Detection of Subacromial Bursa Thickening by Sonography in Shoulder Impingement Syndrome

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Background: Normally, the subacromial-subdeltoid bursa is thinner than 2 mm using ultrasound examination. The subtle thickening of the bursa could be an early sign of subacromial impingement and possibly a rotator cuff tear. The aim of this study was to compare the thickness of subacromial bursa measured using ultrasonography in the painful shoulder with normal side, and also to differentiate Neer stages I and II impingements in patients with unilateral shoulder pain.

Methods: We performed bilateral shoulder sonography in 268 consecutive patients with unilateral shoulder pain and clinical suggestion of rotator cuff pathology. The study group consisted of 102 cases of Neer stage I and 166 cases of Neer stage II impingement syndrome. The bursa thickness was calculated from the superficial peribursal fat to the upper margin of the supraspinatus.

Results: A statistically significant association was detected ($p < .0001$) between the symptomatic shoulder and asymptomatic side (mean thickness, 1.27 mm/0.75 mm). The thickness of bursa in patients with Neer stage I impingement had no statistically important link the results of the patients with Neer stage II impingement.

Conclusion: Increased bursa thickness in the symptomatic side may be an alternative sonographic indicator of subacromial bursitis and partial-thickness rotator cuff tears, even when measured to be less than 2 mm. Sonographic examination of subacromial bursa thickness is not an appropriate technique to differentiate the Neer stages I and II impingement. Further study is needed to quantify the echogenicity of the supraspinatus tendon and to show a level of accuracy in patients with rotator cuff tendinosis or partial tears.

(Chang Gung Med J 2007;30:135-41)

Key words: ultrasonography, subacromial-subdeltoid bursa, impingement, rotator cuff

Tendinitis of the rotator cuff, subacromial-subdeltoid bursitis (SA/SD) and biceps tendinitis frequently result in shoulder pain. Since many clinical tests for diagnosing painful shoulder are unreliable in determining the location of the periarticular lesions, various forms of diagnostic imaging are required.[1] In the United States, magnetic resonance imaging has been frequently employed to image the rotator cuff. Fluid in the subacromial bursa was formerly an adjunctive sign when diagnosing full-thickness tear

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Received: Jun. 16, 2006; Accepted: Oct. 24, 2006

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of the rotator cuff with MRI.[2,3]

Ultrasonography of the shoulder has sensitivity and specificity rates of 80 to 100% and 91 to 100% in the diagnosis of full-thickness rotator cuff tears, respectively.[4-9] Ultrasonography was frequently applied when diagnosing partial-thickness rotator cuff tears, SA/SD bursitis and biceps tendonitis.

The SA/SD bursa is normally under 2 mm thick and appears as a hypoechoic strip sandwiched by hyperechoic peribursal fat, which is sandwiched by the deltoid muscle and the supaspinatus tendon.[6,10] van Holsbeeck et al mentioned that subtle thickening of the bursa could be an early sign of subacromial impingement and more than 90% of patients with pathologic distension of the SA/SD bursa had rotator cuff tears.[6,10] Our purpose in this study was to compare the thickness of subacromial bursa measured using ultrasonography in the painful shoulder with the normal shoulder, and also to differentiate Neer stages I and II impingements in patients with unilateral shoulder pain.

METHODS

From March 2002 through December 2005, 452 consecutive patients with unilateral shoulder pain with overhead activity for more than 2 months underwent bilateral shoulder sonography and plain radiography (anterior-posterior view, axial view, and outlet view) at our orthopedic department. The sonography and physical examination using Neer's test or Hawkin's test were performed in each patient by the authors. The impingement test using subacromial lidocaine injection blindly after sonography confirmed positive results in 268 patients. Patients who failed to experience relief from lidocaine injections and who had rheumatoid arthritis, severe osteoarthritis, shoulder instability or full-thickness rotator cuff tears were excluded from this study.

The 268 patients (120 males and 148 females) included in this study ranged in age from 21 to 76 years (mean age, 55.5 years), and they all had unilateral shoulder pain with clinical suggestion of rotator cuff pathology. The mean duration of symptoms was 4.5 months (range, 2 to 8 months). While all the subjects were right-hand dominant, 162 patients had dominant shoulder problems and 106 non-dominant should problems. Major presenting complaints included pain in and around the shoulder and restricted movement in the involved shoulder. Neer's three-stage classification of impingement syndrome was used to assess the patients' clinical conditions.[11] Stage I consists of reversible edema and hemorrhage in the bursa and rotator cuff, while stage II implies fibrosis and thickening of subacromial soft tissue and sometimes a partial rupture of rotator cuff. Stage III reveals a complete rupture of the rotator cuff.

