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Editorial Musings

Diagnostic value of tendon thickness and structure in the sonographic diagnosis of supraspinatus tendinopathy: room for a two-step approach

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ABSTRACT

Objective: The aim of our study was to systematically compare different methodologies to establish an evidence-based approach based on tendon thickness and structure for sonographic diagnosis of supraspinatus tendinopathy when compared to MRI.

Methods: US was obtained from 164 symptomatic patients with supraspinatus tendinopathy detected at MRI and 42 asymptomatic controls with normal MRI. Diagnostic yield was calculated for either maximal supraspinatus tendon thickness (MSTT) and tendon structure as isolated criteria and using different combinations of parallel and sequential testing at US. Chi-squared tests were performed to assess sensitivity, specificity, and accuracy of different diagnostic approaches.

Results: Mean MSTT was 6.68 mm in symptomatic patients and 5.61 mm in asymptomatic controls ($P < .05$). When used as an isolated criterion, MSTT > 6.0 mm provided best results for accuracy (93.7%) when compared to other measurements of tendon thickness. Also as an isolated criterion, abnormal tendon structure (ATS) yielded 93.2% accuracy for diagnosis. The best overall yield was obtained by both parallel and sequential testing using either MSTT > 6.0 mm or ATS as diagnostic criteria at no particular order, which provided 99.0% accuracy, 100% sensitivity, and 95.2% specificity. Among these parallel and sequential tests that provided best overall yield, additional analysis revealed that sequential testing first evaluating tendon structure required assessment of 258 criteria (*vs.* 261 for sequential testing first evaluating tendon thickness and 412 for parallel testing) and demanded a mean of 16.1 s to assess diagnostic criteria and reach the diagnosis (*vs.* 43.3 s for sequential testing first evaluating tendon thickness and 47.4 s for parallel testing).

Conclusions: We found that using either MSTT > 6.0 mm or ATS as diagnostic criteria for both parallel and sequential testing provides the best overall yield for sonographic diagnosis of supraspinatus tendinopathy when compared to MRI. Among these strategies, a two-step sequential approach first assessing tendon structure was advantageous because it required a lower number of criteria to be assessed and demanded less time to assess diagnostic criteria and reach the diagnosis.

1. Introduction

Supraspinatus tendinopathy is considered the most common cause of shoulder pain in primary care [1]. Although the diagnosis is primarily clinical, ultrasound (US) has been performed with increasing popularity for reassurance, especially if symptoms are refractory to initial conservative management. However, there is no consensual agreement on sonographic criteria to define pathology, and studies that compare different sonographic protocols to determine the best diagnostic yield are lacking. The aim of our study was to systematically compare different methodologies to establish an evidence-based approach based on tendon thickness and structure for sonographic assessment of supraspinatus tendinopathy when compared to MRI.

2. Materials and methods

Our study evaluated 164 symptomatic patients and 42 asymptomatic volunteers. Patients were recruited from symptomatic consecutive individuals referred for shoulder MRI from April 2010

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Table 1
MRI protocol.

Orientation	Coronal oblique T2 FatSat	Coronal oblique T1 SE	Axial proton density FSE FatSat	Axial T1 SE	Sagittal proton density FatSat	Sagittal T1 SE
FOV (cm)	14	14	14	14	14	14
Matrix size	512 × 256	288 × 256	288 × 256	288 × 256	288 × 224	288 × 224
Slice thickness (mm)/gap (mm)	3.0/0.9	3.0/0.9	3.0/0.3	3.0/0.3	3.0/0.3	3.0/0.3
TR (ms)	3650	450	4700	670	4600	447
TE (ms)	60	13	30	13	90	13

FatSat: fat saturated; FOV: field of view; FSE: fast spin echo; SE: spin echo; TE: echo time; TR: repetition time.

to December 2012 and from January 2014 to February 2014. For symptomatic patients, the inclusion criterion was supraspinatus tendinopathy documented on MRI; exclusion criteria were previous rotator cuff surgery and concurrent partial- (bursal, interstitial, or articular-surface) or full-thickness supraspinatus tendon tear. For asymptomatic volunteers, the inclusion criterion was normal supraspinatus tendon on MRI.

