A novel technique of cranial MR angiography: hybrid MRA.

T. Kodama[1], T. Yano[1], S. Tamura[1], Y. Machida[2], and T. Kimura[2]

[1]Radiology, Faculty of Medicine, University of Miyazaki, Miyazaki, Japan, [2]Toshiba Medical Systems, Otawara, Japan

Purpose

3D time-of-flight (TOF) MR angiography (MRA) is widely used as a non-invasive imaging technique of intracranial arteries. This technique, however, have some limitations such as signal decline of peripheral and slowly-flowing vessels due to saturation effect, and signal loss due to phase dispersion. In contrast, we showed that black blood imaging using a 3D gradient-echo sequence and dephasing gradients (flow-sensitive black blood: FSBB) was a feasible technique for visualizing small and slowly-flowing vessels. The purpose of this study was to evaluate the utility of a new MRA sequence, hybrid MRA (HMRA), combining the contrast of TOF and FSBB by using the dual-echo data acquisition from the initial clinical experiences.

Materials and Methods

Fifteen patients with steno-occlusive cerebral vascular diseases underwent MR examination including a 3D TOF MRA and HRMA. Nine patients had a history of extracranial (EC) – intracranial (IC) bypass operation. All examinations were performed on a clinical 1.5T scanner (EXCELART Vantage ZGV, Toshiba). Pulse sequence of the HMRA was designed with a 3D dual-echo gradient-echo sequence. In this study, TR of 31.2 ms and TE of 6.4/23.8 ms were selected. The gradient moment nulling (GMN) and dephasing gradient was applied to obtain the first echo and the second echo, respectively. Original images of the HMRA were made by subtracting the second-echo images from the first-echo images with a variable weighting coefficient (Fig. 1). Maximum intensity projection (MIP) was performed in the same way as the TOF MRA. In this study, a weighting coefficient of 1.5 was chosen based on the theoretical study. 3D TOF MRA was performed with single or two slabs acquisition, and preparation pulses such as a magnetization transfer contrast (MTC) or fat saturation (FS) pulse was used (table).

Table. Pulse sequence of TOF MRA and HMRA

	TOF		HMRA
	routine	EC-IC bypass	
No. of slab	1	2	1
MTC pulse	(+)	(+)	(-)
FS pulse	(-)	(+)	(-)

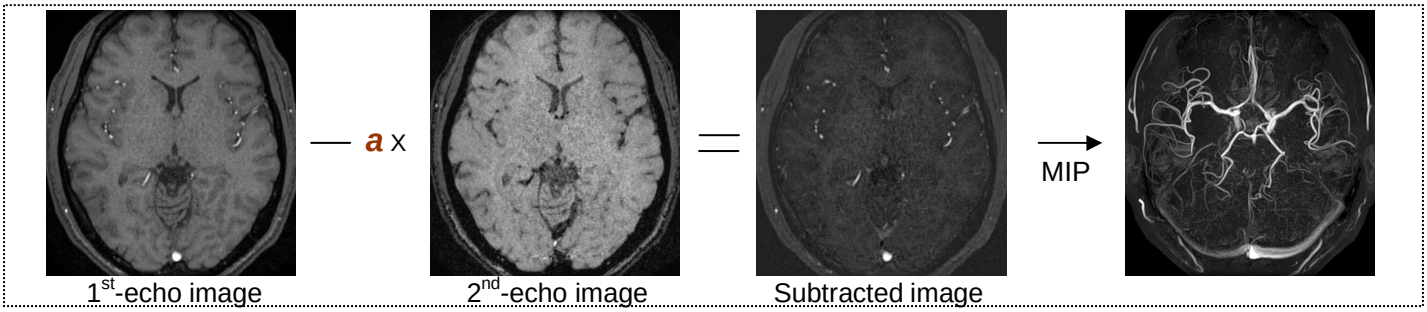


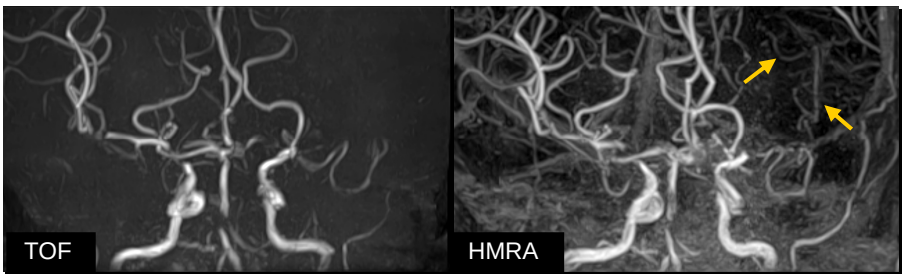
Fig. 1. Postprocessing steps of the HMRA. The second-echo image is subtracted from the first-echo image with a weighting coefficient of ***a*** (>0). Black blood of the 2nd-echo image contributes as bright signal on the subtracted image.

Results

In 6 patients with steno-occlusive vascular disease including moyamoya disease, visualization of the peripheral arteries was improved on HMRA compared with 3D TOF MRA using MTC pulse. In two patients with moyamoya disease and a patient with occlusion of the middle cerebral artery (MCA), some distal branches not visualized on TOF MRA were visualized on the HMRA. In the patient with MCA occlusion, retrograde filling of the distal branches of the MCA via the leptomeningeal anastomoses was revealed on the DSA. In 9 patients who had undergone EC-IC bypass operation, HMRA seemed to be of equal value with 2 slab TOF MRA using fat saturation and MTC pulses in spite of its shorter acquisition time. One of the problems of this technique was the susceptibility artifacts especially in the skull base. Because this technique was based on the subtraction between images with a different TE, the intensity of fatty tissue could not be totally subtracted in some instances.

Conclusion

HMRA can be a feasible tool for evaluating intracranial arteries, especially in patients with steno-occlusive vascular diseases.



Reference

1) Kimura T, et al. Proc of ISMRMS P3015, 2007.

Fig. 2. Occlusion of the left MCA. Some branches of the left MCA is visualized only on the HMRA image (arrow)