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Clinical Study

# Aneurysmal acute subdural hemorrhage: Prognostic factors associated with treatment

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ABSTRACT

Acute subdural hematoma is an uncommon presentation of aneurysmal hemorrhage that has been identified as a poor prognostic sign. Current series are small, have short follow-up, or were collected over a long period during which treatment evolved. To evaluate prognostic factors, we analyzed a large modern series of aneurysmal subdural hematoma (aSDH) with long-term follow-up. A prospectively maintained database was queried for patients presenting with aSDH from 2001–2013. Thirty patients met the study criteria. Statistical analysis was performed with unpaired *t*-test or Fisher's exact test. Aneurysm treatment involved open clipping (n = 18), endosaccular coiling (n = 8), both (n = 1), or no treatment (n = 3). Good Glasgow Outcome Scale score at discharge was present in 20% and increased to 40% at 6–12 months postoperatively. Good clinical presentation was associated with good final outcome in 75%, whereas poor clinical presentation correlated with good outcome in 30%. Good outcome correlated with younger age ($p = 0.04$), smaller aneurysm ($p = 0.04$), and lower Hunt-Hess score (HH) at intervention ($p = 0.04$). Favorable outcome did not correlate with sex, race, presence of subarachnoid or intraparenchymal hemorrhage, size or laterality of hemorrhage, midline shift, aneurysm treatment modality, or HH at admission ($p > 0.15$). There was no difference between good and poor outcomes in terms of time to treatment or hematoma evacuation. Poor clinical presentation may be exaggerated by mass effect of hematoma; aggressive treatment is not futile. Presenting neurological status, age, and aneurysm size are predictors of outcome, while laterality and size of hematoma and extent of midline shift are not, suggesting that clinical status is more important than radiographic findings.



## 1. Introduction

Acute subdural hematoma (SDH) is an uncommon presentation of aneurysmal hemorrhage. Published series up to 10 years ago suggested that poor prognosis accompanied the generally poor clinical grade at presentation [1–5]. This outcome was considered inferior to those for patients suffering from traditional aneurysmal subarachnoid hemorrhage (SAH). These series were generally small and retrospective.

However, more recent studies suggest that despite poor clinical presentation, a reasonable clinical outcome can be achieved with aggressive management even among poor grade patients [6–10]. Other studies have reported a mixed prognosis [11]. Nonetheless, the available data are confounded by inclusion of small patient cohorts and short follow-up outcome assessments. In addition, these patient series were collected over a long period of time during which treatment options may have evolved, given the shift in published outcomes. To assess the indications for treatment and outcomes in this patient population, we reviewed our single institution prospectively collected aneurysm database and herein present, to our knowledge, the largest series of aneurysmal acute subdural hemorrhage managed through modern microsurgical and endovascular techniques and report a long-term follow-up.

## 2. Methods

We queried our institution's prospectively maintained aneurysm database for all patients presenting with aneurysmal hemorrhage and any form of SDH from 2001 to 2013. During this period of time, microsurgical techniques remained consistent. Of 1564 patients, 41 patients were identified for possible inclusion. Inclusion criteria included the presence of at least one cerebral aneurysm and nontraumatic convexity acute SDH. Exclusion criteria included age younger than 18 years (two patients), isolated falcine (one patient) or

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tentorial (five patients) SDH, pseudoaneurysm (one patient), or lack of available initial imaging (two patients). The resultant 30 patients composed the study population. Baseline demographic information including clinical status at the time of presentation and intervention, radiographic features of both the SDH (size, laterality, midline shift) and the aneurysm (size, location, laterality), medical and surgical (endovascular, microsurgical and hematoma evacuation) management, and clinical outcome at discharge, 6, and 12 months were analyzed. Long-term (6–12 month) follow-up was prospectively available among 23 of 30 patients; the remaining seven patients' outcomes were collected retrospectively through chart review, death registry, and/or telephone survey.

All patients received an initial head CT scan as well as digital subtraction angiography and/or computed tomography angiography. These patients were treated at a tertiary care hospital with a high volume of aneurysmal SAH, a dedicated neurocritical care unit, and surgical and endovascular staff with significant aneurysm management experience. Admission and preprocedural clinical grade was assessed using the Hunt-Hess (HH) grading system; discharge and long-term clinical outcomes were assessed using the Glasgow Outcome Scale (GOS). Treatment modality was based on a multidisciplinary assessment, taking into consideration clinical status, mass effect of SDH, physical characteristics of the aneurysm, and overall medical condition. Long-term (6–12 month) follow-up was available for 23 of 30 patients. Patients without follow-up were presumed to have maintained the discharge GOS score for data analysis. For analysis of prognostic factors for outcome, a dichotomized outcome was chosen, with good clinical outcome defined as GOS score 4–5 and poor clinical outcome defined as GOS score 1–3. Statistical analysis was performed with unpaired *t*-test or Fisher's exact test when appropriate. We did not feel multivariate analysis was valuable due to the small number of patients in each subgroup. The Indiana University Institutional Review Board approved this study.