MRI was performed on a 1.5 T magnet with a four-channel phased array shoulder coil (Magnetom Espree, Siemens Medical Solutions), and interpreted in consensus by 2 senior dedicated radiologists with more than 10 years of experience in musculoskeletal MRI. The supraspinatus tendon was considered normal if it exhibited low signal intensity on all pulse sequences. A focal area of increased signal intensity on short TE sequences without increased signal intensity on a T2-wheighted image and without thickening or thinning of the tendon was also interpreted as normal [2]. Supraspinatus tendinopathy was defined as increased intrasubstance signal on short TE sequences that was not as bright as the fluid on T2-weighted images [3]. Supraspinatus tear was defined on the basis of tendon morphology (focal or diffuse thinning/absent tendon) or signal intensity (frank fluid signal intensity) [4]. Table 1 outlines the MRI protocol, obtained according to the ACR-SSR Practice Guideline for Performance and Interpretation of MRI of the Shoulder (revised 2010) [5].

All eligible symptomatic patients and asymptomatic volunteers accepted to participate and were referred on the same day for sonographic assessment of maximal supraspinatus tendon thickness (MSTT) and supraspinatus tendon structure. US was performed with an Acuson X300 Premium Edition unit using a 5–13 MHz linear array transducer (Siemens Medical Solutions Mountain View, CA). All Individuals were scanned while placing the back of his or her ipsilateral hand in the lower lumbar region and keeping the elbow close to the body [6]. Abnormal tendon structure (ATS) was defined as the presence of reduced tendon echogenicity or altered fibrillar pattern. Reduced tendon echogenicity was defined as a supraspinatus tendon iso- or hypoechoic relative to the deltoid muscle [6]. Altered fibrillar pattern was defined as loss of the normal linear parallel fibrillar pattern of the tendon (Fig. 1) [7]. Tendon echogenicity and fibrillar pattern were assessed in all patients for focal or diffuse changes (Fig. 2). In order to avoid anisotropy, tendon echogenicity and fibrillar pattern were evaluated only in the region where both supraspinatus and deltoid fibers were perpendicular to sonographic beam [8]. Multiple-axis images were also obtained to depict the point of MSTT; then, three measurements of the MSTT were acquired on long-axis views, perpendicular to bone cortex, and the mean value was used for statistical analysis. For measurements, the horizontal line of the caliper was deeply positioned on the superficial margin of the hyperechoic bone interface or on the superficial hyperechoic margin of the hyaline cartilage, when applicable. Superficially, the horizontal line of the caliper was systematically positioned on the hyperechoic line representing the epitendon (Fig. 3). The level of magnification was considered appropriate for measurements only when the supraspinatus tendon occupied at least half of the height of the screen. Parameters

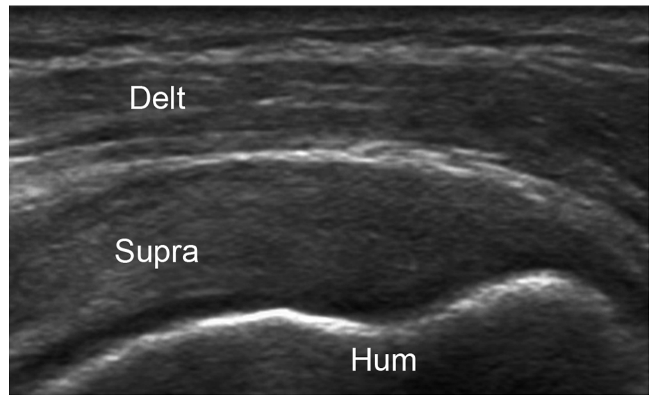

Fig. 1. Diffuse abnormal tendon structure. Long-axis 12-5 MHz image demonstrates diffuse loss of the fibrillar pattern of the supraspinatus tendon (Supra), which is also isoechoic relative to deltoid muscle (Delt). Hum = humerus.

Fig. 2. Focal abnormal tendon structure. Long-axis 12-5 MHz image demonstrates focal loss of the fibrillar pattern of the superficial fibers of the supraspinatus tendon (asterisks). Deep fibers retain normal fibrillar pattern. Delt = deltoid. Hum = humerus.

such as scanning frequency, tissue harmonic imaging, B-mode steering, focal zone number and placement, gain, and contralateral comparison were not standardized but left to the discretion of the examiner. In the last 10 symptomatic patients and 3 asymptomatic volunteers, examiner also systematically recorded a video clip at the start of scanning while first evaluating ATS and then assessing MSTT. Based on such video clips, mean time required to individually assess ATS and MSTT were calculated.

All sonographic studies were performed by a single experienced radiologist with 12 years of experience in musculoskeletal US and more than 10,000 shoulder examinations who was blinded to the clinical status and to the images and interpretation of the MRI. Intrapersonal variation for the sonographic measurements of MSTT