

Assessment of osteonecrosis following instrumentation for femoral neck fracture using contrast enhanced MAVRIC sequences

Nadja Alexandra Farshad-Amacker¹, Matthew F. Koff¹, Jonathan P. Dyke², Lionel E. Lazaro³, Dean G. MD Lorich³, and Hollis G. Potter¹

¹MRI Research Laboratory, Hospital for Special Surgery, New York, NY, United States, ²Department of Radiology, Weill Medical College of Cornell University, New York, NY, United States, ³Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, United States

Target audience: Radiologists and orthopaedic surgeons who require improved visualization of structures near fracture fixation to allow early detection of osteonecrosis (ON) and cartilage integrity.

Purpose: To compare the ability of a 2D fast spin-echo (FSE) sequence and the multi-acquisition variable-resonance image combination (MAVRIC) sequence to visualize ON in patients after surgical treatment for femoral neck fracture (FNF) and to evaluate difference of ON volume between the two sequences. We also sought to determine the feasibility of performing estimated semi-quantitative perfusion measurements in the marrow with the MAVRIC sequence following fracture fixation.

Methods: This study was approved by the local IRB. A total of 20 patients (7 male, 13 female; 59.9 ± 13.6 y.o. [mean ± SD]) had stainless steel pin fixation with fibular allograft placement for FNF. The patients had post-operative MRIs acquired using metal-artifact reduction 2D-FSE sequence [1] and a MAVRIC sequence [2-4] at 3 months and 12 months post-operatively. In addition, pre- and post-contrast T1-weighted (T1w) MAVRIC [repetition/echo time 1000/14] images were acquired at both time points. The FSE and MAVRIC images were evaluated for the presence and volume of ON. Standardized regions of interest (ROIs) were defined within the center of the ON, in the rim of the ON, in the ilium and in the femoral diaphysis (FD) in the pre- and post-contrast MAVRIC sequences to measure the percentage signal intensity (SI) enhancement. Uptake calculations were corrected by evaluating cortical bone. The proportion of detecting ON between the FSE and MAVRIC was performed using a Chi square test. The volume and percentage SI uptake was compared between the groups and over time using paired student t-tests.

Results: 75% of the patients had ON identified in MAVRIC images, 60% in FSE images, and <1% on conventional radiographs. In 87% the ON was located at the anterosuperior aspect of the femoral head. Subchondral collapse was seen in the first postoperative MRI at 3 months in 28% of patients with ON, and was increased to 72% after 12 months. The disparity of ON detection between the MAVRIC and FSE sequences was not significant (p=0.16); there was significant difference of ON volume between the MAVRIC and FSE sequences (p=0.001) (Figures 1 and 2). The ON volumes from MAVRIC images were 246 % larger than corresponding values from FSE images (Figure 2). We were successful in estimating perfusion in bone around metallic implants using MAVRIC. A significant increase in % SI uptake in the rim of the ON, compared to the ilium and FD, was detected at 3 months post-operatively (Figure 3). There was no significant increase in % SI uptake in the center of the ON compared to the ilium and the femur.

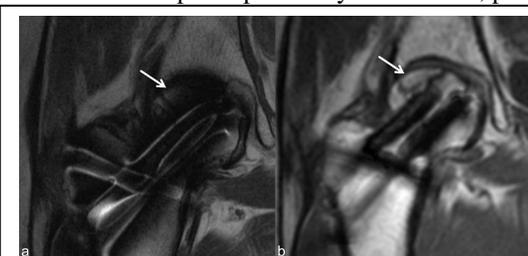


Figure 1. Examples of the detection of ON (arrow) in 2D FSE (a) and MAVRIC (b) sequences.

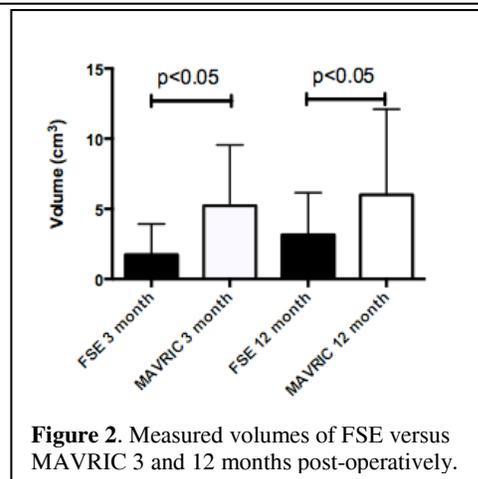


Figure 2. Measured volumes of FSE versus MAVRIC 3 and 12 months post-operatively.

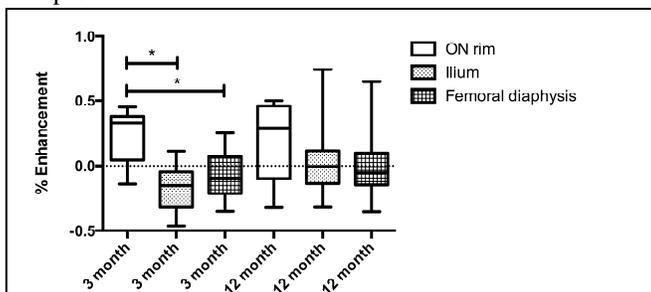


Figure 3. Percentage enhancement, corrected for cortical bone, of the ON rim versus ilium and femoral diaphysis 3 month (significant difference *) and 12 months post-operatively.

Discussion:

Standardized radiographs markedly underestimated the incidence of ON after FNF fixation and the FSE images underestimated both the incidence and the volume of the ON lesion. While an indirect assessment of perfusion, the contrast enhancement with MAVRIC around fixation may prove efficacious in predicting collapse and clinical prognosis following FNF. Such undiagnosed ON could be a possible cause for unexplained pain after surgical fixation of FNF [5].

Conclusion: The MAVRIC sequence is superior to 2D FSE imaging for detecting ON around metallic implants. It is feasible to perform post-contrast SI uptake measurements using the MAVRIC sequence.

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