Fresh Blood Imaging (FBI) of Peripheral Arteries at 3T MRI - Comparison with 1.5T -

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PURPOSE;

Fresh blood imaging (FBI) is a novel non-contrast enhanced MR angiography technique, which uses a physiological signal change of an artery during a cardiac cycle[1)]. FBI offers excellent diagnostic capabilities, which is almost equivalent to that of CT angiography[2)]. However, there are some concerns for FBI using a 3T MRI system; i.e. increased SAR, prolonged T1 relaxation time, and increased B1 inhomogeneity. Above all, the most important issue for FBI is whether misregistration artifacts are prominent due to gaining of high signals at 3T.

The purpose of this study is to compare FBI using a 3T MR equipment (3T-FBI) with that at 1.5 T (1.5T-FBI) in the evaluation of the iliac and lower extremity arterial system.

MATERIALS AND METHODS;

Institutional review board approval and informed consent were obtained. Ten healthy volunteers were participated in this study (8 male, 2 female, mean age 28 y.o.).

All MR examinations were performed at both a 3T-clinical imager (Vantage Titan^{TM} 3T, Toshiba, Tokyo) and a 1.5-T clinical imager (EXCELART Vantage^{TM} XGV PPP powered by Atlas, Toshiba, Tokyo) using a combination of an Atlas SPEEDER body and an Atlas SPEEDER spine coil. ECG-gated three-dimensional (3D) half-Fourier FSE acquisition parameters in 3T-MRI were as follows: TR=4R-Rs, TE=80 ms, ETS=5 ms, Flip/Flop=90/160 deg, TI=150 ms, parallel factor=3, Slice Thick=3 mm, Mtx=256x208, FOV=40x30 cm, Total Time≒4:30 min. At 1.5T parameters are as follows; TR=2R-Rs, TE=64 ms, ETS= 4ms, Flip/Flop=90/160 deg, TI=150 ms, parallel factor=2, Slice Thick=3 mm, Mtx=256x256, FOV=40x40 cm, Total Time≒4:00 min. After diastolic and systolic ECG-triggered 3D data were acquired, the system automatically operated that the systolic images were subtracted from the diastolic images, and the subtracted images then underwent a maximum intensity projection (MIP) processing.

The iliac and lower extremity arteries were divided into 4 groups; group A was relatively larger arteries which included common iliac, external iliac, superficial femoral, and popliteal arteries. Group B contained arteries with small branches which included internal iliac and deep femoral arteries. Group C included anterior tibial, peroneal, and posterior tibial arteries. Group D contained arteries of foot, including dorsal, plantar, and metatarsal arteries. Visualization of each artery in 3T-FBI and 1.5T-FBI was graded separately by a radiologist and two radiation technologists with a 5-point scale (5; excellent, 4; good, 3; fair, 2; poor, 1; not visualized). Contrast-to-noise ratio (CNR) and full width at half maximum (FWHM) were calculated at subtracted images for the common iliac, external iliac, superficial femoral, and popliteal arteries. The Mann-Whitney U test and the paired *t*-test were used for statistical analysis.

RESULTS;

In all groups, arterial visualization of 3T-FBI was significantly superior to that of 1.5T-FBI, especially in group B and D, in which contain smaller arteries; in Group A, average score was 3T=4.88, 1.5T=4.13 ($p<0.001$); in Group B; 3T=4.60, 1.5T=2.98 ($p<0.001$); in Group C, 3T=4.78, 1.5T=3.70 ($p<0.001$); and in Group D, 3T=4.15, 1.5T=2.20 ($p<0.001$). CNRs of 3T-FBI were significantly higher than those of 1.5 T in all arteries (77.11±3.9, 49.4±4.07, respectively, $p<0.0001$). Arterial FWHMs of 3T-FBI were slightly greater than those of 1.5T-FBI, but not a significant difference (6.62±1.32, 6.61±1.07, $p=0.84$), except the popliteal artery (4.52±0.48, 3.70±0.65, $p<0.05$). The slight difference of FWHMs could be due to some burring effect caused by a longer inter-echo spacing of fast spin echo of 5 msec at 3T vs. 4 msec at 1.5 T. However, the burring can be reduced by increasing parallel factor; 3 at 3T vs. 2 at 1.5T.

DISCUSSIONS;

Visualization evaluation of the arteries of pelvic and lower extremities in 3T-FBI was significantly superior to that in 1.5T-FBI. CNR of 3T was also superior to that of 1.5T. From these results, non-contrast-enhanced FBI is reliable at 3T. The reason of better non-contrast-enhanced FBI at 3T is thought to be higher signal than at 1.5T. However, possible issues of 3T FBI for a screening examination are; higher SAR that gives some parameter limitations, longer T1 to increase in scan time, increasing motion artifact signal due to higher SNR, and B1 inhomogeneity decreases image quality. Further improvement in hardware and software may resolve image quality of 3T-FBI, especially in the B1 and SAR issues

In conclusion, FBI at 3T clearly demonstrated great depiction of lower extremity arteries with higher CNR, especially in the smaller and more peripheral arteries which could not be depicted well at 1.5T-FBI.

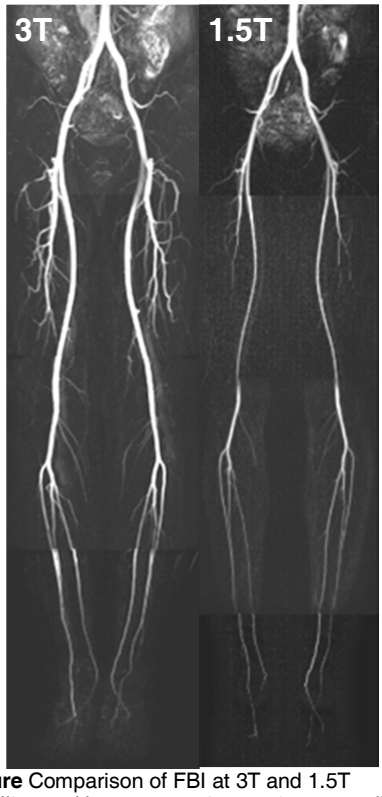

Figure Comparison of FBI at 3T and 1.5T
The Iliac and lower extremity arteries are well demonstrated with high CNR, especially in peripheral small branch arteries at 3T.

REFERENCES;

1. Miyazaki M, Lee VS. Nonenhanced MR Angiography, Radiology2008: 248: 20-43
2. Nakamura K, Miyazaki M, et al. Noncontrast-enhanced peripheral MRA: technical optimization of flow-spoiled fresh blood imaging for screening peripheral arterial diseases. Magn Reson Med. 2011 Feb;65(2):595-602