

Diagnostic Accuracy of High Resolution Black Blood MRI in the Evaluation of Intracranial Large Vessel Arterial Occlusions

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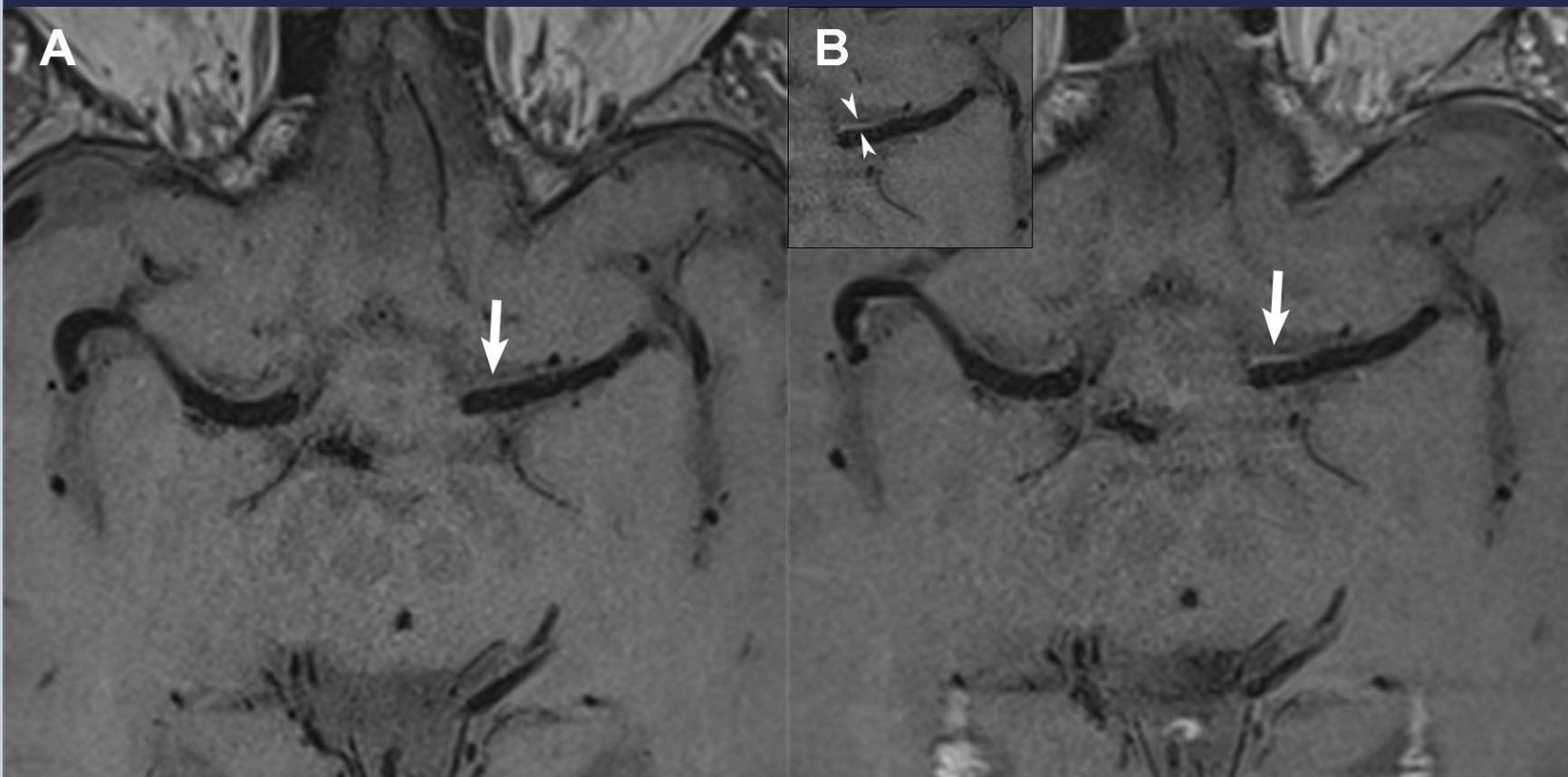
There will be no discussion of unapproved/off-label or investigational device utilization.

