

Accuracy of Non-Contrast Fresh-Blood MRA for the Assessment of Lower Extremity Peripheral Vascular Disease

T. S. Albert, MD¹, E. J. Kelly, PhD², P. Zetterlund, MD¹, C. Luna, RT¹, N. Yellin, RN¹, and M. Miyazaki, PhD.³

¹Salinas Valley Memorial Hospital Cardiovascular Diagnostic Center, Monterey, CA, United States, ²Toshiba America Medical Systems, Tustin, CA, ³Toshiba Medical Research Institute USA, Inc, Vernon Hills, IL

Purpose

In the United States alone, diseases of the lower vasculature account for over 10,000 surgeries per year [1], necessitating accurate imaging and diagnostic procedures. While Digital Subtraction X-Ray Angiography (DSA) remains the gold standard for evaluating peripheral vessels, it is invasive and has added risks of ionizing radiation and potential renal impairment [2,3]. Contrast enhanced magnetic resonance angiography (CE-MRA) for visualization of the peripheral vessels became a common alternative to X-ray arteriography. Although contrast-enhanced MR Angiography (CE-MRA) has been shown to depict runoff vessels with a high degree of clarity, recent studies linking the onset of Nephrogenic Systemic Fibrosis (NSF) with gadolinium contrast exposure in renal impaired patients have limited the availability of this test in some of the most vulnerable patients. Non-contrast MRA techniques, such as Fresh Blood Imaging (FBI) [4,5] has the ability to assess peripheral artery disease, identify stenoses and provide high resolution angiograms useful for diagnosis and treatment planning without the use of a contrast agent. FBI is a safe and effective alternatives to CE-MRA and may be useful for diagnosis and treatment planning. In this study, a clinical population with a variety of vascular disease underwent a multi-station high-spatial resolution non-contrast 3D FS-FBI MRI exam and an X-Ray angiography exam. The accuracy of FS-FBI was evaluated for the assessment of peripheral vascular diseases compared to conventional X-Ray Angiography.

Materials and Methods

Twenty Consecutive patients who had both non-contrast fresh-blood imaging MRA (FBI) of the pelvis+lower extremities and invasive DSA were included (mean age 71 ± 10 yrs, 65% male, 40% diabetic, 85% with history of CAD, 85% hypertension). FBI was performed on a Toshiba Vantage Atlas 1.5 T MRI scanner equipped with high-performance 33 mT/m gradients and maximal slew rate of 200 T/m per second. The non-contrast FBI exam was utilized in three stations – iliac, femoral, and tibial. Imaging parameters were: TE/TR=80ms/2-3RR, Flip Angle =90/180, Matrix = 256x256, Slice Thickness = 1.5-2mm , 30-40 slices, ECG gating, parallel imaging factor = 2 , ECG gating, scan time = 3-8 minutes. Both systolic and diastolic 3D image sets were collected in one acquisition. Maximum intensity projection (MIP) images were created off of the subtraction between diastolic and systolic datasets. DSA was performed using clinical standards with ionic contrast agents. Using a 25-segment model blinded analysis of source and MIP FBI images and DSA images were completed for both image quality (poor-1; good-2; excellent-3) and stenotic severity (Non Diagnostic (ND), 0-25%, 26-50%, 51-75%, 76-99%, total occlusion).

Results

479 out of 500 segments were evaluable by FBI (n=21 segments had MRI incompatibilities (e.g. stents)) while 320 segments had both FBI and DSA data. Image quality for FBI was good or excellent in 80.8% (387/479) of evaluable segments with good/excellent image occurring 84.6% (110/130) in the pelvis, 83.2% (158/190) in the thigh, and 74.8% (119/159) at or below the knee. Overall clinical accuracy (accurately determining a stenosis >75% by FBI) revealed a sensitivity of 0.90, specificity 0.94, positive predictive value 0.81, and negative predictive value of 0.97. Figure 1 shows a visual comparison between an FBI MIP image and corresponding DSA.

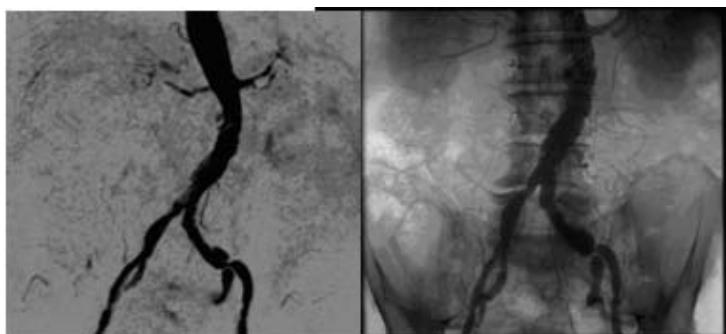


Figure 1. Coronal FBI reverse MIP of the pelvis (left) and corresponding invasive angiogram MIP (right). The non-contrast MRA technique showed critical narrowings of the left internal and external iliac arteries, which were confirmed by angiography.

As seen in the figure, the critical narrowings of the left internal and external iliac arteries seen on the FBI image are highly correlated on the DSA image. These results show high accuracy of FBI for the assessment of peripheral vascular disease.

Discussion

We have demonstrated that high quality diagnostic angiographic imaging can be accomplished using non-contrast imaging techniques that do not require the use of ionizing radiation or any gadolinium based contrast agent. A recent study by Nakamura et al [6] compared FBI to CTA, and found FBI to have a high negative predictive value for screening peripheral vascular disease. FBI is a robust non-contrast, non-invasive technique for pelvic and lower extremity vascular imaging. Image quality is high in the pelvis and thigh with modest degradation in image quality below the knees. In comparison to the gold standard of DSA, FBI shows high clinical accuracy. FS-FBI has many advantages over DSA and CE-MRA, and has proven to be clinically valid for screening purposes. Primarily, due to its repeatedly high negative predictive value, revealed in this study and prior studies, FBI may become the primary technique used to rule out peripheral vascular disease for all patients.

References

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