

Subtraction MR venography from time-resolved MR angiography; comparison with phase-contrast MR venography and contrast-enhanced MR venography

Jinhee Jang¹, Bum-soo Kim¹, Bom-ji Kim¹, Hyun Seok Choi¹, So-Lyung Jung¹, and Kook-Jin Ahn¹

¹Radiology, Seoul St. Mary Hospital, Catholic University of Korea, Seoul, Korea

Purpose: To evaluate the value of subtraction venography (SubMRV) from time-resolved contrast-enhanced MR angiography (TRMRA), as compared with phase-contrast MR venography (PC MRV) and contrast-enhanced single-phase MR venography (CEMRV).

Methods: From 2013 May to 2013 October, 19 patients who underwent MR venographies were included. SubMRV was obtained from two volume data of TRMRA: subtraction of arterial phase data from venous phase data. Corregistration of two volume data and subtraction was done by commercially available software. Intra-individual comparison of three MRVs (PCMRV, CEMRV, and SubMRV) was done by two experienced neuroradiologists by consensus for followings: degree of image quality, contamination of arterial structures on venography, and qualitative assessment of pre-defined 15 venous segments. Also, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of each MRV were obtained. Comparison was done by Friedman test.

Results: Qualitative image quality was statistically different in three MRV (table 1). CEMRV was best and SubMRV and PCMRV were similar. SubMRV minimized arterial contamination in almost all cases, and it was significantly different. Arterial contamination was most severe in PCMRV. SNR and CNR comparison results were similar to qualitative image quality score comparison (table2). Among 15 pre-defined venous structures, 11 segments showed statistically different qualitative scoring. PC MRV showed statistically lower score of each segments than other MRVs. Among 11 venous segments, score of SubMRV and CEMRV were not statistically different in seven segments (inferior sagittal sinus, straight sinus, vein of Galen, both cavernous sinuses, left transverse sinus, left sigmoid sinus, and left jugular bulb).

Discussion: There are some reports about the feasibility of TRMRA for evaluation of head and neck venous structures.¹⁻⁴ These TRMRA techniques are mainly produced based on variable view-sharing method.^{5,6} One of the main characteristics of view sharing methods is long temporal footprint and poor arterial to venous separation.⁷ To overcome this point we produced SubMRV images for vein-only images. Subtraction process should remove only unwanted arterial visualization, and targeted structures should leave untouched. For this purpose, choosing two appropriate phases are crucial. To avoid loss of signal of venous structures throughout subtraction process, we choose phase with minimal venous signal (solid arrow on Fig.1B) instead of those with arterial peak (empty arrow on Fig.1B). Although the signal of arterial structures is not on peak, it is still substantial and enough to remove arterial signal on venous phase.

Conclusion: Image quality of SubMRV was acceptable and comparable with clinically used other MRV. SubMRV removed arterial contamination successfully. Visualization of dural sinuses on SubMRV was superior to PCMRV.

Table 1. Qualitative assessment of MRVs

	PCMRV	CEMRV	SubMRV	Friedman test
Image quality	1	0	0	
	2	3	1	
	3	16	1	
	4	0	17	
Mean rank	1.5263	2.8421	1.6316	<0.001
Arterial contamination	0	0	0	
1	1	13	1	
2	10	5	0	
3	8	1	0	
Mean rank	2.8947	2.0789	1.0263	<0.001

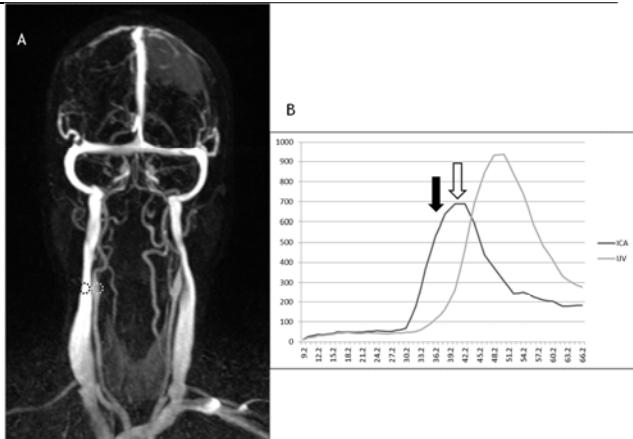


Fig. 1. A representative venous phase image of TRMRA (A) and time intensity curve (B) of ICA (gray dot rim on A) and IJV (black dot rim on A) acquired from TRMRA. Time-to-center of chosen arterial phase was marked on solid arrow. Empty arrow showed peak arterial time, with substantial signal of venous structure.

Table 2. SNR and CNR of MRVs (median and interquartile range)

	PCMRV	CEMRV	SubMRV	Friedman test
SNR	67.74, 60.28-74.65	167.89, 140.16-192.56	139.60, 121.00-195.24	
Mean rank	1.1053	2.5263	2.3684	<0.001
CNR	61.95, 55.22-69.52	160.91, 133.08-185.77	136.08, 117.02-191.68	
Mean rank	1.1053	2.5263	2.3684	<0.001

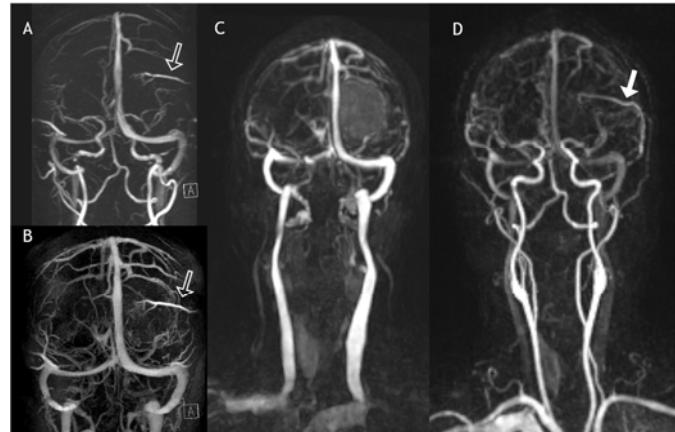


Fig. 2. A patient with meningioma in Lt parasagittal area. PCMRV (A) and CEMRV (B) showed transverse linear vascular structure (empty arrow on A and B) around the meningioma, suggesting draining vein. SubMRV (C) did not show the draining vein, but an enhancing mass itself. Arterial phase of TRMRA showed feeding artery from middle meningeal artery (solid arrow on D).

References

1. Meckel S, Glucker TM, Kretzschmar M, et al. Cerebrovasc dis 2008;25:217-224.
2. Zivadinov R, Lopez-Soriano A, Weinstock-Guttman B, et al. Radiology 2011;258:562-570.
3. Yigit H, Turan A, Ergun E, et al. European radiology 2012;22:980-989.
4. Rahman MT, Sethi SK, Utraiainen DT, et al. Magnetic resonance imaging 2013.
5. Lim RP, Shapiro M, Wang EY, et al. AJNR 2008;29:1847-1854.
6. Lee YJ, Laub G, Jung SL, et al. JMRI 2011;33:71-76.
7. Haider CR, Hu HH, Campeau NG, et al. Magnetic resonance in medicine 2008;60:749-760