HYBRID-MRA: A NEW NON-CONTRAST MRA TECHNIQUE WITH DUAL-ECHO 3D GRADIENT ECHO SEQUENCE IN COMBINATION OF TIME-OF-FLIGHT AND FLOW-SENSITIVE BLACK-BLOOD

T. Kimura[1], M. Ikedo[1], and S. Takemoto[2]

[1]MRI Systems Dvision, Toshiba Medical Systems, Otawara, Tochigi, Japan, [2]MRI Systems Dvision, Toshiba Medical Systems, Tokyo, Japan

Introduction

MR angiography (MRA) using a time-of-flight (TOF) is most widely used as a non-contrast technique for the brain since major arteries can be well visualized easily. However, TOF has shortcomings for visualizing narrower or slow-flow blood vessels. In contrast, a black-blood (BB) sequence is known as an alternative MRA technique for visualizing such vessels, but it is not widely used since minimum intensity projection (minIP) may have difficulty especially when the volume is large. We have proposed a novel BB technique named Flow-Sensitive BB (FSBB) employed 3D-GRE with flow dephasing [1,2], but shortcomings of BB remains as it is. For the purpose of enhancing slower arterial flow as well as faster flow without increasing imaging time, we proposed a new MRA technique named Hybrid-MRA (HMRA) that combined standard TOF of White-Blood (WB) MRA with the BB sequence and assessed its feasibility in volunteers and clinical cases.

Materials and Methods

Imaging was performed on a 1.5-T whole-body imager (EXCELART Vantage™, Toshiba Medical Systems). Dual-echo 3D-gradients-echo sequence (FE3D) and parallel imaging with a reduction factor of 2 were employed to reduce miss registration and imaging time. MTC pulses were not used in the HMRA to maintain blood CNR for BB. In the 1st echo for TOF, TE=6.4 ms and three-axis gradient moment nulling (GMN) was employed to reduce the displacement of fast-flow vessels. In the 2nd echo for BB, TE=24 or 27 ms and flow dephasing gradient of b=2 s/mm^2 were employed for enhancing slow-flow vessels. Volume images for HMRA were obtained by two kinds of method; the first was a simple weighted subtraction between original images of WB, S_{WB}, and BB, S_{BB}, as $S_H = S_{WB} - \alpha S_{BB}$ where α is a weighting coefficient; and the second was applying a spatially high-pass filter before weighted subtraction to reduce the effects of background signal. Maximum intensity projection (MIP) was performed without volume selection. Several techniques for generating HMRA were compared to standard TOF and TOF with SORS-MTC (SORS-TOF) [3] that are clinically used at present.

Results and Discussion

Smaller vessels were well visualized by the HMRA compared to the standard TOF-MRA, and blood CNR at smaller vessels for HMRA became greater as α became greater, since the blood CNR for BB was greater than for the TOF as blood vessels became smaller (**Fig. 1**). In comparison among different MRA techniques **(Fig. 2)**, smaller vessels on the vertical MIP image by the HMRA without filter (**c**) were better than by the SORS-TOF (**a**) and by the standard TOF (**b**), and fat signal in the scalp were minor when the horizontal MIP without volume selection. Although vessels were visualized sufficiently in the HMRA without filter when the MIP volume was within the brain parenchyma as shown in **Fig.1**, the susceptibility effects on the BB worsened the visibility of vessels especially when the skull base was included in the MIP volume. In contrast, The HMRA with high-pass filtering to BB images (**d**), however, dramatically improved the visualization of vessels in any MIP direction even when MIP volume included the base of skull. Furthermore, the effects of fat signal on the HMRA without filtering were further reduced by the high-pass filtering. In a case of right MCA occlusion without symptoms (**Fig. 3**), the HMRA could visualize collateral vessels in the area of the occluded MCA. A shorter TE for FSBB with keeping sufficient b-value is likely to further improve the visibility of vessels in HMRA.

