

## High Field Magnetic Resonance Microscopy of Enteses

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**Introduction:** Enteses are the regions between tendons or ligaments and bone. They typically have an adaptive structure with uncalcified and calcified fibrocartilage interposed between tensile tendon/ligament, and cortical or subchondral bone. This reflects the biomechanical need to disperse stress between soft and hard tissues. There are also functional adaptations in tendons and ligaments in which sesamoid fibrocartilage is seen at sites where tissue is subject to compression. Enteses are commonly involved in traumatic disease in the form of insertional tendonopathy as well as in inflammatory disease, including in particular the seronegative arthropathies (1, 2). The constituent tissues of enteses all have short T2s and so their detailed structure is not well shown with conventional (longer) TE sequences. In disease, abnormal features usually only become apparent with conventional MR sequences at an advanced stage when pathologic prolonged T2 tissue accumulates.

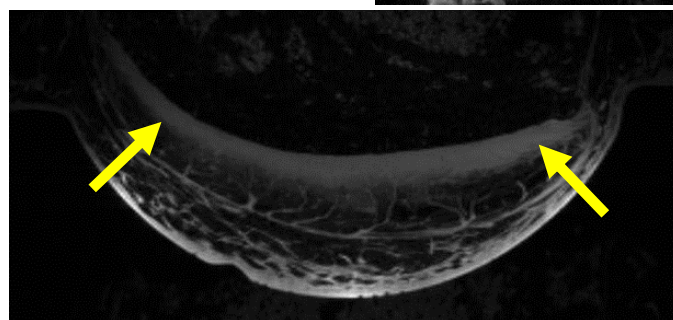
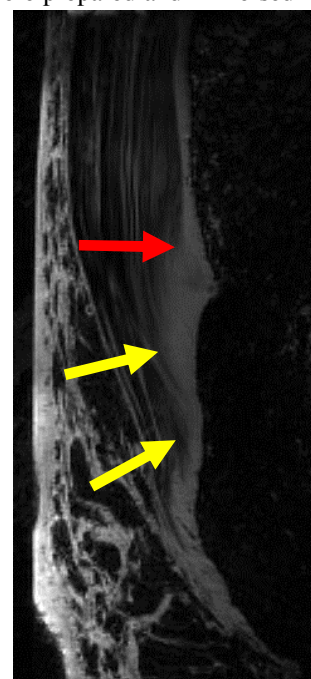
There has been considerable interest in recognizing normal anatomy as well as subclinical and less advanced clinical disease in enteses. Details of normal enteses have been seen at lower field systems (3T or less) (3, 4, 5). In this study we describe our initial experience with MR microscopy of enteses at 11.7T. Possible issues included T2 shortening of already short T2 tissues, and the increased susceptibility affects in bone/soft-tissue interface regions (particular with use of gradient echo and FID based sequences).

**Materials and Methods :** Fresh and fixed samples of the Achilles and supraspinatus tendon enteses were prepared and immersed in Fomblin to reduce susceptibility effects. Studies were performed on a Bruker 117/16 USR system operating at 11.7T. Curved four element coil receive only arrays were used as well as circular transmit/receive planar coils and transmit/receive solenoids of 9mm and 16mm diameter. 3D Gradient echo (GE) pulse sequences of TE = 1.9-10ms TR = 25-30.1ms with matrices up to 512 x 256 x 128 were used. Isotropic spatial resolution was from 40 – 125 $\mu$ m. 3D UTE sequences were used with a TEs of 100 $\mu$ s. Also, 2D multi slice multi echo sequences with in-plane resolution down to 25 x 25 $\mu$ m were used with 100–200 $\mu$ m slice thickness.

**Results:** The Achilles tendon enthesis was seen at high resolution (Fig. 1). This included enthesial and sesamoid fibrocartilage and the lining of the retrocalcaneal bursa. GE sequences were not significantly artifacted. Very good contrast signal could be obtained at TE = 2ms. The calcified component was visualized with UTE sequences. In the supraspinatus tendon, enthesis fibrocartilage was well shown and the calcified region was seen with UTE subtraction images. Disease was apparent as an increase in T2 and a loss of fascicular pattern in the associated tendon.

**Conclusion:** Microscopic imaging of enteses at 11.7T was achieved with spatial resolution superior to that of previous studies. Susceptibility issues did not prove to be a problem and nor did formalin fixation interfere with image contrast. High field imaging may prove to be very useful for anatomic correlation as well as developing techniques to improve visualization in clinical studies. The work is also likely to be of value in animal studies including assessing techniques designed to promote healing and repair following injury and surgery.

**Figure 1: Achilles tendon enthesis.** Sagittal (right) and axial (below) 3D FLASH MR images of the achilles tendon enthesis. Note the enthesial (yellow arrows) and sesamoid (red arrow) fibrocartilage.



### References:

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