A 14 MHz linear array transducer (LOGIQ 9, GE Medical Systems, Wisconsin, U.S.A.) was used to examine both shoulders of the patient. Each patient's arm was put into full internal rotation with the hand placed posterior to the spine. The supraspinatus tendon, biceps tendon groove, subacromial-subdeltoid bursa, subscapularis tendon, infraspinatus tendon and the acromioclavicular joint were examined. Transverse and longitudinal planes from the rotator cuff and subacromial-subdeltoid bursa were scanned, and the bursa thickness was measured.

The subacromial-subdeltoid bursa is imaged as a hypoechoic line, 1 to 2 mm thick with differing layers of peribursal echogenic fat, between the deltoid muscle and the supraspinatus tendon. The selected scanning area lay between the coracoid process and greater tuberosity, and the thickness was calculated from superficial peribursal fat to the upper supraspinatus margin. We selected the thickest measurement of subacromial bursa in transverse or longitudinal planes of area scanned. The quantity of intrabursal fluid was not measured. Each patient's contralateral asymptomatic shoulder was measured to compare the subacromial bursa thickness in the symptomatic shoulder.

The intact rotator cuff tendons normally appear as a homogenous structure over the humeral head, showing a consistent thickness on ultrasound. Lesions located within the tendon but not penetrating to the surface were not regarded as tears.[12] The upper surface of supraspinatus was examined sonographically in both shoulders. When the supraspinatus revealed more hypoechogenic and bursal sided fraying than the asymptomatic side, it was considered as Neer stage II impingement syndrome (Fig. 1). Edematous bursa without obvious hypoechogenic change of supraspinatus tendon was classified as Neer stage I (Fig. 2).

All of the patients had previously undergone conservative treatment, such as non-steroid anti-

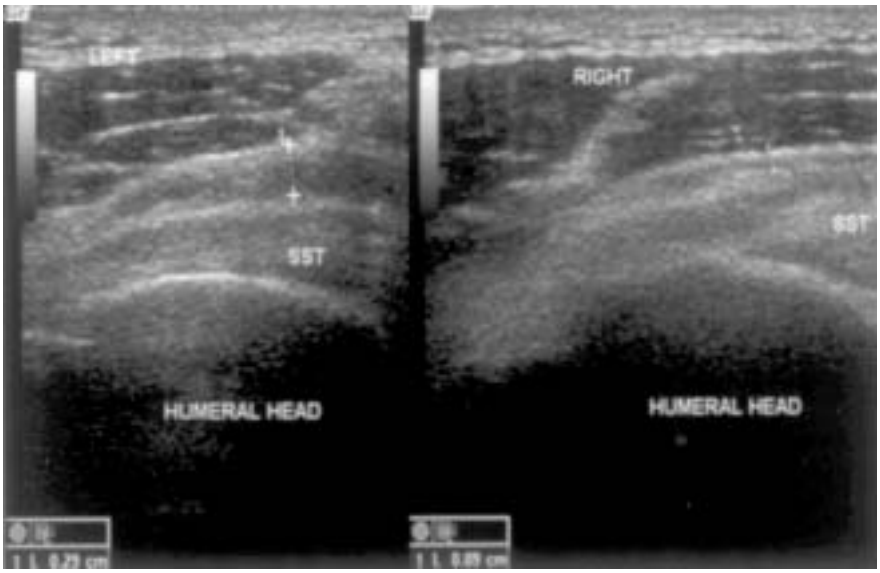

Fig. 1 The 50-year-old male patient had left shoulder pain for 4 months. Ultrasonography revealed effusion in the left subacromial bursa. The left bursal thickness was 0.29 cm. The left supraspinatus showed more hypoechogenicity than the right side and we considered it as Neer stage II impingement.