Background

- 3D TOF MRA is considered as the most common MRA technique for evaluating intracranial steno-occlusive disease in the setting of an acute ischemic stroke.
- Previous Studies have proven TOF to be insensitive to in-plane flow or slow flow, which can lead to overestimating the severity of stenosis or to a false diagnosis of a vascular occlusion.*
- In this study we tried to investigate a new MRA technique that can be more accurate and of a significant added value for the diagnosis of intracranial arterial occlusions.

Background and Purpose

- 3D black blood (BB) MRI using a T1 sampling perfection with application-optimized contrast using different flip angle evolutions (SPACE) sequence allows high resolution vessel wall imaging to evaluate the intracranial arterial wall (extra-luminal) and its associated pathologies.
- We investigated the diagnostic features and accuracy of 3D BB MRI in the detection of intraluminal arterial thrombosis.



High resolution BBMRI axial pre- (A) and post- (B) contrast images demonstrate patent bilateral MCAs with normal intraluminal hypointensity (black blood) due to flow suppression techniques. Normal thin vessel wall or marginal periarterial enhancement (arrows) is observed on post contrast versus pre contrast imaging, best delineated in the inset (arrowheads).

Methods

- We retrospectively identified 31 patients with intracranial arterial thrombosis that underwent 3D BBMRI \pm contrast, high resolution T1 SPACE sequences.
- 3D BBMRI findings were evaluated by 2 independent neuro-radiologists blinded to all other angiographic studies, conventional MRI sequences.
- 19 total intracranial vessel segments (ICA terminus, A1/A2 ACA, M1/M2 (superior and inferior division) MCA, vertebral, basilar, and P1/P2 PCA) per patient were evaluated and graded on a three-point qualitative scale (grade 0-2) for intraluminal T1 SPACE hyperintensity and contrast enhancement.

Methods

Intraluminal Hyperintensity 3-point scale

Grade 0 None

Grade 1 Partially visualized / Hyperintense signal less than the intra-orbital fat/ Loss of black blood flow

Grade 2 Clearly visualized / Hyperintense signal equal or more than the intra-orbital fat

Intraluminal Enhancement 3-point scale

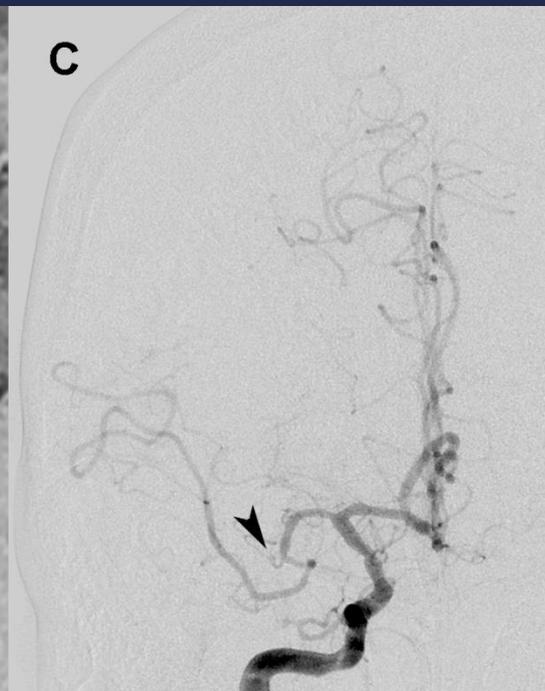
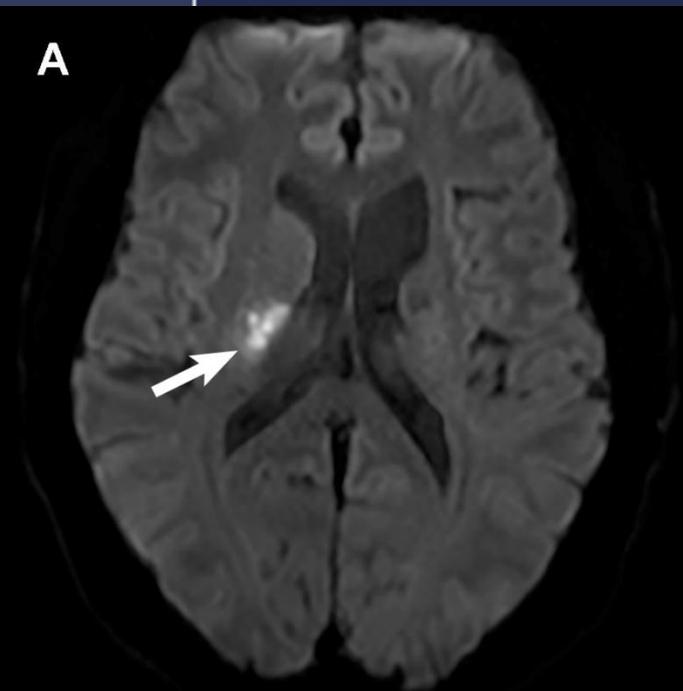
Grade 0 Signal equal to pre-contrast image

