

Reduction of Pulmonary Vein Blood Inflow Artifact in Free Breathing Left Atrial Late Gadolinium Enhancement MRI

M. Hedjazi Moghari¹, D. C. Peters¹, J. Smink², L. Goepfert¹, K. V. Kissinger¹, B. Goddu¹, T. H. Hauser¹, M. E. Josephson¹, W. J. Manning¹, and R. Nezafat¹
¹Dept. of Medicine (Cardiovascular Div.), Beth Israel Deaconess Medical Center, Harvard Medical Sch., Boston, MA, United States, ²Philips Healthcare, Netherlands

Introduction: High spatial resolution left atrial (LA) late gadolinium enhancement (LGE) is acquired during free-breathing with 2D pencil-beam right hemidiaphragm (RHD) respiratory navigator (NAV). A NAV restore pulse with larger diameter is usually applied after the inversion pulse of the LGE sequence to restore the magnetization of the RHD [1]. This NAV restore pulse also re-inverts the pulmonary vein (PV) blood flowing into the LA and creates an inflow artifact, which manifests as LA and PV signal enhancement [2]. In this study, we propose a RHD projection NAV with an additional delay between the NAV and imaging that precludes the need for the NAV restore, and thus minimizes the inflow artifact.

Material and Method: Fig.1 shows the schematic of proposed free-breathing LGE sequence. A projection NAV exciting a large 2D slab covering the RHD and PVs was used. An additional delay of 100ms between the projection NAV and imaging was employed to allow for signal recovery of the RHD (with potential residual respiratory motion artifact). The amount of delay was determined in a pilot study on 5 healthy subjects, by investigating the signal recovery of the RHD experiencing an inversion pulse. In an IRB approved study, LA LGE were acquired in 8 healthy adult subjects (6 females, 25±9 years) and 10 atrial fibrillation (AF) patients (8 males, 58±14 years), using conventional free-breathing LGE with navigator [2] and with the proposed sequence, in random order. The imaging parameters were: TE/TR/α=2.5ms/5.2ms/25°, FOV of 320×320 mm², 40 slices, spatial resolution of 1.4×1.4×4 mm³.

All images were acquired using 1.5T MR scanner (Achieva, Philips Healthcare, Best, NL) with 5 channel cardiac coil array. Images were evaluated by two readers, blinded to the acquisition techniques. Readers scored the PV artifacts using a 4-point scale (1=severe, 2=moderate, 3=mild, 4=none). Separate scores were given, in consensus by both readers, for motion and blood artifacts, and the scores were analyzed separately. A paired two-sided Wilcoxon test was performed on the visual grading with $p < 0.05$ considered statistically significant.

Results: The inflow artifact scores were 3.8±0.4 and 2.1±0.7 for the projection and pencil-beam NAV, respectively ($p < 0.001$). Respiratory motion artifact scores were similar between the two techniques (3.0±0.5 projection vs. 3.1±0.5 pencil-beam NAV, $p = \text{NS}$). Fig.2 displays the LGE images of two subjects acquired with the pencil-beam and projection NAV. Fig.3 shows the LGE images of an AF patient imaged after an RF ablation using the pencil-beam and projection NAV. The images acquired with pencil-beam contain signal enhancement from both the ablation (dotted yellow arrow) and inflow artifact (solid white arrow).

Conclusions: The proposed RHD projection NAV reduces the NAV inflow artifact associated with the 2D pencil-beam in free-breathing LGE.

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References: [1] Spuentrup E., RoFo, 2002; [2] Peters D. C., Radiology, 2007.

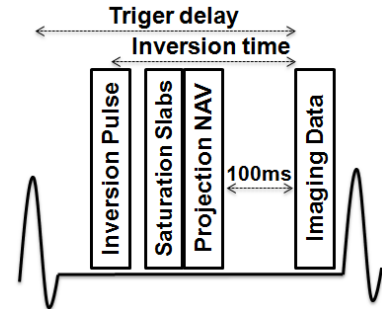


Fig. 1: PV LGE sequence diagram using projection NAV.

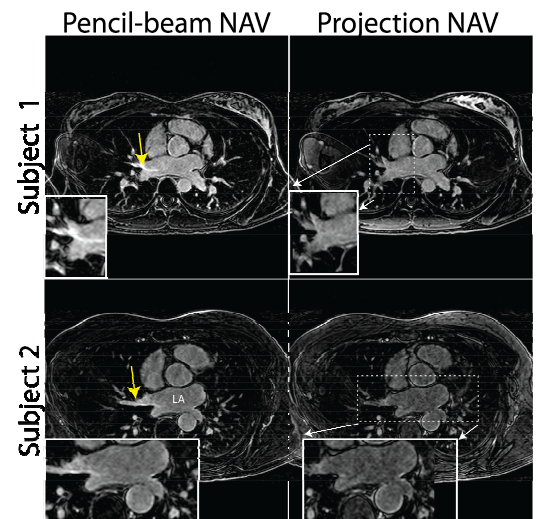


Fig.2: Axial slices for the LGE images acquired with the pencil-beam and proposed projection NAV. Arrows display the inflow artifact in PVs and LA for the pencil-beam NAV.

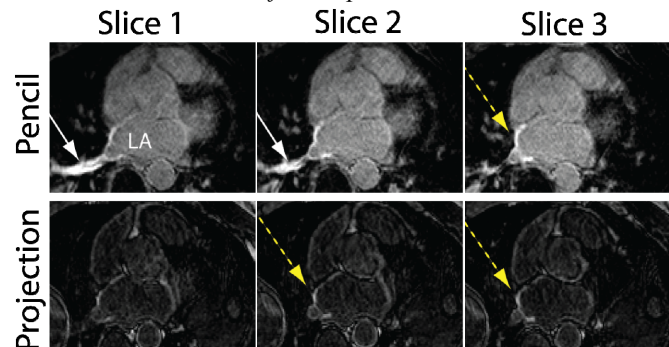


Fig. 3: LGE images acquired with the pencil-beam and projection NAV. Both inflow artifact (white arrow) and late enhancement from ablation (yellow arrow) are observable with the pencil-beam NAV. The PV inflow artifact is absent with the proposed projection NAV.