Comparison of STIR and T2 FAT SAT in bone bruise imaging for occult scaphoid fracture

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Comparison of STIR and T2 FAT SAT in bone bruise MRI musculoskeletal imaging of occult scaphoid fracture (1.5T)

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Introduction

Since the introduction of Magnetic resonance imaging (MRI), the use of high-field-strength MRI in musculoskeletal imaging has become more common. The benefits of MRI are shown as a desirable method in the diagnostics of occult scaphoid fracture in particular the visualization of bone bruise (1). Different fat suppression sequences with different backgrounds can detect the presence of bone bruise e.g. Short tau inversion recovery (STIR), Spectral fat saturation (FAT SAT), Hybrid, Fat – water separation and Dixon (2).

However, a majority of published articles describes the standard method for musculoskeletal MRI fat suppression comprising the STIR or T2 FAT SAT sequence, but no unified guidelines is described. Sufficient choice of sequence may result in consequences for the patient as pseudoarthrosis, osteoarthrosis, avascular necrosis and chronic wrist pain, if a fracture remains undiagnosed (3,4).

The importance of identifying and locating bone bruise is essential in relation to fracture but in addition, bone bruise may also be the only pathological finding explaining the patients symptoms of pain. This highlights the importance of the technicians awareness of the advantages and disadvantages affiliated with the various sequences (3,4).

Aim of the study

To investigate differences between STIR and T2 FAT SAT in detection of bone bruise in a prospective study.

Methods

In the period March 2014 until January 2015 195 patients underwent MRI examinations of the scaphoid bone. Fifty-one patients (average: 19 years, M: 40, F:11) met the inclusion criteria’s.

Inclusion criteria for acute MRI scan of scaphoid bone

- Relevant trauma less than 2 weeks
- Negative X ray of scaphoid bone
- Positive clinical finding
- Age > 10 years (> 3 mm between the scaphoid bone and the lunate bone)
- Bone bruise on coronal STIR and sagittal T2 FAT SAT
- Motion artifact free sagittal T2 FAT SAT and STIR images

The fifty-one recruited patients underwent an additional sagittal STIR Sequence scan. The sagittal T2 FAT SAT and STIR were then compared and evaluated.

Imaging Technique

The MRI scans were performed on a 1.5 T extremity scanner (GE Healthcare Systems, ©Optima MR430s, 4.02 software release, Milwaukee, WI, USA), a 123 mm quadrature coil was used.

Figure 1: Illustration of STIR principal, chemical shift. The inversion recovery gradient relates to the fat and water signals T'1u = T'1w = (70% of T1) (8-7). Figure 2: Illustration of the FAT SAT principal, chemical shift. A) When using a narrow bandwidth (bw), an excitation of only the fat protons will occur. B) Using a low field strength (< 1T) the signal from the water and fat will overlap and it will not be possible to achieve an ideal fat saturation (5-7).

Parameter settings:

The high-field-strength MRI have resulted in a higher signal to noise ratio (SNR) as well as a wider chemical shift between the fat and water signals. Theoretically a high field strength (>1T) is required when executing a T2 FAT SAT sequence, consequentially causing a technique with a high SNR in relation to a short scaitime, but with a sensitive field heterogeneity, vulnerable to off centered imaging and metal implants. The STIR sequence is a safe method for the diagnostic but with low SNR in relation to a longer scaitime. However, it will always be possible to improve the image quality in MRI at the detriment of e.g. a even longer scaitime, but all consequences (i.e. movement artefacts) ought to be considered before conducting a standard protocol (5-7).

Figure 3: 1.5 T extremity scanner (GE Healthcare Systems, ©Optima MR430s). The extremity MRI allowed the central placement of the hand relative to the magnetic field. The patient’s hand was placed in the Anterior- Posterior position. B) Placement of the middle slice (BS). A team of experienced radiographers ensured every scan to be executed identically. Otherwise excluded.

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Image evaluation

Bone bruise and image quality assessment included three methods:

1. Comparison of the area
2. Comparison of CNR
3. Comparison of bone bruise image contrast

The image material was continually and independently assessed by all three readers blinded to each other’s results. All measurements were performed on the same slice and the same PACS monitor, to ensure a identical and comparable image quality.

Data were subsequently analyzed by unpaired Student’s t-test and Pearson correlation analysis (PCG).

Results

There was no significant variation relative to the area of the bone bruise (p > 0.005) and the CNR (p > 0.005). There was a significant variation relative image contrast C (p < 0.005).

The PCC showed that the agreement of the tendon (C) (p < 0.005).

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Conclusion

An interchangeably usage of the two sequences was found acceptable for the diagnostic (> 1 T) if the protocol is properly composed. However, the T2 FAT SAT sequence provides a image contrast superior to the STIR sequence.

References


Seated Radiology, vol.44, number 8, p. 312.