## 3. Results

Presenting characteristics are described in Table 1. The average age of patients was 61 years (range 39–86). Eighty percent of patients were female, and 80% were Caucasian. The average HH grade at presentation was 3.8 (range 1–5), and at intervention, it was 3.9. The average initial SDH maximum thickness was 6.7 mm (range 3–20 mm), and the average midline shift was 5.9 mm (range 1–15 mm), as measured at the level of the foramen of Monro. Of these, 21 (70%) SDH were on the right, 26 (87%) presented additionally with SAH, and 19 (63%) had intraparenchymal hematomas.

Aneurysm characteristics and treatment modality are summarized in Table 2. Locations of aneurysms by frequency were as follows: posterior communicating artery, 10 (33%); anterior communicating artery, six (20%); middle cerebral artery, six (20%); anterior choroidal artery, four (13%); and ophthalmic, four (13%). All aneurysms were in the anterior circulation. Average aneurysm size was 8.1 mm (range 3–19 mm). Eighteen patients (60%) underwent aneurysm clipping, eight (27%) received endosaccular coiling, one (3%) underwent both, and three (10%) were not treated due to their poor neurologic status. Twenty-four patients (80%) underwent surgical hematoma evacuation, and four (13%) underwent decompressive craniectomy. Six (20%) did not undergo surgical hematoma evacuation. In other words, among the 24 patients who underwent craniotomy for hematoma evacuation, 18 underwent simultaneous clip ligation of their aneurysm, one underwent partial coil embolization followed by clip ligation of the residual aneurysm at the time of hematoma evacuation, and five underwent coil embolization followed by hematoma evacuation. Among the four patients who underwent craniectomies, one patient underwent clip ligation and three patients had endosaccular coiling. The calculated frequency of aneurysmal SDH at our institution is 1.9% of all patients presenting with aneurysmal SAH.

Outcomes are depicted in Tables 3 and 4. Nine patients (30%) died prior to discharge, and two subsequently died after discharge in poor neurologic state. Good (GOS score 4–5) discharge condition occurred in six (20%) patients. The rate of good outcome increased to 40% (12 of 30) at 6–12 month follow-up evaluation. Seventy percent of patients presenting in good (HH 1–2) clinical condition achieved a good outcome (three of four patients; one patient declined to HH 5

**Table 1**
Demographic and clinical characteristics of the study population at presentation

| | n | % or (range) |
|---|---|---|
| Age, years | 61 | (39–86) |
| Sex, female | 24% | 80 |
| Race, Caucasian | 24% | 80 |
| HH admission | 3.8 | (1–5) |
| HH intervention | 3.9 | (1–5) |
| SDH width, mm | 6.7 | (3–20) |
| MLS, mm | 5.9 | (1–15) |
| Laterality, right | 21 | 70 |
| Presence of SAH | 26 | 87 |
| Presence of IPH | 19 | 63 |

HH = Hunt-Hess score, IPH = intraparenchymal hematoma, MLS = midline shift, SAH = subarachnoid hemorrhage, SDH = subdural hematoma.

**Table 2**
Aneurysm characteristics and treatment modality

| | n | % or (range) |
|---|---|---|
| Aneurysm location | | |
| Pcomm | 10 | 33 |
| Acomm | 6 | 20 |
| MCA | 6 | 20 |
| AchoA | 4 | 13 |
| Ophth | 4 | 13 |
| Anterior circulation | 30 | 100 |
| Interval to treatment, days | 0.78 | (0–3) |
| Aneurysm size, mm | 8.1 | (3–19) |
| Aneurysm treatment | | |
| Clipping | 18 | 60 |
| Coiling | 8 | 27 |
| Both | 1 | 3 |
| None | 3 | 10 |
| Hematoma treatment | | |
| Craniotomy | 24 | 80 |
| Craniectomy | 4 | 13 |
| None | 6 | 20 |

AchoA = anterior choroidal artery, Acomm = anterior communicating artery, MCA = middle cerebral artery, Ophth = ophthalmic, Pcomm = posterior communicating artery.

**Table 3**
Outcomes following aneurysm management at discharge and 6–12 month follow-up

| Clinical characteristic | Outcome | |
|---|---|---|
| Mortality | | |
| In-hospital mortality | 9 (30%) | |
| Post-discharge mortality | 0 | |
| Clinical outcome | Discharge | 6–12 month follow-up |
| GOS 4–5 | 6 (20%) | 12 (40%) |
| GOS 1–3 | 24 (80%) | 18 (60%) |
| Admission HH 1–2 (n = 4) | | |
| GOS 4–5 | | 3 (75%) |
| GOS 1–3 | | 1 (25%)* |
| Admission HH 4–5 (n = 23) | | |
| GOS 4–5 | | 8 (35%) |
| GOS 1–3 | | 15 (65%) |

Data are presented as n (%).
* One patient presented HH 1 with subsequent rehemorrhage.
GOS = Glasgow Outcome Scale, HH = Hunt-Hess score.

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