conspicuity of scant amounts of fluid with MR imaging, sonographic obscuration of fluid located only within the subacromial bursa by the acromion, or failure of sonography to detect fluid with internal echoes [13]. Additional sonographic studies of healthy volunteers, possibly in conjunction with MR imaging, may be necessary to determine the true prevalence of detectable bursal and joint fluid.

Two criticisms of this study are apparent. First, the amount of fluid within the bursa and biceps tendon sheath was not measured, and the diagnosis of an effusion was therefore subjective. However, because previous sonographic studies of bursal or intraarticular fluid also have not measured the amount of fluid present [2, 13], we presumed that the determination of an effusion by an experienced sonologist at the time of the examination was adequate. Second, for the purpose of this study, in our retrospective review we essentially ignored the sonographic appearance of the rotator cuff. This choice, of course, would not be the case in clinical practice, where the contours and echogenicity of the rotator cuff are carefully evaluated to exclude tears. However, even when one does examine the cuff sonographically, small tears may be missed. When we reviewed the dictated reports of the subset of patients with both bursal and joint effusions, we found that six (29%) of 21 surgically proved rotator cuff tears were not detected prospectively. Three of these six rotator cuff tears were partial-thickness tears, and the other three were full-thickness tears of the supraspinatus tendon at sur-
surgery. The high specificity of combined bursal and joint effusions for rotator cuff tears may help reduce some of these false-negative diagnoses by increasing the sonologist’s level of suspicion in difficult or equivocal cases.

In summary, the sonographic detection of fluid in the SA/SD bursa, especially when seen in conjunction with a joint effusion, is highly specific and has a high PPV for rotator cuff tears. Although relatively insensitive, the finding of combined bursal and joint effusion should prompt careful sonographic evaluation of the rotator cuff for tear. If none is detected, then further evaluation with either MR imaging or arthrography is recommended. Similarly, we concur with others that the sonographic detection of fluid in the biceps tendon sheath may be associated with the presence of rotator cuff tears [2]. Although this finding has a lower specificity and lower PPV, its recognition should still prompt careful evaluation of the rotator cuff.

REFERENCES