Association of middle cerebral artery steno-occlusion with intraplaque hemorrhage with acute cerebral infarction: a magnetic resonance imaging study

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Introduction: Evidence suggests that symptomatic steno-occlusion in acute ischemic stroke is associated with initial neurologic severity and stroke outcome[1,2]. Further understanding of the characteristics of intracranial atherosclerosis with symptomatic middle cerebral artery (MCA) steno-occlusion could be helpful for stroke risk stratification and treatment strategy modification. Besides the commonly inspected luminal stenosis, intraplaque hemorrhage (IPH), as indicated by studies based on carotid artery lesions, has also been associated with increased lesion progression rate and the incidence rate of clinical events[3]. However, it remains unclear whether direct IPH and luminal thrombosis imaging can identify MCA high-risk lesions in symptomatic subjects and whether lesion characteristics are more effective indicators for cerebral infarct severity than stenosis.

Purpose: To assess the association between infarction pattern and size and IPH in patients with recently symptomatic MCA steno-occlusion lesion.

Methods:

Study Population

Thrity-eight symptomatic patients with angiographically diagnosed unilateral or occlusion were enrolled. Patients were considered symptomatic if they had an ischemic stroke or transient ischemic attack in the territory of MCA. All subjects underwent high-resolution intracranial artery and brain MR imaging within 1 week after onset of symptoms. Exclusion criteria were as follows: (1) high-risk cardioembolic sources; (2) coexistent >50% ipsilateral internal carotid artery stenosis; (3) other etiologies such as vasculitis, moyamoya disease or cancer-related stroke.

MR imaging

All scans were conducted using a 3T whole body scanner (Philips Achieva, the Netherlands) with 8-ch phase array brain coil. Intracranial artery IPH imaging sequence was used the Simultaneous Non-contrast Angiography and intraPlaque hemorrhage (SNAP) technique described before[4]. The SNAP imaging parameters were: PSIR enabled 3D IRTFE, IRTR 1970ms, TR/TE 10/5.5ms, FA: 11º, FOV 160×160×50mm³, acquired matrix size: 1×1×1mm³, interpolated to 0.5×0.5×0.5mm³, scan time 2min40sec. A routine MR protocol, including T1-, T2-weighted and diffusion-weighted imaging (DWI), was used for brain imaging. The imaging parameters of DWI sequence are as follows: TR/ TE 1598/46 ms, matrix of 128×128, slice thickness of 6mm, and FOV of 24×24cm^2.

Data Analysis

The SNAP images were first processed for MRA visualization as described before[4]. The degree of MCA stenosis was then evaluated by an experienced neuroimaging radiologist using the NASCET criteria. The SNAP images were also processed and used for IPH detection[4]. Brain DWI images were evaluated by an experienced radiologists blinded to MCA information. Acute cerebral infarcts (ACIs) were defined as regions that were hyperintense on DWI images and hypointense on the apparent diffusion coefficient map. The presence or absence and the volume of ACIs in MCA territory in symptomatic side were determined. ACIs were classified as lesions of the pial artery (PI), perforating artery (PAI) and border-zone (BZ).

Results:

Of 38 patients, 27 (71.1%) had ACIs in MCA territory of the symptomatic side, 14 (36.8%) MCA IPH were revealed in the symptomatic vessels. Of note, 9 of 16 (56.3%) with MCA >70% stenosis and 7 of 11 (63.6%) with MCA total occlusion were found to have IPH. The Table shows the association between presence of IPH and ACI lesion patterns and volume. Large PAI, large territorial and multiple infarcts occurred more frequently in patients with IPH than those without IPH in the groups of MCA >70% stenosis and occlusion. In addition, ACI volume were larger in patients with IPH than those without IPH ($P < 0.05$) (Fig.).

Table. Association between presence of IPH and infarct lesion

ACI lesion	MCA⩾70% stenosis (n=16)		MCA Occlusion (n=11)	
	IPH(+)	IPH(-)	IPH(+)	IPH(-)
Small PAI	1	3	0	1
Large PAI	3	1	2	1
PI	0	1	0	0
BZ	1	1	1	2
Large territorial	1	0	2	0
Multiple infarcts	3	1	2	0
Total	9	7	7	4
ACI volume	3.3 ± 6.1	2.7±5.9	5.6±11.5	3.8±6.7

Discussion and conclusions:

In conclusion, our study suggests it's feasible to evaluation of luminal stenosis and IPH at the same time for steno-occlusion MCA patients. A substantial number of IPH characterized by SNAP imaging exist in symptomatic steno-occlusion MCA in current study. IPH together with stenosis may account for the heterogeneity of infarct sizes and patterns. The results appeared supportive to the predominance of thrombosis/emboli mechanisms. Our findings indicate that characterizing atherosclerotic plaque by IPH sensitive vessel wall imaging might be useful for stratification of plaque risk and infarction severity.

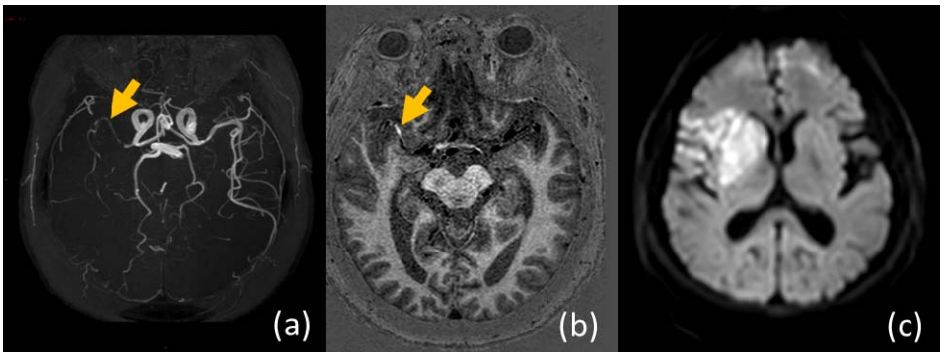

Fig. MR imaging of the brain in a 67 year old male patient. Both severe luminal stenosis on SNAP MRA view(a) and IPH on SNAP IPH view (b) in the right MCA were nicely delineated. DWI(c) shows the large acute infarction in right MCA territory.

References:

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