

Quantitative Ultrashort TE (UTE) Imaging Predicts Joint Health in Hemophilic Arthropathy

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Introduction: Hemophilia is an inherited disorder, which affects about 1 in 5,000 male births. Due to a deficiency of either factor VIII or IX blood-clotting proteins, abnormal bleeding results. One of the most common manifestations is spontaneous bleeding into joints, which leads to progressive articular destruction. Historically, clotting factor replacement through blood products was the mainstay of treatment. Unfortunately in the early 1980s, more than 50% of the population of hemophilic patients would become infected with HIV as well as other blood-borne diseases, and as a result would die in the subsequent decade¹. Nowadays, patients with hemophilia have near normal life expectancy due to safe clotting factor products. As a result, adult hemophilic arthropathy due to recurrent clinical or subclinical bleeding episodes is encountered more than ever before. Management of these patients may be improved through non-invasive monitoring of joint status. However, acute and chronic blood products can demonstrate short transverse decay, resulting in poor signal and contrast with surrounding musculoskeletal tissues when using conventional sequences. Ultrashort TE (UTE) MRI has been increasingly used in the clinical setting to circumvent these shortcomings and to provide quantification. The purpose of this study was to evaluate the joints of patients with hemophilia with conventional and UTE MRI.

Methods: *Patients:* 21 patients with hemophilia (mean age 42 ± 16 years; 16 type A, 5 type B) were recruited for this prospective study. In total 7 knee, 7 ankle, and 7 elbow joints were evaluated. *Clinical Reference Standard:* Pain scores and the semi-quantitative Hemophilia Joint Health Score (HJHS) 2.1² (9 primary measures including swelling, duration, muscle atrophy, joint pain, crepitus, flexion and extension loss, strength for a total of 20 points/joint and a global gait score) were obtained for each patient, with increasing scores indicating worsening status. *Imaging:* Patients underwent MR imaging at 3T using a conventional clinical MRI protocol as well as a 4-echo 3D-UTE-Cones sequence (TR=17ms, TE=0.03, 4, 7, 11 ms, FA=12°, matrix=256x256, slice thickness=2mm, scan time ~6 minutes). *Data Analysis:* MRI images were evaluated by a musculoskeletal radiologist and scored using the semi-quantitative International Prophylaxis Study Group (IPSG) MRI scale³ (including 6 primary measures as well as soft tissue subscore, osteochondral subscore, and total score). Additionally, UTE-T2* values of cartilage in weight-bearing joints (patellae and tali) were quantified. *Statistics:* IPSG MRI scores for all 21 joints were compared with pain and HJHS scores (excluding gait to allow analysis for the non-weight-bearing elbow joints) using Spearman rank correlation. UTE-T2* values of the 14 weight-bearing joints were compared with pain, global gait, and total HJHS scores. *P-values* less than 0.05 were considered significant.

Results: Multi-echo UTE-Cones images facilitated evaluation of soft tissue changes, including hemosiderin and synovial hypertrophy (**Figure 1**). Of the 9 primary MRI measures, only osseous erosions were significantly correlated with HJHS clinical scores ($\rho=0.56$, $p<0.01$). Total osteochondral subscores were significantly correlated with HJHS clinical scores ($\rho=0.53$, $p=0.01$, respectively), but soft tissue subscores and total scores were not ($p>0.05$). UTE-T2* values for cartilage significantly correlated with HJHS clinical scores (including global gait, $\rho=-0.58$, $p=0.03$ and HJHS total scores, $\rho=-0.72$, $p<0.01$). Pain scores demonstrated no correlation with any MRI measure.

Conclusion: Quantitative UTE-MRI may be more sensitive than conventional MRI for the evaluation of joint health in patients with hemophilia, particularly for cartilage abnormalities. In hemophilic arthropathy, UTE-T2* values of cartilage decrease as joint health declines.

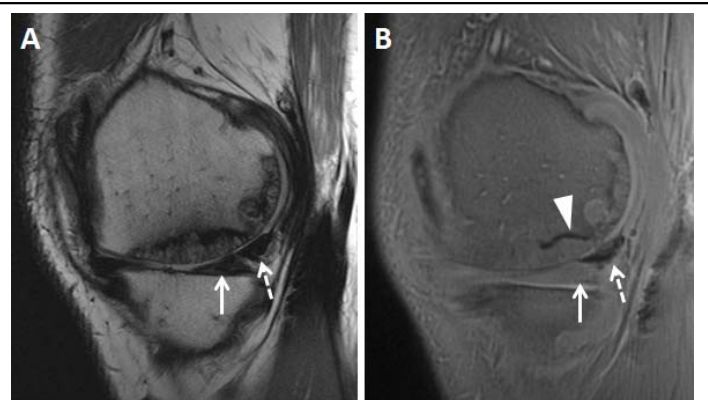


Figure 1. 37 year-old man with hemophilic arthropathy of the knee. (A) Conventional intermediate-weighted sagittal MR image (TR 2600 ms, TE 40 ms) shows no distinction between meniscus (arrow) and hypertrophic hemosiderin-laden synovium (dashed arrow), both appearing dark with near-zero signal. (B) Improved contrast with UTE MRI (TE 0.03 ms) allows distinction between meniscus (arrow) and synovium (dashed arrow). Additional foci of hemosiderin deposition are seen lining a subchondral cyst (arrowhead) as well as in the medial gutter and posterior recesses.

References: [1] Evatt BL. J Thomb Haemost 2006;4:2295-301. [2] HJHS 2.1 Instruction Manual. 2006. [3] Lundin B et al. Haemophilia 2012 18:962-970.

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