Diffuse Patterns of Nonaneurysmal Subarachnoid Hemorrhage Originating from the Basal Cisterns Have Predictable Vasospasm Rates Similar to Aneurysmal Subarachnoid Hemorrhage

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Background: Nonaneurysmal subarachnoid hemorrhage (SAH) has been historically associated with a benign clinical course. However, recent studies have suggested that nonaneurysmal SAH can present with different hemorrhage patterns that may be associated with differential rates of morbidity. Herein, we analyze a retrospective consecutive cohort of patients with nonaneurysmal SAH to determine outcomes. We also seek to evaluate a validated radiographic grading scale to determine its utility in predicting vasospasm in the setting of different hemorrhage patterns. *Methods:* After institutional review board approval, the records of 563 consecutive patients admitted with spontaneous SAH between January 2007 and 2014 were retrospectively reviewed. A total of 138 of these patients had no identifiable source of hemorrhage and were further divided into 2 groups depending on their pattern of hemorrhage: perimesencephalic or diffuse. Clinical characteristics and outcomes were assessed. *Results:* In nonaneurysmal SAH, 70 patients (50.7%) had a perimesencephalic pattern of hemorrhage, whereas 68 (49.3%) experienced diffuse SAH. Radiographic vasospasm developed in 6 patients (8.6%) with perimesencephalic SAH and in 14 patients (20.6%) with a diffuse SAH pattern. When comparing historical rates of vasospasm based on the Barrow Neurological Institute (BNI) scale and rates in the nonaneurysmal diffuse pattern in this series, there was no significant difference in distribution (chi-square; $P = .149$), compared with a difference seen with the perimesencephalic group ($P < .00001$). *Conclusions:* Nonaneurysmal SAH is associated with the potential for vasospasm, with higher rates in the diffuse versus perimesencephalic SAH patterns. The BNI grading scale for aneurysmal SAH can be used to predict the risk of vasospasm in diffuse, nonaneurysmal SAH. **Key Words:** Aneurysm—vasospasm—subarachnoid hemorrhage—hydrocephalus.

Spontaneous subarachnoid hemorrhage (SAH) can be classified based on etiology: aneurysmal or nonaneurysmal. Aneurysmal SAH has well-recognized outcomes, and treatment guidelines are focused on early aneurysm obliteration to prevent re-rupture, as well as the prevention of secondary insults that result from the sequelae of

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the initial SAH such as vasospasm and hydrocephalus.[1] The outcomes of nonaneurysmal SAH are less well known, and as a result, their management is less standardized. Repeated neurovascular imaging is often performed to identify an aneurysmal source that may not have been apparent on initial studies.[2,3]

When spontaneous SAH is seen without an aneurysmal source, hemorrhage patterns can be dichotomized into either the perimesencephalic pattern (Figure 1),[4] where blood is confined mainly to the basal cisterns surrounding the midbrain, or diffuse (Figure 2), where blood extends into the distal Sylvian or interhemispheric fissures. Although nonaneurysmal hemorrhage has typically been associated with a benign course,[5-8] recent evidence has suggested that hydrocephalus, vasospasm, and stroke can all occur.[9,10] We sought to identify outcomes from a series of patients with nonaneurysmal SAH and to determine the utility of a modern radiographic grading scale to predict rates of vasospasm.

Methods

Patient Characteristics

After institutional review board approval, the records of 563 consecutive patients admitted with spontaneous SAH between January 2007 and January 2014 were retrospectively reviewed. Patients with SAH limited to the convexity of the cortical surface were excluded. Of the 563 patients, 138 were further selected who did not have evidence of an aneurysmal source. All historical, clinical, radiographic, and follow-up information was obtained retrospectively from the electronic medical record.

Patient clinical characteristics were collected and included age, sex, prehemorrhage modified Rankin Scale score,[11] Hunt and Hess grade,[12] and length of follow-up. Radiographic characteristics of the initial hemorrhage were also identified, including the modified Fisher grade,[13] the Barrow Neurological Institute (BNI) grade,[14] presence of intraventicular hemorrhage, and the need for temporary external ventriculostomy. Radiographic grading scale scores were determined by the authors, who were blinded to the clinical outcome of study patients.

SAH Management

All patients were initially managed in a dedicated neurosciences intensive care unit. Patients with clinical or radiographic hydrocephalus or with admission Hunt and Hess grades 3 or more underwent external ventricular drain placement for cerebrospinal fluid (CSF) diversion and intracranial pressure monitoring. External ventricular drains were managed according to a

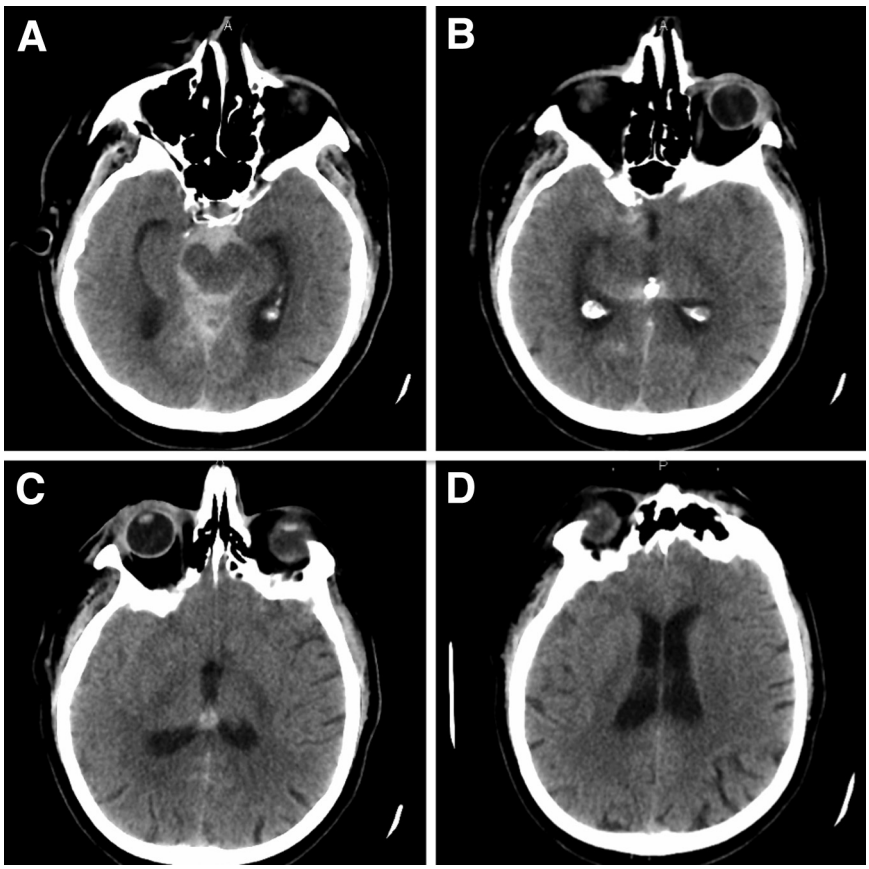

Figure 1. *Perimesencephalic subarachnoid hemorrhage pattern. Noncontrast axial head computed tomography of patient who experienced a nonaneurysmal subarachnoid hemorrhage confined to mainly the basal cisterns surrounding the midbrain. Representative images are demonstrated in sequence from A-D in their inferior to superior location.*