High-Permittivity Thin Dielectric Pad Improves Peripheral Non-Contrast MRA at 3T

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Target Audience: Clinicians and investigators performing peripheral MRA and pelvic MRI at 3T.

Purpose: Non-contrast magnetic resonance angiography (NC-MRA) is an alternative diagnostic tool for assessment of peripheral vascular disease in patients with impaired kidney function. While peripheral NC-MRA based on subtraction of two turbo-spin-echo acquisitions may benefit from increased signal-to-noise ratio at 3T, it also suffers from signal loss in the right femoral artery due to previously described radially symmetric B_1^+ inhomogeneities[1], which, in other parts of the body, have been shown to be minimized using high-permittivity dielectric pads[2]. The purpose of this study was to utilize high-permittivity dielectric padding to reduce NC-MRA signal loss associated with B1 inhomogeneity at 3T.

Methods: Nine healthy volunteers and two patients with peripheral arterial disease were imaged at 3T (Tim Trio, Siemens) to compare the following three NC-MRA acquisitions with spatial resolution = 1.5 x 1.6 x 2.0 mm and scan time = 3 min: without pad, with commercially available dielectric pad (Siemens: 37 x 25 x 5 cm), and with a custom made high-permittivity thin dielectric pad[2] (barium titanate, 38 x 20 x 2 cm), which is 60% thinner than the commercial pad, and is low cost (~$150). Figure 1 shows placement of the dielectric pad on the pelvis of a subject lying supine on the MR table with the peripheral coil. For the MRA protocol two datasets, during systole and diastole, were acquired using an ECG gated 3D FSE sequence that used nonselective excitation and refocusing pulses[3]. For each MRA acquisition, we also acquired a B1 map[4] in the axial plane to quantify the B1 variation around the common femoral arteries. For quantitative analysis, we calculated apparent contrast-to-noise ratio (CNR) of the left (control) and right common femoral arteries, where apparent CNR is defined as $(SI_{artery}-SI_{background\_Tissue})$/noise. Given that the three acquisitions used identical imaging parameters, RF excitation and receive settings, except for the dielectric pad, we assumed the same noise value for CNR comparison for each subject. The mean normalized B1 encircling the left and right common femoral arteries was measured (see Fig.1). ANOVA was used to compare the three CNR groups (with Bonferroni correction to compare each pair). Images were graded by three radiologists blinded to pad presence in consensus on a Likert scale 1-5 (worst-best) for conspicuity of common femoral arteries. Kruskal-Wallis test was used to compare the three conspicuity scores (with Bonferroni correction to compare each pair).

Results: Compared with baseline and commercial-dielectric-pad acquisitions, high-permittivity-dielectric pad acquisition exhibited greater signal recovery in right femoral artery (Fig.1, see B1 maps and maximum-intensity-projections (MIPs)). Over 11 subjects (Fig.2), the apparent CNR and conspicuity score in the left common femoral artery were not significantly different the three acquisitions ($p > 0.5$). In contrast, the mean normalized B1, apparent CNR, and conspicuity score in the right common femoral artery were significantly different between the three acquisitions ($p < 0.001$), except for the baseline-commercial acquisition pair.

Conclusions: Our study shows that NC-MRA signal loss in the right common femoral artery at 3T can be recovered through the use of a low-cost home-made high-permittivity dielectric pad. This study shows feasibility to perform NC-MRA of the thigh at 3T with high-permittivity dielectric padding.

References:[1] Storey, P, et al., ISMRM 2009. [2] de Heer, P, et al., MRM 2012. [3] Storey, P, et al., JMRI 2011. [4] Chung, S, et al., MRM 2010.

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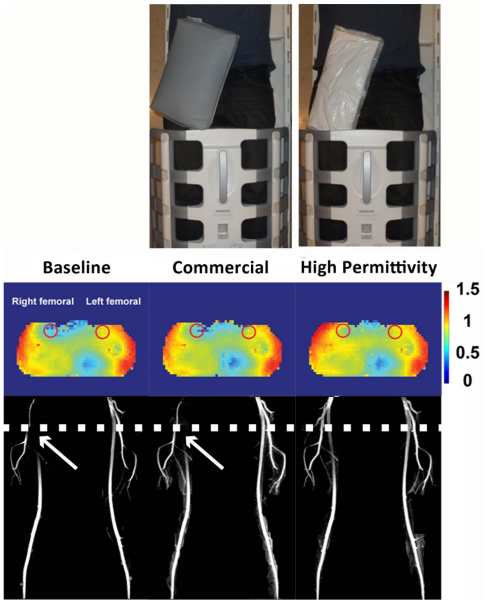

Figure 1: (Top row) Placement of commercially available and high-permittivity dielectric pads. (Middle row) Normalized B1 maps in the axial plane that cross-sections the common femoral arteries. (Bottom row) NC-MRA MIPs: (left column) without pad, (middle column) with commercial pad, and (right column) with high-permittivity pad. White dotted line corresponds to the axial plane of the B1 map. White arrows point to signal loss in the right femoral artery due to B1 inhomogeneity.

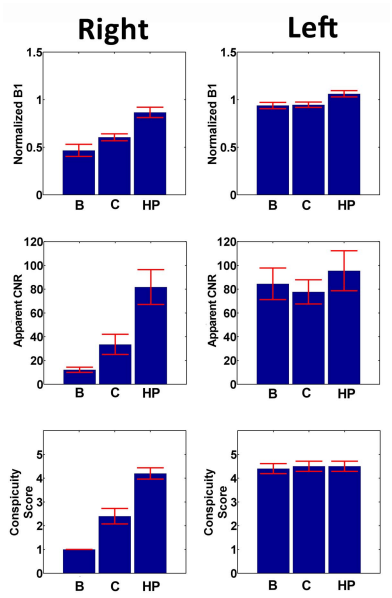

Figure 2: (Top row) Normalized B1 encircling the right and left femoral arteries. (Middle row) Apparent CNR in the right and left common femoral arteries. (Bottom row) Conspicuity score graded by three radiologists in consensus. B: baseline, C: commercial pad, HP: high-permittivity pad.