Non-contrast MRA of the Toes using time-Spatial Labeling Inversion Pulse (time-SLIP) and Optimization of Flow-spoiled Gradient Pulses for the Assessment of Foot Arteries in Flow-spoiled Fresh Blood Imaging (FBI)

J. Isogai[1], M. Miyazaki[2], T. Shimada[1], H. Hatakeyama[1], T. Yamada[1], N. Matsuo[1], S. Maejima[1], K. Yodo[3], and T. Miyata[3]

[1]Hasuda Hospital, Hasuda, Saitama, Japan, [2]Toshiba Medical Research Institute USA, IL, United States, [3]Toshiba Medical Systems Corporation, Japan

Purpose

The aim of our study is to selectively visualize arteries of the foot and toes without contrast media. Efficacy of flow-spoiled fresh blood imaging (FBI) was investigated for the depiction of the distal foot arteries, such as the arcuate and metatarsal arteries (1). In addition, a time-spatial labeling inversion pulse (time-SLIP) in combination with FBI, was investigated for efficacy of depicting the digital arteries of the toes (2). In order to obtain a greater flow-dephasing effect for artery-vein separation, optimization of the flow-spoiler gradient strength was examined on a vascular phantom, and was then applied to slow-flow arteries of the distal foot.

Materials and Methods

All the studies were performed on 10 healthy volunteers using a 1.5T MRI system (EXCELART Vantage XGV Toshiba, Japan), using either a QD head or torso SPEEDER coil. For the assessment of arteries of the toes using time-SLIP with FBI, we varied 1) foot positions, 2) black blood tag width, where a selective excitation pre-pulse is applied independently of the imaging field, and 3) black blood inversion time (BBTI), which is from the selective IR pulse to the start of effective TE (TEeff). On a homemade vascular phantom, the relationship between signal intensity of the flow and flow-spoiled gradient pulse strength was obtained by a Flow-Prep scan (varying the flow-spoiler gradients) with changing a flow velocity calculated by a cross-sectional area and injection rate which was confirmed with 2D phase contrast (PC) velocity measurement.

Results

Time-SLIP with FBI showed the excellent depiction of the arteries in the toes when the ankle was not in the flexion or extension position. The contrast between vessels and background decreased with the long BBTI and the narrow width of the tag pulse. The detail anatomies of the digital arteries in the toes were obtained as showing in Fig.1. The flow-spoiled gradient pulse strength was optimized on various velocities in the flow phantom experiment, and the appropriate strength was then applied on imaging of the foot arteries, which allowed immediate visualization of slow-flow arteries, as shown in Figs. 2 and 3.

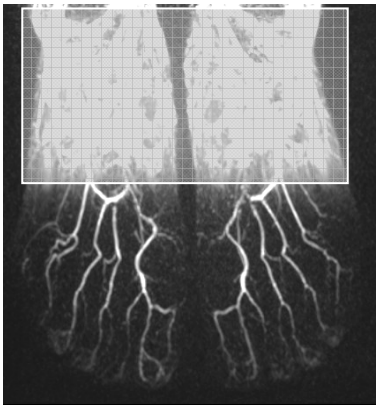

Fig.1) Non-contrast MRA of the toes using time-SLIP.

Conclusion

MRA using Flow-spoiled FBI was available to visualize slow-flow arteries of the foot especially when the flow-spoiled gradient pulse strength was optimized. MRA using time-SLIP with FBI sequence was the most effective with a narrow limit of selective visualization of arteries in the toes without the use of contrast media.

References

1)Miyazaki M, et al. Radiology, 227:890-896; 2003.
2)Kanazawa H and Miyazaki M, ISMRM 2002, p140.

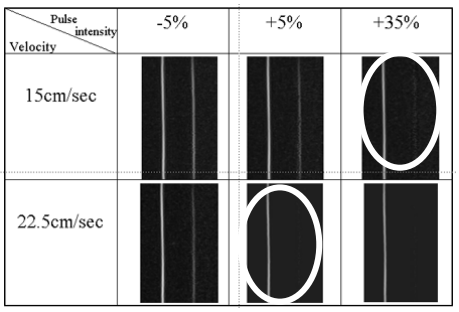

Fig.2) The appropriate flow-spoiler gradient strength was obtained using Flow-Prep scans on the flow phantom. The different dephasing pulse was applied on for each velocity.

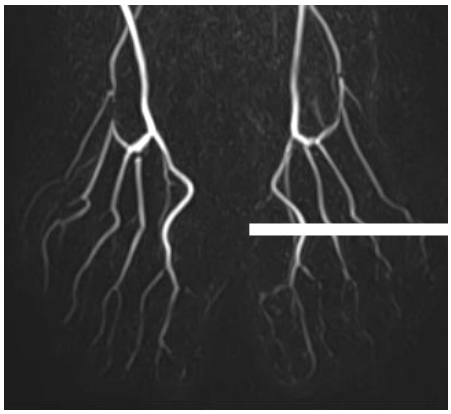

Fig.3) Non-contrast MRA of the distal foot using Flow-spoiled FBI. The velocity measured with 2D-PC facilitates to apply the appropriate flow-spoiled gradient pulse strength.