Watershed shift phenomenon

First, Hayashi and colleagues proposed “watershed shift” phenomenon as an intrinsic hemodynamic ischemia at the adjacent cortex to the site of the direct STA-MCA anastomosis for pediatric moyamoya disease [1)].

Retrograde blood supply from STA-MCA bypass may conflict with the anterograde blood flow from proximal MCA, and thus result in the temporary decrease in CBF at the cortex supplied by the adjacent branch of MCA. Careful evaluation of the correlation between postoperative CBF images and clinical symptom is essential to make accurate differential diagnosis between watershed shift and cerebral hyperperfusion.

The watershed shift could result in cerebral infarction during the perioperative period among pediatric moyamoya disease, while fluctuating focal neurological deficit due to this phenomenon could be spontaneously resolved in most of the adult patients without causing infarction. Besides hemodynamic ischemia due to watershed shift, thromboembolism from the anastomosed site [2)] and the mechanical compression by swollen temporal muscle flap could also cause cerebral ischemia in the acute stage [3)].

Regarding the characteristic findings of early CBF imaging, the thromboembolism is characterized by hypoperfusion at the peripheral vascular territory of the anastomosed site [4)] , while mechanical compression results in hypoperfusion at relatively wide cortical area under the swollen temporal muscle used for indirect bypass [5)].

Sufficient hydration, maintenance of prompt hemoglobin concentration, and anti-platelet administration is essential especially to avoid watershed shift and thromboembolic complication during and after surgery [6)].

Among 74 patients with superficial temporal artery to middle cerebral artery bypass for moyamoya disease for 78 affected hemispheres, 60 adult patients comprising 64 hemispheres underwent serial quantitative CBF analysis by 123I-iodoamphetamine single-photon emission computed tomography after revascularization surgery. The local CBF was quantitatively measured at the site of anastomosis and the adjacent cortex before surgery, as well as on 1 and 7 days after surgery. Then, they investigated the incidence, clinical presentation, and risk factors of the WS phenomenon.

The WS phenomenon was evident in 7 patients (7/64 hemispheres; 10.9%) after STA-MCA anastomosis for adult MMD. None of the patients developed neurological deterioration due to the WS phenomenon, but 1 patient developed reversible ischemic change on diffusion-weighted imaging at the site of the WS phenomenon. Multivariate analysis revealed that a lower preoperative CBF value was significantly associated with the occurrence of the WS phenomenon (20.3 ± 7.70 mL/100 g/min in WS-positive group vs. 31.7 ± 8.81 mL/100 g/min in WS-negative group, p= 1.1 × 10-2).

The incidence of the WS phenomenon was as high as 10.9% after STA-MCA anastomosis for adult MMD. The clinical outcome of the WS phenomenon is generally favorable, but there is a potential risk for perioperative cerebral infarction. Thus, we recommend routine CBF measurement in the acute stage after revascularization surgery for adult MMD to avoid surgical complications, such as local cerebral hyperperfusion (CHP) and cerebral ischemia, caused by the WS phenomenon. Concomitant detection of the WS phenomenon with local CHP is clinically important because blood pressure

reduction to counteract local CHP may have to be avoided in the presence of the WS phenomenon [7].

References

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