Contrast enhanced short and ultrashort echo time MRI of the Achilles tendon in spondyloarthritis

R. Hodgson[1], R. Evans[2], C. Burnett[2], A. Grainger[2], P. O'Connor[2], L. Coates[3], P. Helliwell[3], P. Emery[3], D. McGonagle[3], and M. Robson[4]
[1]Leeds Musculoskeletal Biomedical Research Unit, University of Leeds, Leeds, Yorks, United Kingdom, [2]Chapel Allerton Hospital, United Kingdom, [3]University of Leeds, [4]Unversity of Oxford

Introduction

MRI is useful in the assessment of the Achilles tendon which is commonly involved in spondyloarthritis (SpA). However, the short T2 of the normal tendon means that conventional MRI is limited to the detection of relatively severe changes when the tendon becomes swollen or the T2 increases into the range where signal is visualized on T1 weighted images. Ultrashort echo time imaging overcomes this limitation, but is not implemented on all scanners. The aim of this work was (i) to determine the appearance of the Achilles tendon in SpA on high resolution T1W, short echo time and UTE images and (ii) to determine which sequences are most sensitive for detecting tendon abnormalities.

Methods

Achilles tendons were imaged in 10 symptomatic SpA patients and 5 asymptomatic volunteers.
Images of the inferior Achilles tendon were acquired using a 4cm surface coil at 3T. Sequences used were (i) T1W axial multislice pre and post contrast (TR=824ms, TE=16ms, 2mm slices, 0.4x0.3mm in-plane resolution); (ii) 3D VIBE post contrast (TR=16ms, TE=5ms, flip angle 30º, 0.5mm resolution); (iii) 3D very short TE SPGR pre and post contrast (TR=7ms, TE=2ms, flip-angle=15º, 0.5mm resolution); and 2D UTE axial and sagittal multislice pre and post contrast (TR=100ms, TE=0.07ms, flip-angle=45º, 3mm slices, 0.3mm in-plane resolution). Difference images (post contrast - pre contrast) were calculated.
Images were assessed by a consultant musculoskeletal radiologist. The craniocaudal extent of abnormal high signal was measured on each of the sequences.

Results

In all asymptomatic volunteers, all sequences except UTE showed predominantly dark tendon with reticular high signal which was most prominent anteriorly just superior to the superior boarder of the calcaneus. This pattern was reversed in UTE images which showed predominantly high signal throughout (not shown). The reticular high signal showed mild enhancement with a few enhancing vessels.
Images from SpA patients showed a subtle increase in the reticular signal on T1W images which tended to extend further posteriorly than in the normal volunteers. On 2ms echo time images there was extensive abnormal signal extending superiorly from the enthesis. The extent of abnormal signal intensity was greatest on the TE=2ms images followed by the TE=5ms images and least on the TE=16ms images. UTE images showed high signal throughout as in normal volunteers (not shown). After administration of contrast, abnormal enhancement was greatest on the UTE difference images followed by the TE=2ms, then the TE=5ms with the TE=16ms images showing least abnormal enhancement. The extent of abnormal enhancement on the UTE images was less than the extent of abnormal signal intensity on the unenhanced TE=2ms images.

Figure 1: Images from normal volunteer (a,b) and typical patient with SpA (c,d).
(a,c): T1W. TE=16ms
(b,d): SPGR. TE=2ms.

The extent of abnormal signal intensity is greatest on the SPGR image.

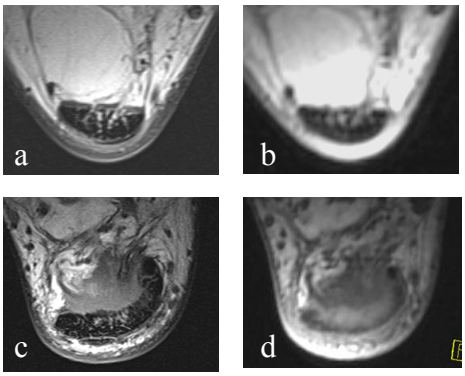
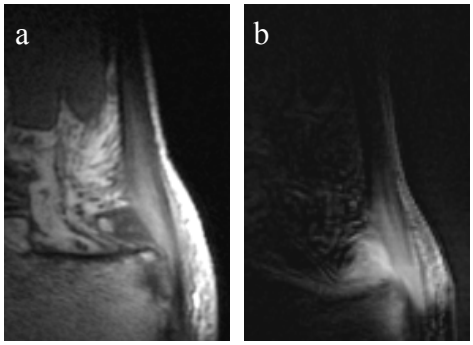


Figure 3: Images from a patient with SpA.
(a) Unenhanced SPGR (TE=2ms).
(b) UTE difference image (post - pre contrast).
The extent of abnormality is greater on the unenhanced SPGR than the enhanced UTE image.



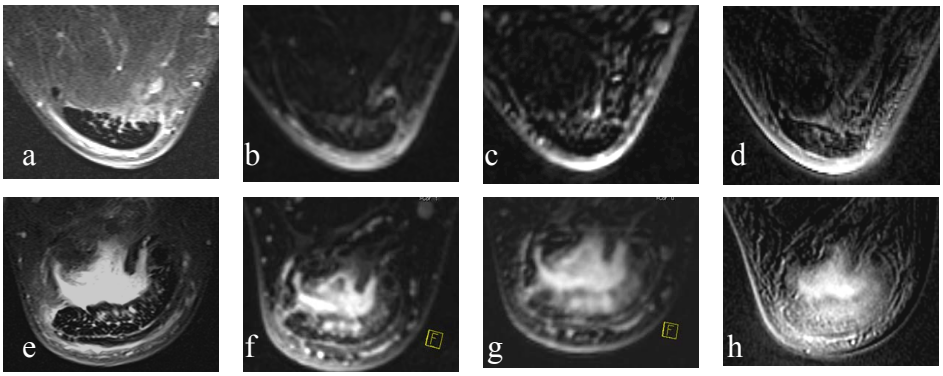


Figure 2: Contrast enhanced images from normal volunteer (a-d) and typical patient with SpA (e-h).
(a,e): T1W. TE=16ms
(b,f): VIBE. TE=5ms
(c,g): SPGR. TE=2ms difference image (pre-postcontrast)
(d,h): UTE. TE=70µs difference image (pre-postcontrast)

The contrast enhancement is greatest in the order:
UTE difference > SPGR difference > VIBE > T1W.

Discussion

These results suggest that short echo time images with TE~2ms are the most sensitive for detecting abnormality in the Achilles tendon in patients with spondyloarthritis. This reflects the T2 of the normal tendon (~ 2ms [1]). UTE images are most sensitive for the detection of abnormal enhancement after intravenous contrast, as the short T2 of the tendon limits enhancement on other sequences with longer TEs. Short echo time imaging demonstrates a greater extent of abnormality than contrast enhanced UTE (although CE-UTE may provide complementary information about vascularity). This is clinically important as short TE 3D SPGR images can be readily acquired using conventional scanners without specialized UTE sequences.

References: [1] Filho GH et al. Quantitative characterization of the Achilles tendon in cadaveric specimens. Am J Roentgenol. 2009 Mar;192(3):W117-24.