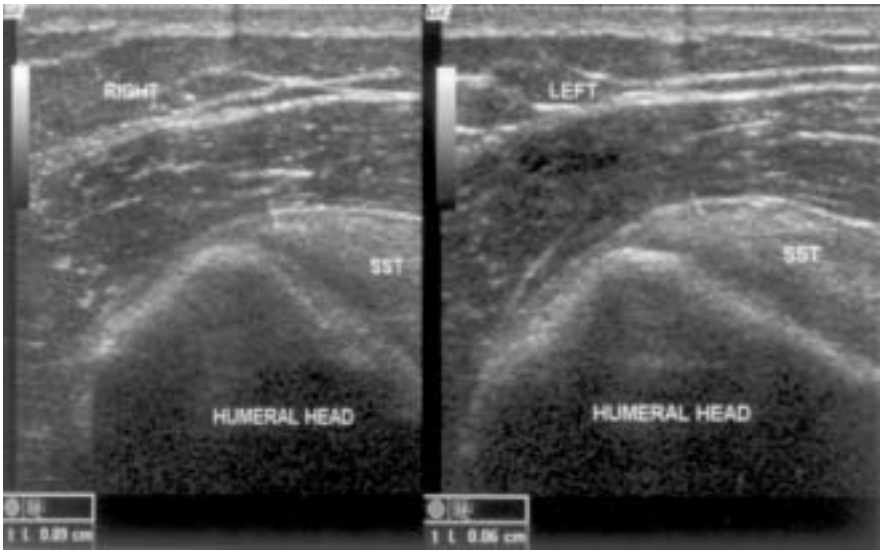

Fig. 2 The 47-year-old female patient had right shoulder pain with limited motion for 4 months. Ultrasonography showed thickening of subacromial bursa and peribursal fat. The right supraspinatus revealed no obvious hypoechogenic changes and was classified as Neer stage I. The bursal thickness was 0.09 cm in right symptomatic side and 0.06 cm in the left asymptomatic side.

inflammatory drugs, and physical therapy. No surgery was performed after sonographic examination. The Student *t*-test was used to establish statistical significance. A p value of < 0.05 was considered significant.

RESULTS

The average thickness of subacromial bursa in symptomatic shoulders was 1.27 ± 0.41 mm (range, 0.5 to 2.9 mm), while the mean thickness of the subacromial bursa in contralateral asymptomatic shoul-

ders was 0.75 ± 0.23 mm (range, 0.3 to 1.5 mm) (Table 1).

In 166 of the 268 cases, the supraspinatus of the symptomatic shoulder revealed more hypoechogenic and bursal sided fraying than the asymptomatic side. These lesions were defined as Neer stage II impingement and rotator cuff tendinosis. One hundred and two symptomatic shoulders with edematous bursa and no obvious hypoechogenic changes of the rotator cuffs were classified as Neer stage I.

The Neer stage II impingement group had an average bursa thickness of 1.31 ± 0.28 mm (range, 0.5 to 2.9 mm), and the average bursa in the Neer stage I group measured 1.22 ± 0.31 mm (range, 0.7 to 2.5 mm) (Table 2).

In 234 patients, the bursa of the symptomatic shoulder was thicker than that of the asymptomatic shoulder. In 10 patients, the bursa thickness of the symptomatic shoulder was thinner than in the asymptomatic shoulder (mean, 0.86 mm/1.06 mm). Twenty-four patients had equal thickness in both shoulders.

No statistically significant association was found between the men and women, Neer stages I and II group, or dominant and non-dominant shoulder in the bursa thickness of symptomatic shoulder. However, a significant association was discovered ($p < .0001$) between the symptomatic shoulder and contralateral asymptomatic shoulder.

The sonographs of 72 patients with painful shoulders revealed biceps tendon sheath effusion at the level of the biceps tendon groove and thickness of subacromial bursa exceeding 2 mm appeared in 18 patients with symptomatic shoulders. Otherwise, subacromial spurs were found in 76 patients using outlet views.

Table 1. Subacromial Bursa Thickness in 268 Patients with Unilateral Pain

	Symptomatic side	Asymptomatic side
Mean thickness	1.27 ± 0.41 mm	0.75 ± 0.23 mm

$p < 0.0001$

Table 2. Subacromial Bursa Thickness in Patients with Neer Stages I and II Impingement Syndrome

	Neer stage I: 102 patients	Neer stage II: 166 patients
Mean thickness	1.22 ± 0.31 mm	1.31 ± 0.28 mm

$p > 0.05$

DISCUSSION

The SA/SD bursa is thin walled, lined with synovial membrane and is undetectable on plain radiographs.[13,14] Subacromial bursitis, bicipital tendinitis and rotator cuff tendopathy frequently result in impingement syndrome.[13] Shoulder sonography is a noninvasive, effective and accurate imaging method with high sensitivity and specificity rates for detecting rotator cuff tears.[1,6-8,13,15,16] However, many ultrasonographers performed unilateral sonography in affected shoulders.

Normally, the SA/SD bursa is thinner than 2 mm on ultrasound examination and usually it is not clearly visible in its non-distended state.[10,17] Fluid within the SA/SD bursa is thought to be an indirect sign of rotator cuff tear and impingement syndrome.[8,13,15,18,19] However, Arslan et al argued that sonographic detection of intra-articular fluid and SA/SD bursal effusions were unreliable signs of a rotator cuff tear.[8] In one study, fluid was detected within the SA/SD bursa of 20% of healthy individuals.[3]

In the present study, we used the intact or hypoechogenicity of the rotator cuff to define Neer stage I or II impingement. The supraspinatus of symptomatic Neer stage II impingement shoulders revealed more hypoechogenic and bursal sided fraying than the asymptomatic side. Neer stage I revealed thickening of the bursa with slightly hypoechogenic change of rotator cuff. However, there were no statistically significant association of bursa thickness between Neer stages I and II groups, which may imply that the bursa thickness does not affect the Neer classification of the impingement syndrome.

