# Aneurysmal intracerebral hemorrhage

Along with a aneurysmal subarachnoid hemorrhage (SAH), a ruptured intracranial aneurysm may also cause an intracerebral hemorrhage (ICH).

# Epidemiology

Intracerebral hemorrhage: occurs in 20–40% (more common with aneurysms distal to the Circle of Willis, e.g. MCA aneurysms).

Intracerebral hemorrhage (ICH) occurs in one-third of patients with aneurysmal subarachnoid hemorrhage (SAH) and is associated with poor prognosis. Identification of risk factors for ICH from aneurysmal rupture may help in balancing risks of treatment of unruptured intracranial aneurysms.

Additional ICH was associated with an increased risk of delayed cerebral ischemia (DCI). Furthermore, adding the presence or absence of ICH to the modified Fisher Scale (mFS) improved the identification of patients at the highest risk for the development of DCI. Thus, a simple adjustment of the mFS might help to identify patients at high risk for DCI <sup>1)</sup>.

The most important associative factor for ICH is neurological status on admission. The finding regarding the value of ultra-early treatment suggests the need to more robustly reevaluate the concept that hematoma evacuation of an ICH and repair of a ruptured aneurysm within 6 hours of ictus is the most optimal treatment path<sup>2</sup>.

## Treatment

The location of the ruptured aneurysm in the MCA remains the major risk factor for occurrence and volume of ICH. Given the presence of brain swelling and other bleeding components of SAH, surgical intervention on aneurysmal ICH is indicated at lower volume values, than it is generally accepted for spontaneous ICH <sup>3</sup>.

### **Case series**

All patients admitted with aneurysmal SAH between 2003 and 2016 in the Department of Neurosurgery, University Hospital Duisburg-Essen, Essen, Germany were eligible for the study of Darkwah Oppong et al.

Various demographic, clinical and radiographic characteristics of patients were correlated with the occurrence and volume of ICH in univariate and multivariate manner. The associations between ICH volume and the need for surgical procedures and functional outcome were also analyzed.

991 patients were included into final analysis. ICH occurred in 301 (30.4%) cases. Location in the middle cerebral artery (MCA, p < 0.001, aOR = 7.04), WFNS grade 4-5 (p < 0.001, aOR = 4.43), rebleeding before therapy (p = 0.004, aOR = 2.45), intracranial pressure over 20 mmHg upon admission (p = 0.008, aOR = 1.60) and intraventricular bleeding (p = 0.008, aOR = 1.62) were

independently associated with ICH presence. In turn, WFNS grade 4-5 (p < 0.001) and MCA aneurysms (p < 0.001) were the only independent predictors of ICH volume. According to the receiver operating characteristic curves, the clinically relevant cutoff for additional surgical interventions (decompression/hematoma evacuation) was 17 mL. ICH occurrence and ICH volume  $\geq$ 17 mL independently predicted poor outcome at 6 months after SAH (defined as modified Rankin Scale>3).

Of over 30 tested variables, the location of the ruptured aneurysm in the MCA remains the major risk factor for occurrence and volume of ICH. Given the presence of brain swelling and other bleeding components of SAH, surgical intervention on aneurysmal ICH is indicated at lower volume values, than it is generally accepted for spontaneous ICH<sup>4</sup>.

### 2016

Six hundred thirty-two consecutive patients with aneurysmal SAH treated from January 2005 to December 2012 were eligible for this study. Demographic parameters and preexisting comorbidities of patients, as well as various clinical and radiographic characteristics of SAH were correlated with the incidence and volume of aneurysmal ICH.

One hundred fifty-five patients (25%) had ICH on initial computed tomography with a mean volume of 26.7 mL (±26.8 mL). Occurrence and volume of ICH were associated with the location (distal anterior or middle cerebral artery >proximal anterior cerebral or internal carotid artery >posterior circulation, P < .001/P < .001) and size (>12 mm, P = .026/P < .001) of the ruptured aneurysm. Vascular risk factors independently increased the risk of ICH as well (arterial hypertension: odds ratio [OR] = 1.62, P = .032; diabetes mellitus: OR = 3.06, P = .009), while the use of aspirin (P = .037) correlated with the volume of ICH. The predictors of ICH were included into a risk score (0-9 points) that strongly predicted the occurrence of ICH (P = .01). Poor functional outcome after SAH was independently associated with the occurrence of ICH (P = .003, OR = 2.77) and its volume (P = .001, OR = 1.07 permL-increase).

Aneurysmal ICH is strongly associated with poorer functional outcome and seems to be predictable even before the bleeding event. The proposed risk factors for aneurysmal ICH require further validation and may be considered for treatment decisions regarding unruptured intracranial aneurysms <sup>5)</sup>.

#### 2011

In all 310 SAH patients admitted between 2005 and 2007, Liu et al compared clinical risk factors (gender, age, smoking, hypertension, history of SAH and family history) of patients with and without an ICH. From the latest admitted, 50 patients with and 50 without ICH, they compared the location, shape and direction of blood flow of the aneurysms on CT-angiography. Relative risks (RRs) of ICH were 1.2 (95% confidence interval, CI):0.7-1.8) for males, 1.0 (95%CI:0.7-1.4) for age  $\geq$  55 year, 1.0 (95%CI:0.6-1.6) for smoking, 0.9 (95%CI:0.5-1.5) for hypertension, 0.6 (95%CI:0.1-3.8) for history of SAH and 0.5 (95%CI:0.2-1.3) for family history of SAH. RRs of ICH were 1.8 (95%CI:1.2-2.5) for MCA aneurysms, 0.5 (95%CI:0.3-1.0) for ICA aneurysms, 0.4 (95%CI:0.1-1.3) for posterior circulation aneurysms, and 0.7 (95%CI:0.3-1.3) for multilobed aneurysms. The RRs of other aneurysmal characteristics varied between 0.9 and 1.2. Patients with MCA aneurysms are at a higher risk of developing ICH. The other aneurysmal or clinical factors have no or only minor influence on the risk of

ICH after rupture and are, therefore, not helpful in deciding on treatment of unruptured aneurysms<sup>6)</sup>.

1)

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