Multinuclear \((^{19}\text{F} + ^1\text{H})\) high-resolution intravascular MRI of perfluoroctyl bromide (PFOB) microcapsules at 3T

Shashank Sathyanarayana Hegde\(^1\), Li Pan\(^2\), Guan Wang\(^{1,3}\), Yingli Fu\(^1\), and Dara Kraitchman\(^1\)

\(^1\)Radiology, Johns Hopkins University, Baltimore, Maryland, United States; \(^2\)Siemens Corporation, Baltimore, Maryland, United States; \(^3\)Electrical and Computer Engineering, Johns Hopkins University, Baltimore, Maryland, United States

**Audience:** MR Interventionalists interested in cellular therapeutic delivery or vulnerable plaque detection.

**Purpose:** One of the challenges in the development of transplanted cellular therapeutic strategies is effective \textit{in vivo} tracking of cells post-delivery. Fluorine \((^{19}\text{F})\) MRI combined with anatomic proton \((^1\text{H})\) MRI provides an effective method for tracking labeled cells\(^1\). Conventionally, surface and/or body radiofrequency coils have been utilized for the MRI component of such multimodal imaging. Recently, 3T intravascular MRI (IVMRI) probes have been shown to provide high-resolution \textit{in vivo} trans-luminal imaging with local signal-to-noise ratios superior to surface coils\(^2\). Here, for the first time, using an IVMRI probe designed for both \(^1\text{H}\) and \(^{19}\text{F}\) MRI, we show high-resolution localization of perfluoroctyl bromide (PFOB) microcapsules in a porcine heart \textit{ex vivo}. Localization is confirmed by computed tomography (CT) imaging of the microcapsules.

**Methods:** A multinuclear IVMRI probe was designed using a 2mm outer-diameter 3T loopless antenna with a 40mm resonant whip. The whip length was essentially the same at the proton and fluorine Larmor frequencies (128,116MHz)\(^3\), thereby allowing interchangeable operation for both nuclei. A switchable interface afforded either transmit/receive or receive-only operation\(^2\). The probe was inserted into an \textit{ex vivo} porcine heart immersed in body-equivalent (3gL\(^{-1}\)) saline and the ventricle was accessed via the brachiocephalic artery. PFOB microcapsules were produced using a modified alginate microencapsulation method with the addition of 12% (v/v) PFOB allowing for multimodality (MRI + CT) detection. Approximately 0.8cc of PFOB capsules was injected into the tissue between the brachiocephalic and subclavian arteries (Fig. 1a). The same IVMRI probe was used as: (1) a receiver with body-coil transmission for \(^1\text{H}\) MRI on a Philips 3T (Achieva); and (2) in the transmit/receive mode for \(^{19}\text{F}\) MRI on a Siemens 3T (Tim Trio). The proton and fluorine images were co-registered and overlaid to form a composite image. MRI was followed by c-arm CT imaging (Artis Zee, Siemens) to confirm the deposition of the radio-opaque microcapsules.

**Results:** Insertion of the probe into the heart can be seen under \(^1\text{H}\) MRI (bright line, Fig.1a). PFOB capsules are identified under \(^{19}\text{F}\) MRI at 0.8mm in-plane resolution (Fig. 1b, magenta). \(^1\text{H}\) IVMRI at 0.2mm resolution clearly delineates the vessel wall (around \(p\), Fig. 1b). The composite image (Fig. 1b) shows good correlation with a CT cross-sectional reformat at the same location (Figs. 1c, 1d).

**Conclusions:** We show, for the first time, that 3T IV MRI detectors are ideally suited to high-resolution (sub-mm) detection of both fluorine and hydrogen. Multinuclear IVMRI probes provide an effective method to image and monitor potential cardiovascular labeled cellular therapies \textit{in vivo}.

**Refs:**
(2) Sathyanarayana S, et. al., JACC Card Im. 2010; 3:1158-1165.

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![Figure 1](image-url)