Rapid O-15 gas PET without arterial blood sample for studying cerebral hemodynamics

Jyoji Nakagawara¹, Jun Takahashi², Hidehiro Iida³

¹RI Center, Southern Tohoku Research Institute for Neuroscience / Dept. of Neurosurgery, National Cerebral and Cardiovascular Center
²Dept. of Neurosurgery, National Cerebral and Cardiovascular Center
³Dept. of Radiology, National Cerebral and Cardiovascular Center

Background: O-15 gas PET using 3 different O-15 labeled gases such as O2, CO2 and CO is gold standard method to obtain functional images. However, conventional O-15 gas PET was not suitable for child case due to necessity of long-time bedrest and arterial blood sample (ABS) estimating arterial input function (AIF). In this study, rapid O-15 gas PET has been developed by short-time bedrest and automated inhalation method of 3 different O-15 gas tracers. Non-invasive AIF could be estimated from the time-activity curve around petrous ICA. Methods: Rapid O-15 gas PET without ABS applied for 13 children with moyamoya disease (MMD) (their age from 6 to 12 years old, 6 boys and 7 girls). Functional image of CBF, CMRO2 and OEF was obtained by DBFM method using 8 minutes dual inhalation of O-15 labeled O2 and CO2. Functional image of CBV and F/V was obtained from additional 9 minutes inhalation of O-15 labeled CO. Prior this study, well agreement of these functional images with/without ABS confirmed in adult patients with MMD. Results: Rapid O-15 gas PET without ABS completed in all 13 children with MMD. PET examinations were not disturbed by crying or hyperventilation episode during procedures. Functional images showing adequate pathophysiology were completely obtained in all children. Rapid O-15 gas PET without ABS could be superior to CBF-SPECT required acetazolamide-activation concerning on less invasiveness. Conclusions: Rapid O-15 gas PET without ABS could be useful for not only estimating cerebral hemodynamics in child MMD, but also emergent hemodynamic evaluation.
Neurological Deterioration in Patients with Moyamoya Disease during Pregnancy, Delivery and Puerperium

Wonhyoung Park

Department of Neurosurgery, Asan Medical Center, University of Ulsan College of Medicine

Background: The age distribution at onset of moyamoya disease (MMD) is bimodal, with one peak during the first decade of life and a second peak in the forties. Therefore, it is not uncommon for female MMD patients to experience pregnancy, delivery, and puerperium. There are substantial changes in hormones, circulating blood volume, and cerebral blood flow during pregnancy, delivery, and puerperium. These substantial changes may have adverse effects on their cerebrovascular hemodynamic status, because most MMD patients have an impaired cerebrovascular hemodynamic status. Therefore, it is important to identify risk factors for the development of new neurological events and understand the clinical and radiological characteristics of MMD patients who had neurological deterioration during pregnancy, delivery, and puerperium.

Methods: All female MMD patients who experienced pregnancy, delivery, and puerperium between January 2001 and December 2015 in our institution were identified by retrospective chart review. We divided the patients into two groups: those diagnosed with MMD for the first time during pregnancy and puerperium (Group 1) and those diagnosed with MMD before pregnancy (Group 2). Neurological deterioration during pregnancy, delivery, and puerperium was defined as (1) newly developed TIA, seizure, acute cerebral infarction, and intracranial hemorrhage and (2) deterioration of pre-existing neurological symptoms associated with MMD.

Results: Group 1 included two patients with deterioration of pre-existing transient ischemic attacks (TIAs) and acute cerebral infarction, and one patient with seizures and newly developed TIAs during pregnancy and/or puerperium. Group 2 included 20 patients with 23 pregnancies. In Group 2, four patients had deterioration of TIAs during pregnancy and puerperium. There were significant differences between the cases without neurological deterioration and with deterioration in Group 2 [TIAs ≥10 before pregnancy, 0% vs. 75%, p =0.002; severely reduced regional cerebrovascular reserve (rCVR) on single photon emission computed tomography (SPECT), 10.5% vs. 100%, p =0.002; and surgical revascularization before pregnancy, 75% vs. 15.8%, p =0.04].

Conclusion: Patients with severely reduced regional cerebrovascular reserve on SPECT and frequent TIAs before pregnancy may experience neurologic deterioration during pregnancy, delivery, and puerperium. Surgical revascularization before pregnancy may decrease neurologic deterioration during these periods.
Can revascularization surgery improve cognitive dysfunction in adult moyamoya disease?

Ken Kazumata

Department of Neurosurgery, Hokkaido University Graduate School of Medicine

BACKGROUND AND PURPOSE: Revascularization surgery potentially improves cognitive dysfunction in patients with Moyamoya disease. The present study was performed to determine postoperative changes in cognitive function, brain structure and functional connectivity.

METHODS: Twenty-five adult patients were investigated by using cognitive test batteries [Wechsler intelligence scale (WAIS)-III, Trail-Making Test (TMT), Wisconsin Card Sorting Test (WCST), conceptual performance test (CPT), and Stroop test], brain morphometry analysis, diffusion tensor imaging and resting state functional MRI (rsfMRI). Reliable change index (RC) were assessed in cognitive function tests at least 1 year after the revascularization surgery. Any alterations in neuroimaging parameters were determined.

RESULTS: WAIS-III indices such as performance IQ, perceptual organization and processing speed were significantly increased ($p < 0.01$). Reliable change revealed improvement in WAIS indices of 30%. There were no significant changes in diffusion parameters as well as cortical thickness. Resting brain connectivity was changed in prefrontal cortex.

