

# Time-Resolved Spin-Labeled Balanced SSFP Cineangiography for Visualizing Intracardiac Shunt

F. E. Mordini<sup>1</sup>, I. Koktzoglou<sup>1</sup>, and R. R. Edelman<sup>1</sup>

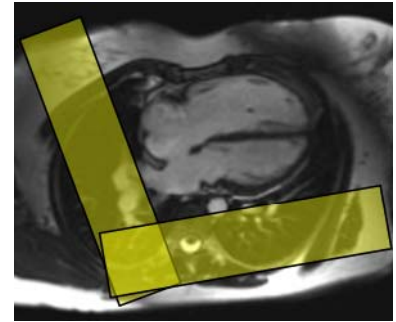
<sup>1</sup>Radiology, NorthShore University HealthSystem, Evanston, IL, United States

## Introduction:

Existing methods for intracardiac shunt evaluation have substantial technical limitations. For example, phase contrast imaging (PC) is sensitive to the velocity encoding setting and the angle of the imaging plane. PC can also be difficult to interpret due to complex flow patterns and separation of morphologic from velocity images. Cine GRE sequences that involve saturation of inflowing blood have poor SNR. Methods requiring gadolinium have limited use within a single exam and have not proven capable of improving shunt visualization. A method that circumvents these technical limitations is desirable. We therefore implemented a time-resolved spin-labeled cineangiographic technique (SLC) to image tagged blood within the heart for visualization of intracardiac shunt.

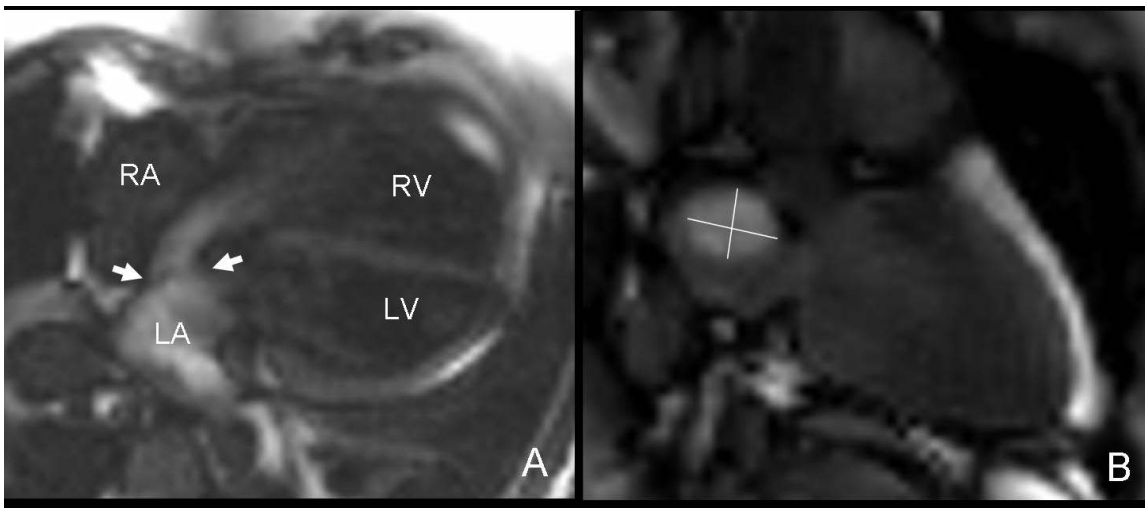
## Methods:

Ten subjects with known atrial septal defects (ASD) were evaluated. Background signal was suppressed with a non-selective inversion radiofrequency pulse. Inversion slabs were then applied to the pulmonary veins (right figure, yellow shaded bars) to tag left atrial blood and to the inferior/superior vena cava to tag right atrial blood. Remagnetized blood within the heart was visualized using a cine ECG gated, segmented, bSSFP sequence. Imaging parameters were FOV 340, matrix 128 x 100, slice thickness 6-8 mm, TR 46 ms, TE 1.3 ms, 30-40 phases, breath-hold time 12-14 seconds. The sequence was implemented on a 1.5T Siemens (Erlangen, Germany) Avanto scanner.



## Results:

Tagged inflowing blood was depicted with high signal intensity (SI) while non-tagged blood was suppressed. In all ASD patients tagged blood with high SI in the left atrium (LA) was visualized crossing the atrial septum demonstrating left-to-right flow (panel A, white arrows). Non-tagged blood with low SI was seen in the right atrium (RA), right ventricle (RV), and left ventricle (LV). Mean CNR of shunt to RA blood was 22.6 (range 8.6-34.6). Flow was visualized both in-plane (long/short axis) and through-plane (en face). Panel B shows the cross-sectional (en face) view of a large ASD with white cross-hairs defining its size and shape. Flow was visualized while maintaining good morphological assessment of surrounding cardiac structures. In 3 patients right-to-left flow was detected.



## Conclusions:

1. In a pilot study, SLC demonstrated RF-tagged blood flowing through the cardiac chambers.
2. The method successfully demonstrated left-to-right and right-to-left intracardiac shunting.
3. SLC has potential use in the detection and pre-procedural assessment of intracardiac shunt.
4. Application in small shunts and valvular disease has yet to be evaluated.