Mid-sagittal saturated MRA for assessment of blood flow from STA-MCA bypass

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Purpose: Superficial temporal artery-to-middle cerebral artery (STA-MCA) bypass is now generally accepted as a direct revascularization surgery that seems to provide a remarkable improvement in cerebral blood flow. Although conventional MRA can visualize the cerebral blood flow, it is difficult to know whether the flow is antegrade from internal carotid artery or retrograde from the bypass. Whereas external carotid angiography (ECAG) can demonstrate the bypass flow, it may not reflect the natural blood flow because of the pressure injection of contrast medium. Our goal was to evaluate the feasibility of the time of flight MRA with saturation pulse band in mid-sagittal area in order to suppress antegrade flow signal from internal carotid arteries and basilar artery ("Mid-sagittal saturated MRA") for assessment of the bypassed blood flow through the STA-MCA bypass by comparing with the external carotid angiogram (ECAG).

Materials and Methods: The subjects were 11 cases (7 male, 4 female, aged 32-75 years, mean 59 years) who had undergone STA-MCA bypass surgery (13 sites). The subjects included 5cases with occlusion or severe stenosis of the internal carotid arteries, 3 cases with that of middle cerebral arteries and 3 cases of moyamoya disease.

MRA was performed on a 1.0 T clinical scanner using a transmitter-receiver type head coil. 3D-TOF technique was applied with following sequence parameters: TR: 42sec, TE: 9.6ms, flip angle: 20°, FOV: 230mm, matrix: 256×192, slab: three 60 mm thick with an effective slice thickness of 1 mm. Saturation pulse was applied to MRA at the mid-sagittal plane with 4cm thickness in order to suppress the flow signal from internal carotid arteries and visualize only bypassed blood flow from the external carotid arteries. ECAG were obtained within one month before or after MRA examination by selective catheterization of external carotid arteries.

We classified the extent of visualization of bypassed blood flow through STA-MCA bypass into four types; 1) from bypass point to M1 (horizontal) portion of MCA, 2) from bypass point to M2 (insular) portion or M3 (operculum) portion of MCA, 3) from bypass point to M4 (gyrus) portion of MCA and 4) no flow from bypass. Agreement in extent of visualization between MRA and ECAG was assessed for 13 sites.

Results: MRA showed the bypass flow types which agree with ECAG in 10 sites of 13 sites, including 1 site to M1, 5 sites to M2 or M3, and 4 sites to M4. There were 3 sites in which MRA and ECAG did not show agreement. In the first case with disagreement, MRA showed retrograde bypass flow to M2-3 segment but ECGA to M1. In the second case, MRA was not able to exhibit any bypass flow although M4 segment was visualized by ECAG. In the third case, MRA showed bypass flow to the M4 segment but ECAG represented no flow through the bypass.

Discussion and Conclusion: In most of the cases, "Mid-sagittal saturated MRA" was able to demonstrate that bypassed flow through the STA-MCA bypass agreed with ECAG. While, in the cases with disagreement, ECAG tend to show larger bypass flow than MRA. This discrepancy might be due to injection pressure of the contrast. Thus, application of this "Mid-sagittal saturated MRA" method seems to allow the noninvasive assessment of natural flow from STA-MCA bypass for follow up of the postoperative patients.

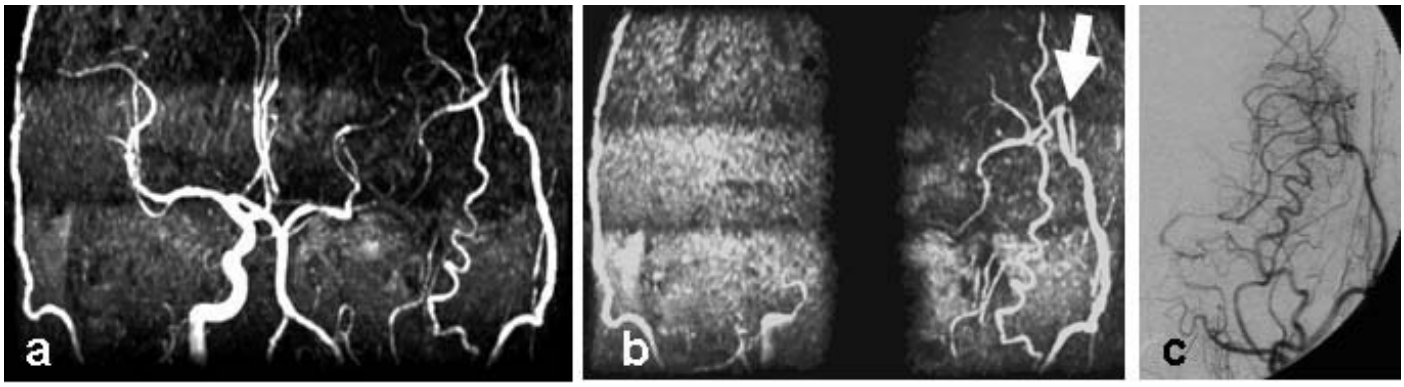

Figure: 73 year old men with left internal carotid artery occlusion

a: Conventional MRA show the left internal carotid artery occlusion. Left MCA is faintly visualized, but it is unknown whether the flow comes from bypass or others such as from collateral circulation or from contralateral ACA.

b: Mid-sagittal saturated MRA demonstrates the blood flow of the left MCA to M1 portion through the STA-MCA bypass. Bypass point is also clearly visualized (arrow). Note the dark band by saturation pulse at the center of the image, in which internal carotid arteries of both sides and basilar artery are included. Signal of antegrade blood flow from internal carotid arteries and basilar artery are suppressed.

c: Left ECAG also shows bypass flow to M1 portion as well as the mid-sagittal saturated MRA.