Accelerated time-resolved Time-Of-Flight Magnetic Resonance Angiography in Mice Models

William Lefrançois[1], Charles Castets[1], Aurélien Trotier[1], Eric Thiaudière[1], Jean-Michel Franconi[1], and Sylvain Miraux[1]
[1]*Centre de Résonance Magnétique des Systèmes Biologiques, Bordeaux, France, Metropolitan*

TARGET AUDIENCE: This work would benefit to research teams aiming to investigate vascular function in healthy and diseased small animal models.

PURPOSE: Anatomical and functional Time-Of-Flight (TOF) Magnetic Resonance Angiography (MRA) appeared to be a powerful tool to characterize small rodents physiological and pathophysiological models in the field of vascular biology. In previous works, a time-resolved TOF method was implemented to directly visualise blood flow in mice, with positive contrast in 3 Dimensions (3D) [1-3]. Nevertheless, like with 3D phase contrast MR, the method presents two limitations: relatively long acquisition time and limited temporal resolution. The goal of this study was to develop an accelerating strategy to improve blood flow visualisation in mice. The method employed cine-3D echo-planar imaging sequence to reduce acquisition time.

METHODS: Experiments were carried out on a 7T Bruker system. A volume resonator was used for excitation and a four element phased array surface coil for signal reception. Healthy mice (C57 black 6, 22–27 g) were anaesthetised with 1.5-2% isoflurane mixed in air. Then, animals were positioned supine within the magnet, with the neck placed at the centre of the NMR coil, for carotid arteries MRA. For flow measurement, the method consists in first saturating the volume of interest to suppress stationary and moving magnetization. Next, two different ECG-triggered sequences were used in a cine mode to acquire time-resolved 3D images containing only bright blood. The first sequence was a Fast Low Angle SHot (FLASH) sequence (TE/TR = 1.9/6.78 ms) and the second was a segmented-EPI sequence (3.34/6.78 ms) allowing to acquire three echoes per cine image after one excitation. In both cases, fifteen cine images were obtained with a temporal resolution of 6.78 ms.

RESULTS: After *in vitro* validation, experiments were realized *in vivo* in mice. Figure 1 shows Maximum Intensity Projections (MIP) of 3D cine images of carotid arteries obtained with FLASH sequence and segmented-EPI sequence. In both cases, the spatial resolution was 156 x 175 x 187 μm^3. The total acquisition time was lower than three minutes with cine segmented-EPI, and was reduced by a factor of 3 compared with cine-FLASH.

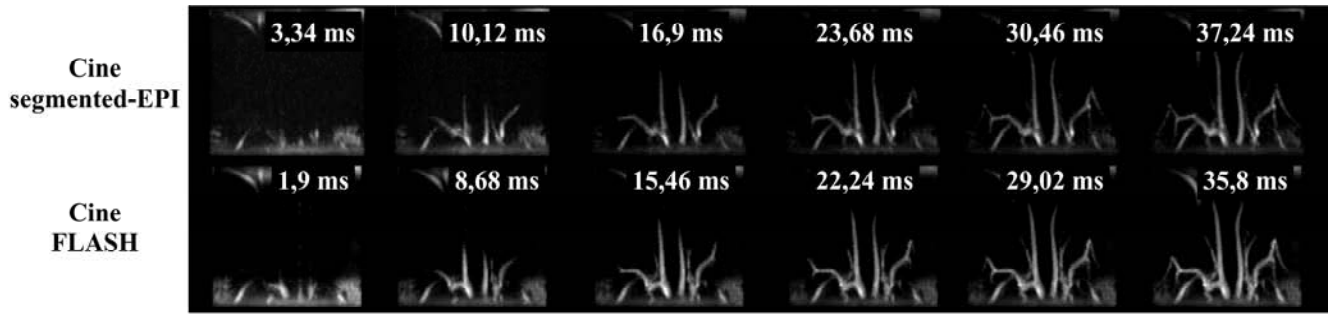

Figure 1

CONCLUSION: It was shown that segmented-EPI can be performed in mouse model to obtain ultra-fast anatomical and time-resolved MRA with high spatial resolution. This new sequence will be next tested on pertinent mouse models simulating for example, cerebrovascular stenosis.

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