Simultaneous bilateral imaging of the femoral arteries in peripheral arterial disease patients

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Introduction:

Peripheral arterial disease (PAD) is a circulatory problem in which blood flow to the limbs is reduced because of constricted arteries. In the lower extremities, the disease is often associated with substantial leg pain and the inability to walk. A previous MRI study of human cadaveric carotid arteries suggested a bilateral nature of atherosclerosis[1]. To this end, we developed a custom bilateral RF receiver coil to simultaneously image both legs of PAD patients[2]. The bilateral coil reduces scan time by a factor of two compared to unilateral coils. Additionally, the bilateral coil offers improved SNR in the sample periphery compared to volume coils[3], which is beneficial for superficial femoral artery (SFA) imaging, as the SFA in the adductor canal (a common site for PAD disease) tends to be located toward the medial region of the legs. Bilateral SFA imaging is challenging, as one aims to resolve the relatively small vessel wall structure over a long superior-to-inferior field-of-view (FOV) in a reasonable examination time. Here we present preliminary results from a PAD patient study.

Methods:

Five patients with PAD were recruited for this study. All experiments were conducted on a 3T scanner (Excite, GE) using the 8-channel bilateral coil for signal reception[2]. Time-of-flight (TOF) images were collected to localize the femoral vasculature from which spin echo proton density (PD) and T2 weighted sequences were prescribed with the following parameters: 512x512 acquisition matrix,26x18cm^2 FOV, slice thickness = 2mm, with TR/TE/ETL/NEX = 1800/13/10/2, 6.7mins/30 slices (PD images); 1800/68/10/3, 9.9mins/35 slices (T2 images).

Results:

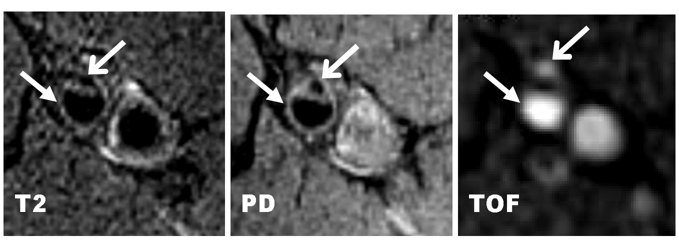
Figure 1 shows images from a patient with a subintimal atherectomy, a surgical procedure in which blood flow is restored to the SFA by creating a new lumen between the intimal and medial layers of the arterial wall. In the top row, the T2 and PD images reveal the division between the new (closed arrows) and former (open arrows) lumens while the TOF image suggests that blood flows through both lumens. For comparison, images from the same position in the contralateral leg imply a patent SFA. Images from a patient with a stented SFA are shown in fig. 2. The top image row illustrates an eccentric lesion in the left SFA, while the bottom row displays the normal vessel in the right leg.

Conclusions:

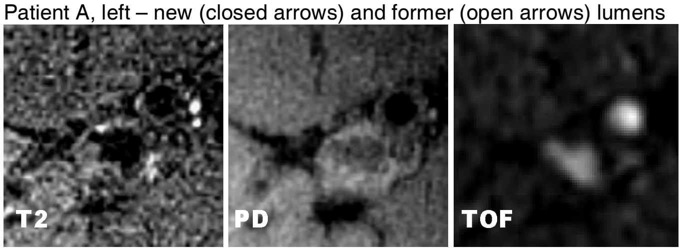
TOF images of both SFAs were acquired simultaneously over a long (~25cm) S/I FOV using the bilateral coil. This enabled quick localization of the diseased or surgically repaired (i.e. stent, atherectomy) site. Bilateral high resolution images (0.5x0.5 mm^2) made it possible to directly compare intermittent lesions in the index SFA to the corresponding anatomical site in the contralateral vessel without repositioning the patient or coil. A complete set of TOF, T1 (not shown), T2, and PD images were acquired in a reasonable exam time of about 45 minutes, demonstrating the utility of this protocol in a clinical setting.

References:

1. Adams, et al. *Stroke* 2002;33:2575-2580. 2. Brown, et al. *Proc. ISMRM* #2587(2006). 3. Roemer, et al. *MRM* 1990;16:192-225.

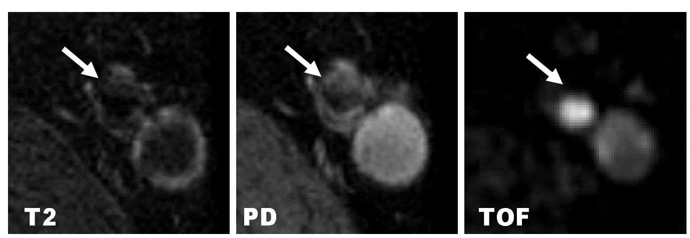


Patient A, left – new (closed arrows) and former (open arrows) lumens

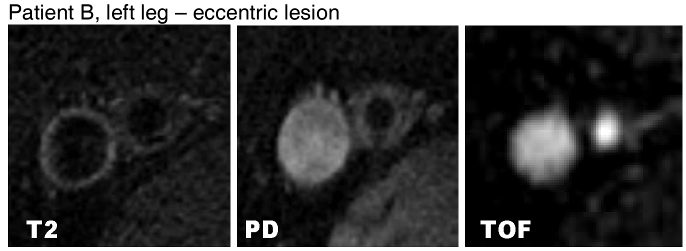


Patient A, right leg– normal SFA with open lumen.

Figure 1. Images of the left (arrows, top row) and right (bottom row) SFA illustrating a neolumen and heathy vessel, respectively. The FOV is 30x30 mm^2 with 0.5x0.5 mm^2 (T2, PD) and 1x1 mm^2 (TOF) resolution.



Patient B, left leg – eccentric lesion



Patient B, right leg – normal SFA with open lumen.

Figure 2. Images illustrating a diseased (arrows, top row) and healthy (bottom row) vessel at the same site in a PAD patient.