Grade 1 Partial enhancement with signal greater than pre-contrast image, but less than pituitary stalk.

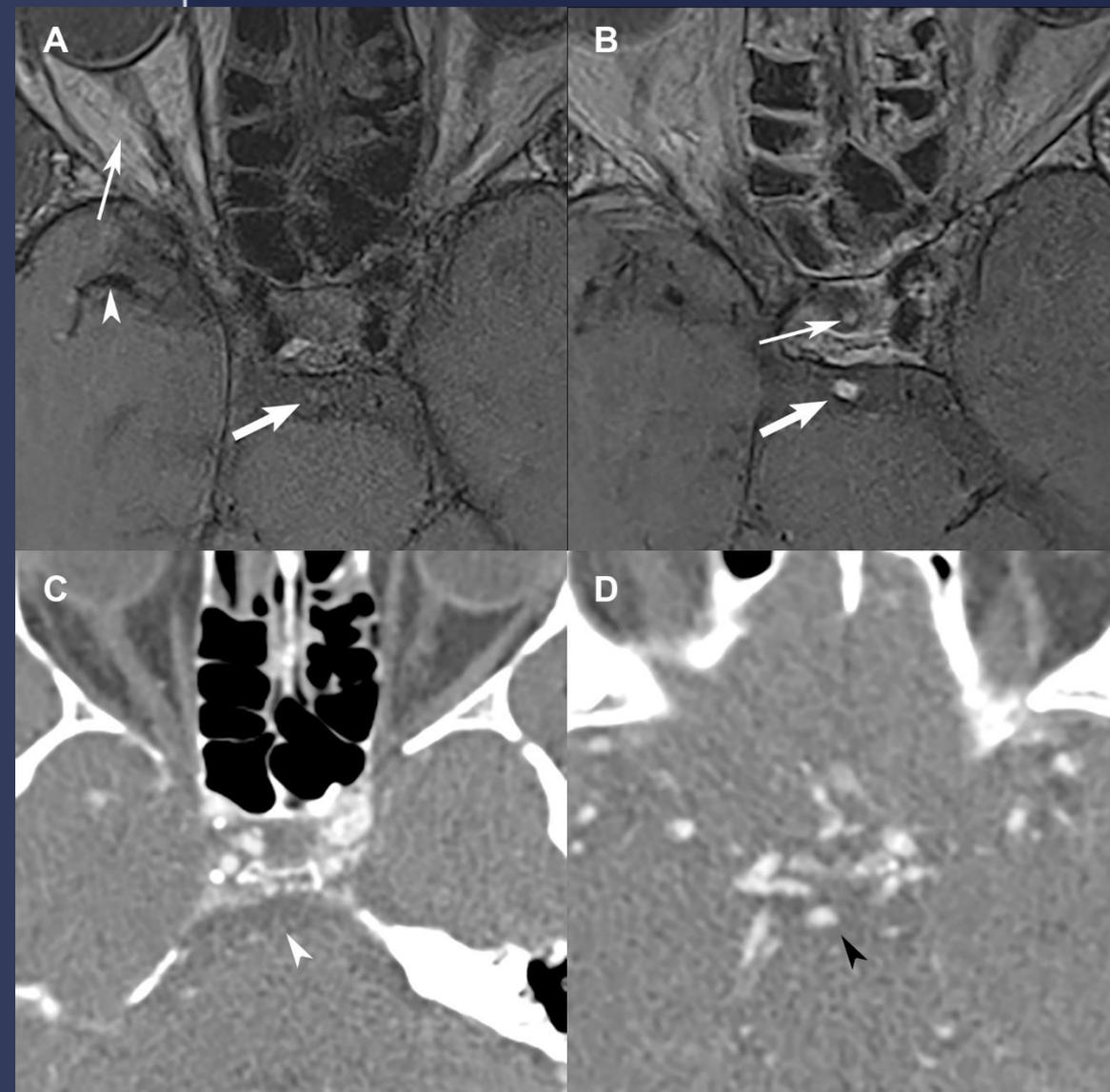
Grade 2 Clear enhancement with signal greater than the pre-contrast image, equal or greater than pituitary stalk.

