Delayed cerebral ischemia case series

To determine the area most at risk of delayed cerebral ischemia (DCI) in relation to the location of the ruptured aneurysm in patients with aneurysmal subarachnoid hemorrhage (aSAH) and, therefore, help to choose the site for focal multimodal neuromonitoring.

Hurth et al. retrospectively analyzed angiographic findings, CCT scans, and patient charts of patients who were admitted with aSAH to the neurosurgical intensive care unit between 2009 and 2017. DCI was defined as infarction on CCT 2-6 weeks after aSAH.

DCI occurred in 17.9% out of 357 included patients. A DCI occurring in the vascular territory of the artery carrying the ruptured aneurysm was found in 81.0% of patients with anterior circulation aneurysms but only in 16.7% with posterior circulation aneurysms (Fisher's exact, p=0.003). The vascular territory most frequently showing a DCI was the ipsilateral MCA territory (86.7%) in ICA aneurysms, the contra- (71.4%) and the ipsilateral (64.3%) ACA territory in ACA aneurysms, the right (93.8%) and the left (81.3%) ACA territory in AcomA aneurysms, and the ipsilateral MCA territory in MCA aneurysms (69.2%) as well as in VA/PICA/SCA aneurysms (100.0%). DCI after the rupture of a BA aneurysm occurred with 33.3% in 6 out of 8 vascular territories, respectively. DCI of multiple vascular territories occurred in 100.0% of BA aneurysms, 87.5% of AcomA aneurysms, 71.4% of ACA aneurysms, 40.0% of ICA aneurysms, 38.5% of MCA aneurysms, and 33.3% of VA/PICA/SCA aneurysms.

Few studies exist that could determine the area most at risk of a DCI after an aSAH. This data could identify the territory most at risk for DCI with a probability of > 60% except for BA aneurysms, which showed DCI in various areas and patients suffering from multiple DCIs. Either the ipsilateral ACA or MCA was affected by the DCI in about 80% of ACA and more than 90% of AcomA, ICA, MCA, and VA/PICA/SCA aneurysms. Therefore, local intraparenchymal neuromonitoring in the ACA/MCA watershed area might detect the vast majority of DCIs for all aneurysm locations, except for BA aneurysms. In ACA and AcomA aneurysms, bilateral DCI of the ACA territory was common, and bilateral probe positioning might be considered for monitoring high-risk patients. Non-focal monitoring methods might be preferably used after BA aneurysm rupture [1)].

Sixty-one patients with aneurysmal subarachnoid hemorrhage underwent 15O PET to measure regional CBF during the period of risk for DCI (median 8 days after SAH, IQR 7-10 days). Regions of visibly abnormal brain on head CT studies, including areas of hemorrhage and infarction, were excluded. Burden of hypoperfusion was defined as the proportion of PET voxels in normal-appearing brain with CBF < 25 ml/100 g/min. Global CBF and hypoperfusion burden were compared between patients with and those without DCI at the time of PET. For patients with focal impairments from DCI, Jafri et al., also compared average CBF and hypoperfusion burden in symptomatic versus asymptomatic hemispheres.

Twenty-three patients (38%) had clinical DCI at the time of PET. Those with DCI had higher mean arterial pressure (MAP; 126 ± 14 vs 106 ± 12 mm Hg, p < 0.001) and 18 (78%) were on vasopressor therapy at the time of PET study. While global CBF was not significantly lower in patients with DCI (mean 39.4 ± 11.2 vs 43.0 ± 8.3 ml/100 g/min, p = 0.16), the burden of hypoperfusion was greater (20%, IQR 12%-23%, vs 12%, 9%-16%, p = 0.006). Burden of hypoperfusion performed better than global CBF as a predictor of DCI (area under the curve 0.71 vs 0.65, p = 0.044). Neither global CBF nor hypoperfusion burden differed in patients who responded to therapy compared to those who had

not improved by the time of PET. Although hemispheric CBF was not lower in the symptomatic versus contralateral hemisphere in the 13 patients with focal deficits, there was a trend toward greater burden of hypoperfusion in the symptomatic hemisphere (21% vs 18%, p = 0.049).

The burden of hypoperfusion was greater in patients with DCI, despite hemodynamic therapies, higher MAP, and equivalent global CBF. Similarly, hypoperfusion burden was greater in the symptomatic hemisphere of DCI patients with focal deficits even though the average CBF was similar to that in the contralateral hemisphere. Evaluating the proportion of the brain with critical hypoperfusion after SAH may better capture the extent of DCI than averaging CBF across heterogenous brain regions [2)].

2016

In one hundred fifty-three patients with aSAH. Delayed cerebral ischemia (DCI) was identified in 32 patients (20.9%). Nosocomial infection (odds ratio [OR] 3.5, 95% confidence interval [CI] 1.09-11.2, p = 0.04), ventriculitis (OR 25.3, 95% CI 1.39-458.7, p = 0.03), aneurysm re-rupture (OR 7.55, 95% CI 1.02-55.7, p = 0.05), and clinical vasospasm (OR 43.4, 95% CI 13.1-143.4, p < 0.01) were independently associated with the development of DCI. Diagnosis of nosocomial infection preceded the diagnosis of DCI in 15 (71.4%) of 21 patients. Patients diagnosed with nosocomial infection experienced significantly worse outcomes as measured by the modified Rankin Scale score at discharge and 1 year (p < 0.01 and p = 0.03, respectively).

Nosocomial infection is independently associated with DCI. This association is hypothesized to be partly causative through the exacerbation of systemic inflammation leading to thrombosis and subsequent ischemia [3)].

A post hoc analysis of the CONSCIOUS-1 study (Clazosentan to Overcome Neurological Ischemia and Infarction Occurring After Subarachnoid Hemorrhage) was performed. Using multivariate logistic regression analysis and propensity matching, independent clinical risk factors associated with infarctions were identified, and the contribution of cerebral infarcts to long-term outcomes was evaluated.

Within the cohort of 413 subjects, early infarcts were present in 76 subjects (18%), whereas delayed infarcts occurred in 79 subjects (19%), and 36 subjects (9%) had new infarctions that were present on both early and delayed imaging. Propensity score matching revealed a significantly higher proportion of early infarcts after clipping (odds ratio, 4.62; 95% confidence interval, 1.99-11.57; P=0.00012). Multivariate logistic regressions identified clipping as an independent risk factor for early cerebral infarction (odds ratio, 0.26; 95% confidence interval, 0.15-0.48; P<0.001), and angiographic vasospasm was an independent risk factor for delayed cerebral infarction (odds ratio, 1.79; 95% confidence interval, 1.03-3.13; P=0.039). Early infarcts were a significant independent risk factor for poor long-term outcomes at 3 months (odds ratio, 2.34; 95% confidence interval, 1.18-4.67; P=0.015).

Clipping is an independent risk factor for the development of early cerebral infarcts, whereas delayed cerebral infarcts are associated with angiographic vasospasm. Early cerebral infarcts are stronger predictors of worse outcome than delayed infarction [4)].

1)
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