Subdural Hemorrhage from Cerebral Amyloid Angiopathy–Related Intracerebral Hemorrhage: A Risk Factor for Postoperative Hemorrhage

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OBJECTIVE: **Surgical treatment for cerebral amyloid angiopathy (CAA)–related intracerebral hemorrhage (ICH) is controversial. A subset of CAA-related ICH with associated subdural hemorrhage (SDH) has been reported. This study aimed to evaluate clinical results and surgical outcomes of this type of ICH with associated SDH.**

METHODS: **Study participants included 98 patients with CAA-related ICH who met Boston criteria. Patients were divided into an SDH group and a control (no SDH) group. Clinical and neuroimaging features and surgical outcomes of the 2 groups were compared.**

RESULTS: **Lobular shape of hematoma was found significantly more often in the SDH group (65.7% [23/35]) compared with the control group (25.4% [16/63]; $P < 0.001$). Subarachnoid hemorrhage was found significantly more often in the SDH group (34.3% [12/35]) compared with the control group (7.9% [5/63]; $P = 0.001$). The rate of postoperative hemorrhage was significantly higher in the SDH group (61.5% [8/13]) than in the control group (16.2% [6/37]; $P = 0.006$). The frequency of occurrence of postoperative hemorrhage was significantly higher in the SDH group (13/13) than in the control group (6/37; $P = 0.017$). A good surgical outcome occurred in none (0/12) of the patients in the SDH group, whereas a good surgical outcome occurred in 51.9% (14/27) of patients in the control group ($P = 0.006$).**

CONCLUSIONS: **Patients with CAA-related ICH with associated SDH more frequently have postoperative hemorrhage and have a worse surgical outcome. These findings are useful in choosing therapeutic methods and preoperative planning of surgical strategy.**

INTRODUCTION

In elderly normotensive patients, cerebral amyloid angiopathy (CAA) is a common cause of spontaneous lobar intracerebral hemorrhage (ICH), which is the most devastating form of stroke, with a mortality rate of almost 50%. Multiple and recurrent ICHs occur with CAA.[1] CAA is caused by the progressive deposition of amyloid in the walls of small arteries, arterioles, and capillaries in the cortical and leptomeningeal vessels. At the present time, no disease-modifying therapies are specific for CAA, and the only available treatment is surgical evacuation for intracerebral hematomas. Surgical treatment for CAA-related ICH is controversial, as uncontrollable perioperative hemorrhages have been reported previously.[2,3] However, more recent studies suggest that surgical evacuation can be performed with acceptable safety in patients with CAA-related ICH without increased frequency of adverse outcome.[4-7]

We hypothesized that not all CAA-related ICHs have poor surgical outcomes, and some undefined factors originating from CAA-related ICH might be responsible for different clinical and surgical courses. As previously reported, we found a subset of CAA-related ICH with associated SDH.[6,8-10] The aim of the present study was to evaluate the clinical results of CAA-related ICH with associated SDH to investigate whether the presence of SDH in CAA-related ICH is relevant and important for predicting surgical outcome. We also discuss the

Key words
- Cerebral amyloid angiopathy
- Intracerebral hemorrhage
- Postoperative hemorrhage
- Subdural hemorrhage

Abbreviations and Acronyms
CAA: Cerebral amyloid angiopathy
CT: Computed tomography
ICH: Intracerebral hemorrhage
MRI: Magnetic resonance imaging
SAH: Subarachnoid hemorrhage
SDH: Subdural hemorrhage