In conclusion, we have proposed and assessed the HMRA technique that could visualize small vessels better than the standard TOF and the SORS-TOF MRA sequences. We believe that the technique will provide clinically additional information about slow-flow vessels such as collaterals that are hard to be visualized by conventional TOF-MRA.

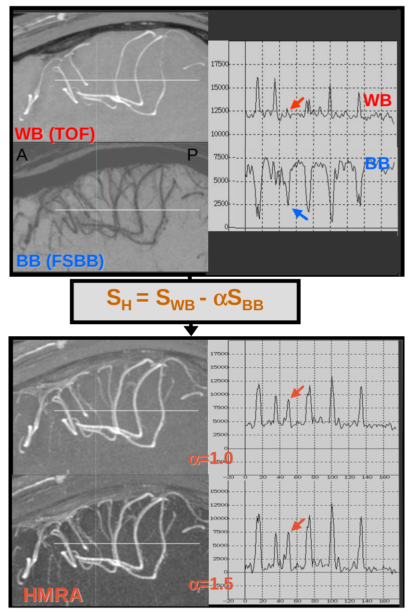


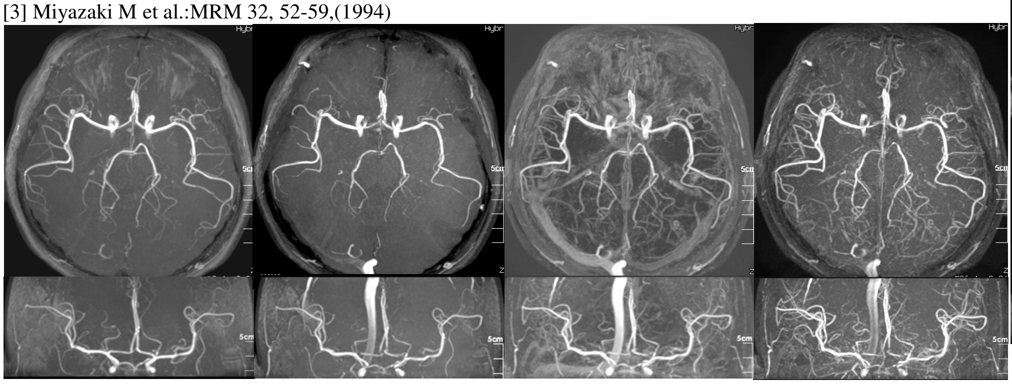
Fig.1 TOF (1st), FSBB (2nd) and Hybrid MRA with different weighted subtraction. Thickness of MIP or minIP was every 10mm..

Acknowledgements

We thank K.Tsuchiya, M.D. and K.Kobayashi, R.T. at Kyorin University for providing clinically data and valuable comments.

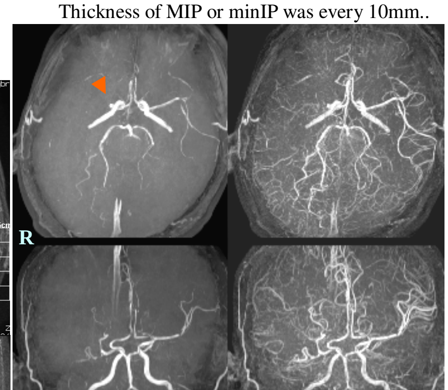
References

[1] Kimura T. et al.: Proc of ISMRM, p3015,(2007), [2] Tsuchiya K. et al.: Proc of ISMRM, p3016, (2007), [3] Miyazaki M et al.:MRM 32, 52-59,(1994)



a SORS (MTC)-TOF **b** TOF **c** HMRA w/o filter (α=1.5) **d** HMRA with filter

Fig. 2 Comparison of different MRA techniques for normal volunteer. Imaging time was every 3m50s.



a TOF **b** HMRA with filter

Fig. 3 Clinical MRA of right. MCA occlusion (arrow). Collateral vessels in the MCA area are visualized better in the HMRA than in the TOF.