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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).

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.

Parameter settings:

A 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.
- Placement of the middle slice (#6). A patient’s hand was relative to the central slice.
- The extremity MRI was published in UTOPIA. 2013

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

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 scores revealed a positive correlation.

References

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.

Figure 1: Illustration of the STIR principal, chemical shift. A) When using a narrow band width (bw), an excitation of only the 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).

Figure 2: Illustration of the FAT SAT principal, chemical shift. A) When using a narrow band width (bw), an excitation of only the 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).

Figure 3: A) 1.5 T extremity scanner (GE Healthcare Systems, ©Optima MR430s). B) Placement of the middle slice (#6). A team of experienced radiographers ensured every scan to be executed identical. Otherwise excluded.

Figure 4: Presentation of the parameter settings for the sagittal STIR and T2 FAT SAT sequences (2,5-7).

Figure 5: The box-plot shows the image contrast (C) (y-axis) for the STIR and FAT SAT sequences. The PCC showed that the agreement of the tendon scores revealed a positive correlation.

Figure 6: (method 1) quantitative measurement of the area of the bone bruise. (method 2) CNR = (Sb-Sa)/(Sa+Sb) (6)

Figure 7: The box-plot shows the image contrast (C) (y-axis) for the STIR and FAT SAT sequences.