CONCLUSIONS: Revascularization surgery may improve cognitive metric associated with executive function and information transfer. No detrimental effect was identified in brain microstructure. rsfMRI suggests alterations in brain organization.
Cortical Distribution of Fragile Periventricular Vascular Channels and Optimization of Bypass Surgery for Hemorrhage Prevention

Takeshi Funaki, Akinori Miyakoshi, Hiroharu Kataoka, Kazumichi Yoshida, Takayuki Kikuchi, Yohei Mineharu, Masakazu Okawa, Yukihiro Yamao, Susumu Miyamoto

Department of Neurosurgery, Kyoto University Graduate School of Medicine

Background: Fragile periventricular vascular channels, which are formed by perforating or choroidal arteries and supply blood to the cortex via the medullary arteries, are a potential bleeding source in moyamoya disease. Understanding the cortical distribution is essential for bypass surgery to reduce hemodynamic burden on these channels. Objective: To test whether cortical distribution varies among subtypes of periventricular channels. Methods: The study population comprised patients with moyamoya disease undergoing 3-Tesla whole-brain magnetic resonance angiography. Raters recorded the sulcus location where the signal of each periventricular channel extended, and dichotomized it as anterior or posterior to the central sulcus. Cortical distributions were then compared between lenticulostriate and choroidal channels. Results: In total, 100 collateral channels comprising 33 lenticulostriate and 67 choroidal channels were assessed. All channels were distributed superior to the Sylvian fissure. All lenticulostriate channels were distributed anterior to the central sulcus (anterior to the precentral sulcus, 16; medial frontal cortex, 9; precentral sulcus, 7; anterosuperior angle of insula, 1). All but one choroidal channel were distributed posterior to or in the central sulcus (central sulcus, 20; postcentral sulcus, 17; posterior angle of insula, 15; posterior to the postcentral sulcus, 14; precentral sulcus, 1; p <0.0001). Conclusions: Cortical distribution varied between fragile channel subtypes. Choroidal channels at high risk of bleeding were predominantly distributed posterior to the central sulcus. This anatomical rule could promote optimization of target regions for bypass surgery aimed at hemorrhage prevention.
Bypass surgery versus medical treatment for symptomatic moyamoya disease in adults

Kwan-Sung Lee¹, Dong-Kyu Jang², Hyoun Kyun Rha², Pil-Woo Huh², Ji-Ho Yang², Ik Seong Park², Jae-Geun Ahn², Jae Hoon Sung²

¹Department of Neurosurgery / Seoul St. Mary’s Hospital / College of Medicine, The Catholic University of Korea
²Department of Neurosurgery / College of Medicine, The Catholic University of Korea

The authors evaluated whether extracranial-intracranial bypass surgery can prevent stroke occurrence and decrease mortality in adult patients with symptomatic moyamoya disease (MMD). The medical records of 249 consecutive adult patients with symptomatic MMD, confirmed by digital subtraction angiography between 2002 and 2011 at 8 institutions, were retrospectively reviewed. The study outcomes of stroke recurrence as a primary event and death during the 6-year follow-up and perioperative complications within 30 days as secondary events were compared between the bypass and medical treatment groups. The bypass group comprised 158 (63.5%) patients, and the medical treatment group comprised 91 (36.5%) patients. For 249 adult patients with MMD, bypass surgery showed an HR of 0.48 (95% CI 0.27-0.86, p = 0.014) for stroke recurrence calculated by Cox regression analysis. However, for the 153 patients with ischemic MMD, the HR of bypass surgery for stroke recurrence was 1.07 (95% CI 0.43-2.66, p = 0.887). For the 96 patients with hemorrhagic MMD, the multivariable adjusted HR of bypass surgery for stroke recurrence was 0.18 (95% CI 0.06-0.49, p = 0.001). For the treatment modality, indirect bypass and direct bypass (or combined bypass) did not show any significant difference for stroke recurrence, perioperative stroke, or mortality (log rank; p = 0.524, p = 0.828, and p = 0.616, respectively). Treating symptomatic MMD in adults, bypass surgery reduces stroke recurrence for the hemorrhagic type, but it does not do so for the ischemic type. The best choice of bypass methods is uncertain.
Prevention of the rebleeding in adult hemorrhagic moyamoya disease

Jun Takahashi¹, Takeshi Funaki², Susumu Miyamoto²

¹Department of Neurosurgery, National Cerebral and Cardiovascular Center
²Department of Neurosurgery, Graduate School of Medicine, Kyoto University

Although hemorrhagic moyamoya disease is accompanied with a high rate of rebleeding attacks (7.1%/y), the preventive strategy had been unclear for years. JAM Trial, the first RCT on hemorrhagic moyamoya disease (2001-2013), proved that STA-MCA direct anastomosis can reduce the rebleeding (HR=0.355, Stroke 2014). Further sub-analyses have elucidated several important facts: extremely high bleeding rate (17.1%/y) in the posterior hemorrhage group (group P, e.g. thalamus and trigone, Stroke 2016), powerful preventive effect of bypass on group P (0%/y, p<0.001, Stroke 2016), and the importance of prominent “periventricular choroidal anastomotic channel” as a significant risk factor of rebleeding (HR=11.0, JNS 2017 and 2018).

Careful inspection of the DSA reveals that STA-MCA bypass can erase the “malignant” periventricular choroidal anastomotic channels when it is properly established and carries a large blood flow to the anterior parietal lobes, the target of the choroidal channel. This must be the reason why simple STA-MCA anastomosis can significantly reduce the high rebleeding rate of the group P.