Methods

- Images were considered positive for arterial thrombosis when focal intraluminal T1 SPACE hyper-intense signal and/or enhancement on 3D BBMRI were graded as 1 or 2 by the independent readers.
- Arterial occlusion was confirmed by digital subtraction angiography (DSA) or computed tomographic angiography (CTA).
- Patients were excluded if they received any intervention (IV/IA tPA thrombolysis and/or mechanical thrombectomy) between BBMRI and reference CTA/DSA.



39 years old presented with left sided hemiplegia. MRI axial DWI (A) image shows restricted diffusion (arrow) in the periventricular white matter consistent with an acute infarct. BBMRI axial pre-contrast (B) image demonstrates a focus of grade 2/strong intraluminal T1 hyperintensity (thick arrow) in the distal M1 segment proximal to the MCA bifurcation, compared to the normal retroglobal orbital fat (thin arrow), suspicious for an acute/subacute occlusion. DSA AP image (C) confirms the M1 right MCA occlusion (black arrowhead), after supply to a prominent anterior temporal branch.



63 years old male presented with nausea, vomiting and double vision secondary to multiple posterior circulation strokes. BMMRI axial pre-contrast image (A) shows a focus of grade 1/weak intraluminal T1 hyperintensity in the basilar artery (thick arrow), replacing the normal intra-arterial black blood signal of the M1 segment (arrowhead), but less intense than the orbital fat (thin arrow). BMMRI axial post-contrast image (B) shows grade 2/strong intraluminal contrast enhancement (thick arrow) of the basilar artery thrombus, compared to the normal avidly enhancing signal of the infundibular stalk (thin arrow). CTA (C, D) at the level of pons and the circle of Willis confirm occlusion of the basilar artery (white arrowhead) with distal basilar tip reconstitution (black arrowhead) from the anterior circulation via the posterior communicating artery.

Results

- Thirty-one patients with 38 intracranial arterial occlusions were studied.
- Median interval time between BBMRI scanning and CTA/DSA reference standard studies was 2 days (0-20).
- Interobserver agreement was good for T1-hyperintensity ($\kappa=0.63$) and excellent for contrast enhancement ($\kappa= 0.89$).

[Statistical Analysis was done taking Observer 1 as gold standard and Observer 2 as test when both partial and clear visualization (combined grades 1 and 2) suggested vessel thrombosis/occlusion.]

Results

- High sensitivity (100%) and specificity (99.8%) for intracranial arterial occlusion diagnosis was observed with either intraluminal T1-hyperintensity or contrast enhancement imaging criteria on BBMRI.
- Strong grade 2 intraluminal enhancement was maintained in >80% of occlusions irrespective of location or chronicity. Relatively increased strong grade 2 intraluminal T1-hyperintensity was noted in chronic/incidental versus acute/subacute occlusions (45.5% vs 12.5%, $p=0.04$).

Conclusions

- BBMRI with or without contrast has high diagnostic accuracy and reliability in evaluating intracranial large vessel arterial occlusions with near equivalency to DSA and CTA.
- 3D BBMRI provides an adjunctive mechanism to confidently diagnose complete arterial occlusions in the setting of low resolution conventional MRI findings and absent flow enhancement on TOF-MRA imaging prone to overestimation, in-plane dephasing or slow flow artifacts.