van Holsbeeck and Strouse disclosed that normal SA/SD bursa should be less than 2 mm thick and claimed distended bursa could cause impingement syndrome.[10] However, they did not specify whether bursa thickness over 2 mm could cause shoulder pain. Farin et al observed that false-negative findings occurred when the arm motions were restricted or when the bursa was lacking fluid distension.[13] Ellman also mentioned that many patients with partial-thickness tears were asymptomatic.[20] The mean bursal thickness of symptomatic shoulders in this

study as calculated by sonography was 1.7 times that of asymptomatic shoulders (1.27 mm/0.75 mm) which was a statistically significant difference ($p < .0001$). Among them, only 18 cases in this study showed bursa thickness of greater than 2 mm in the symptomatic shoulders. This means thickening of subacromial bursa as observed on the sonography, at even less than 2 mm, was found in symptomatic patients, as compared with the asymptomatic sides.

There were some limitations to this study. First, whether the sonographic thickness of subacromial bursa represents the real thickness of the bursa or not. Bureau et al. noted that the bursal inner layers consisted of synovial tissue, whereas its outer layers consisted of connective tissue with a certain amount of fat interposed between the rotator cuff tendons and deltoid muscle.[21] Mitchell et al reported the peribursal fat plane was better delineated on the internal rotation view of the shoulder and accessible to MRI.[22] Thus, the thickest measurement of the bursa from the superficial peribursal fat plane to the upper margin of the supraspinatus and the scanning area lay between the coracoid process and greater tuberosity were presumed adequate in this study.

Second limitation was whether the measurement of the bursa thickness affected the diagnosis and management of impingement syndrome. Although our patients received conservative treatments, this investigation did not confirm the inflammatory histology of the subacromial bursa and the appearance of the rotator cuff during arthroscopic surgery. In general, partial tears of the rotator cuff or joint effusions may have occurred affecting the thickness of the subacromial bursa, especially bursa-sided tears. In the Neer stage II group, hypoechogenic tendinosis was detected in the rotator cuffs of symptomatic shoulders, which might relate to partial thickness tears. Hollister stated that although the contours and echogenicity of the rotator cuffs were carefully evaluated to exclude tears, small tears might be missed.[15] We reviewed sonographic imaging of the supraspinatus in the 34 patients of whom 10 patients displayed bursa thickness of painful shoulder thinner than the unaffected shoulder and 24 patients showed equal thickness of both shoulders. We found the symptomatic shoulders revealed more hypoechogenic than the contralateral asymptomatic side. We consider the causes of impingement pain in those patients might result in tendinosis of rotator cuffs or inflammation of subacromial bursa. Finally, the sonographic identification of a partial thickness rotator cuff tear can be fairly subjective. Further study is needed to quantify the echogenicity of the supraspinatus tendon and to show a level of accuracy in patients with rotator cuff tendinosis.

In conclusion, bilateral examination should be performed and particular attention be paid to the hypoechogenic appearance of the rotator cuff and the thickness of subacromial bursa in unilateral impingement syndrome cases. The increase of the bursa thickness in the symptomatic side may be an alternative sonographic indicator of subacromial bursitis or rotator cuff lesions, even when measured to be less than 2 mm. However, sonographic examination of the subacromial bursa thickness is not an appropriate technique to differentiate Neer stages I and II impingement.

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利用軟組織超音波測量肩峰下滑膜厚度來診斷肩夾擠症候群

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背 景： 正常在超音波顯像下，肩峰下滑膜厚度少於 2 mm，滑囊膜的增厚可能成爲早期旋轉肌破裂的徵兆。這份報告主要藉由軟組織超音波，去測量單側肩夾擠症候群病人之肩峰下滑膜厚度，比較痛側和非痛側有無差異診斷，以及是否能分辨 Neer I 和 II 肩夾擠症候群。

方 法： 我們收集 268 位因單側肩痛及疑似有旋轉肌病變而做兩側肩超音波的病人做研析。其中 166 位因痛側旋轉肌較非痛側 hypoechogenic 而屬 Neer I group，102 位之兩旋轉肌在超音波上顯像濃度接近被分爲 Neer II group。

結 果： 痛側肩膀與非痛側的滑膜厚度有明顯之差異 (平均厚度，1.27/0.75 mm，$p < 0.0001$)，而 Neer I 和 Neer II 兩族群之滑膜厚度無明顯差異。

結 論： 即使測量出厚度少於 2 mm，肩峰下滑膜厚度增加可以在軟組織超音波上，成爲肩峰下滑囊炎及旋轉肌病變的徵兆，但無法成爲診斷 Neer I 和 II 肩夾擠症候群指標方法。

(長庚醫誌 2007;30:135-41)

關鍵詞：軟組織超音波，肩峰下滑囊膜，肩夾擠症候群，肩旋轉肌

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