Evaluation of Time Resolved Non-Contrast 4-D dMRA Technique in Cerebrovascular Diseases: A Preliminary Study

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Introduction

Our preliminary study demonstrates that dMRA with Radial-TrueSTAR provides shorter scan time (up to 3 fold) while preserving similar image qualities compared to dMRA with Cartesian-TrueSTAR2. In the present study, we investigated the clinical utilities of Radial-TrueSTAR dMRA in patients with various cerebrovascular diseases, by comparison with time of- flight (TOF) and DSA.

Methods

Eleven patients with cerebrovascular diseases, including eight arteriovascular malmormation (AVM), two arteriovascular fistular (AVF) and one cerebral aneurysm were enrolled in this study. 4-D MRA images were acquired from each patient using Radial-TrueSTAR. To fully cover the draining veins, two slabs were acquired in some AVM cases. TOF images were also collected from each subject. DSA was also performed in some patients for follow-up. Spetzler–Martin grading scale was evaluated in AVM patients with 4-D dMRA, TOF, dMRA plus TOF and DSA respectively by two neuroradiologists. Diagnostic confidence scores for three components of AVMs (feeding artery, nidus and draining vein) were graded from 1 (poor imaging quality with severe artifacts and no diagnostic value) to 5 (excellent imaging quality with no artifacts and definite diagnosis).

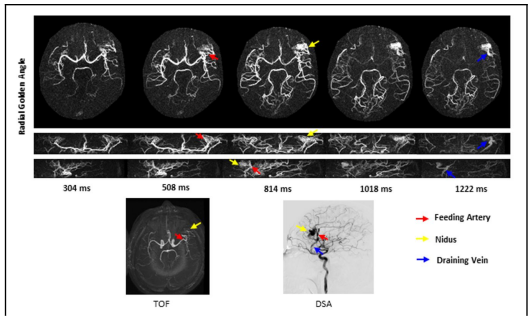

Figure 1. Patient who had left frontotemporal AVM underwent craniotomy surgery. Follow –up imaging was performed 3 years later. We can clearly observe the dynamic courses for labeled blood from feeding arteries (MCA, red arrow), through abnormal vascular nidus (yellow arrow) and then into the draining veins (blue arrow) sequentially which was in accordance with findings on DSA. However, TOF-MRA can only detect the nidus faintly.

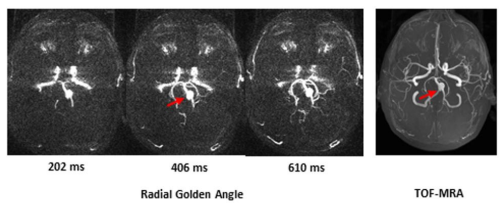

Figure 2. Follow-up imaging was performed in a patient with basilar artery aneurysm. Dmra could detect the aneurysm clearly and its relative hemodynamic information. The positon and morphology of the aneurysm detected with dmra was in accordance with TOF-MRA.

Table 1: Spetzler-Martin grading score from different modalities

Patient No.	Radial DMRA	TOF	DMRA+TOF	DSA
1	S2E1V0	S2E1V0	S2E1V0	S2E1V0
2	S2E0V0	S2E1V0	S2E1V0	S2E1V1
3	S1E1V0	S1E1V0	S1E1V0	S1E1V0
4	-	-	-	S1E0V1
5	S3E0V0	S3E0V0	S3E0V0	S3E0V1
6	-	-	-	-
7	-	-	-	-
8	S2E0V0	S1E0V0	S2E0V0	S2E0V0

S (size of nidus): <3cm 1; 3~6cm 2; >6cm 3. E (eloquence):non-eloquent 0; eloquent 1. V (draining vein): superficial 0; deep 1. *: not detected.

Results

AVM lesions were detected in 6/8 patients on DSA (Table 1). The delineation of AVM lesions using TrueSTAR is consistent with that of DSA (Figure 1), except dMRA failed to detect one small lesion (6mm) with low blood flow which was manifested as lightly stained on DSA. DMRA had the same Spetzler–Martin grading scales in terms of AVM size and location but failed to detect deep draining veins in 2 patients. Compared to TOF, the heterogeneity within the nidus can be observed using Radial-TrueSTAR (Figure 1). Improved diagnostic accuracy was achieved when dMRA and TOF MRA are combined (Table2). Two AVF and one aneurysm were also detected on dMRA clearly (Figure 2).

Table 2 Average scores of diagnostic confidence for AVM components

	Radial DMRA	TOF	DMRA+TOF
Feeding artery	3.75	4.38	4.38
Nidus	4.25	3.38	4.51
Draining vein	3.63	3.63	4
Kendall's tau-b	0.75	0.68	0.82
p value	0.007	0.015	0.001

p values indicate statistical significance of Kendall's coefficient.

Conclusions

Radial-TrueSTAR may become a promising approach with reduced scan time and patient comfort in clinical applications.

References

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Learning Objectives

Non-contrast 4-D dMRA can be used for the evaluation of hemodynamics in cerebrovascular diseases.