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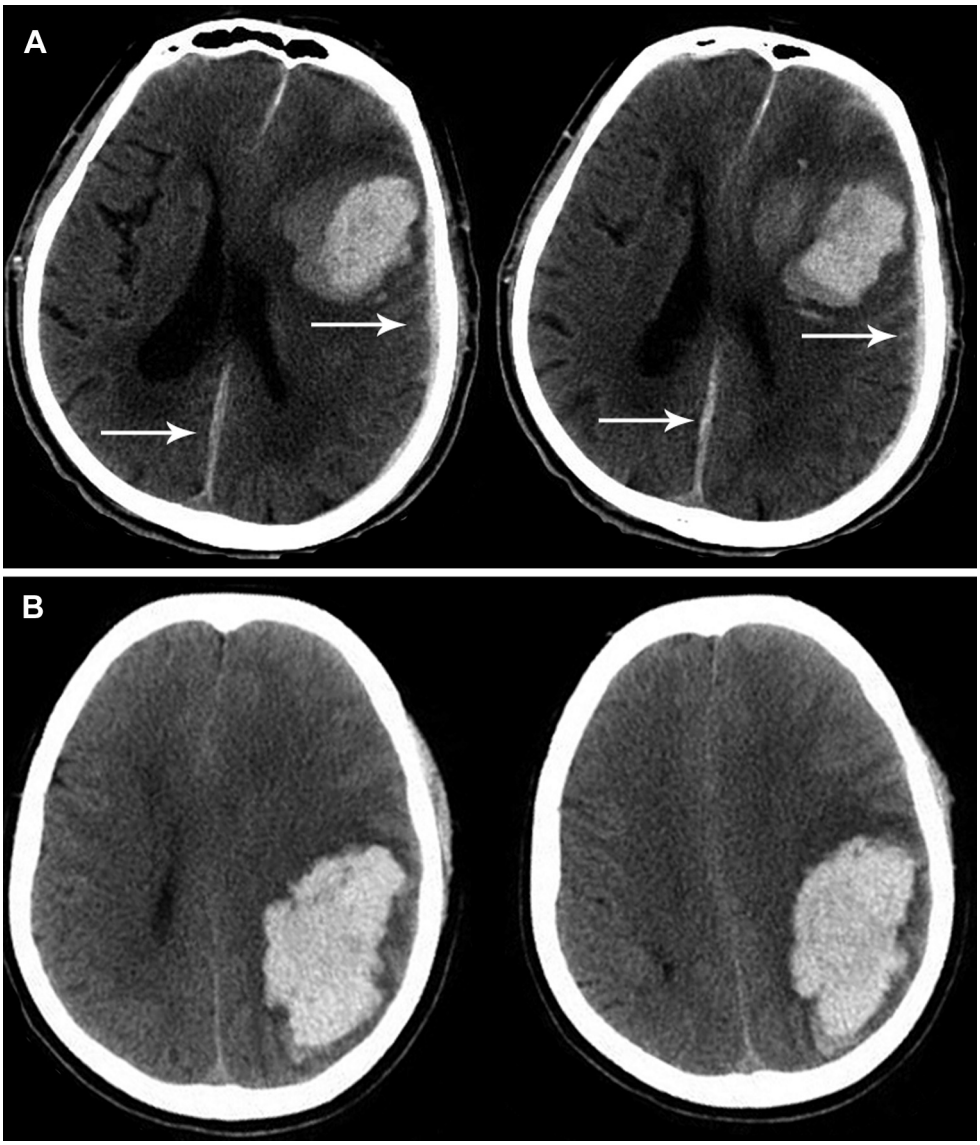

Figure 1. Representative unenhanced computed tomography images of cerebral amyloid angiopathy–related intracerebral hemorrhage (**A**) with associated subdural hemorrhage (*arrows*) and (**B**) without subdural hemorrhage.

possible mechanism of formation of SDH and its implication for therapeutic strategy.

MATERIALS AND METHODS

Study Population

The design of our study was approved by our institutional ethics committee. From January 2012 to September 2015, 4187 patients with ICH were admitted. The clinical data of all cases were recorded. According to the previously validated Boston criteria,[I,II] only patients with probable or possible CAA were enrolled, and patients with other definite causes (trauma, ischemic stroke, tumor, vascular malformation, vasculitis, coagulopathy, anticoagulation with international normalized ratio >3.0) were excluded. Ultimately, 98 cases of CAA-related ICH (62 cases of probable CAA and 36 cases of possible CAA) were included in the study.

Clinical Data

We reviewed medical records for clinical symptoms at presentation and demographics. A full history of the presence of cerebrovascular risk factors was obtained, including hypertension, diabetes mellitus, and previous ICH. All patients underwent routine neurologic examination, laboratory tests, and head computed tomography (CT) scan. Also, magnetic resonance imaging (MRI) and CT

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