Poor-Grade Aneurysmal Subarachnoid Hemorrhage: Factors Influencing Functional Outcome—A Single-Center Series

Patrick Schuss, Alexis Hadjiathanasiou, Valeri Borger, Christian Wispel, Hartmut Vatter, Erdem Güresir

■ OBJECTIVE: **Patients presenting with poor-grade aneurysmal subarachnoid hemorrhage (SAH) have commonly been reported to have a poor prognosis; however, several reports suggest a favorable outcome in a subgroup of patients. We analyzed our database to identify factors determining functional outcome after poor-grade SAH.**

■ METHODS: **During the period 2004–2014, 248 patients with poor-grade SAH were treated in our institution. Poor-grade SAH was defined as World Federation of Neurological Surgeons grades IV–V on admission. Data including patient characteristics, treatment modality, radiologic features, and functional neurologic outcome were assessed and further analyzed. Outcome was assessed according to the modified Rankin Scale after 6 months and stratified into favorable (modified Rankin Scale score 0–2) versus unfavorable (modified Rankin Scale score 3–6). A multivariate analysis was performed to identify predictors of functional outcome.**

■ RESULTS: **A favorable outcome was achieved in 24% of patients with poor-grade SAH. Patients with a favorable outcome were significantly younger ($P = 0.005$), harbored significantly smaller aneurysms ($P = 0.004$), and had a lower initial World Federation of Neurological Surgeons grade ($P < 0.0001$). An unfavorable outcome was significantly more frequent in patients with additional space-occupying hematoma compared with patients without additional space-occupying hematoma ($P = 0.0009$). On multivariate analysis, patient age, World Federation of Neurological Surgeons grade V, signs of cerebral herniation, aneurysm size, and presence of space-occupying hematoma were identified as significant predictors of unfavorable outcome in patients with poor-grade SAH.**

■ CONCLUSIONS: **A favorable outcome was achieved in 24% of severely ill patients with poor-grade SAH. Therefore, treatment of patients with poor-grade SAH should not be omitted. Careful individualized decision making is necessary for each patient.**

INTRODUCTION

Patients with aneurysmal subarachnoid hemorrhage (SAH) with poor admission grade have commonly been reported to have a poor prognosis.[1-3] However, several reports described a favorable outcome in a subgroup of these patients with poor-grade SAH.[4-10] Nevertheless, studies analyzing factors influencing functional outcome after poor-grade SAH are rare. Several previous reports stated that the rebleeding rate is higher in patients with poor-grade SAH.[11,12] Early and aggressive treatment has been suggested in these patients to facilitate functional outcome.[2,8,13] However, aggressive therapy in patients with poor-grade SAH is controversial. We performed a retrospective analysis of our prospectively conducted database and a review of the literature to analyze factors determining outcome in patients with poor-grade SAH.

MATERIALS AND METHODS

Patients

Between January 2004 and July 2014, 282 patients with poor-grade aneurysmal SAH were admitted to our institution. Aneurysmal SAH was diagnosed by computed tomography (CT) or lumbar puncture. Data including patient characteristics on admission and during treatment course, treatment modality, aneurysm size and location, radiologic features, signs of cerebral herniation (dilated pupils), and functional neurologic outcome were collected and entered into a computerized database (IBM SPSS Statistics Version

Key words
- Intracranial aneurysm
- Poor-grade SAH
- Subarachnoid hemorrhage

Abbreviations and Acronyms
CI: Confidence interval
CT: Computed tomography
OR: Odds ratio
SAH: Subarachnoid hemorrhage
WFNS: World Federation of Neurological Surgeons

Department of Neurosurgery, University of Bonn, Bonn, Germany

To whom correspondence should be addressed: Patrick Schuss, M.D. [E-mail: patrick.schuss@ukb.uni-bonn.de]

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22; IBM Corporation, Armonk, New York, USA). The World Federation of Neurological Surgeons (WFNS) scale was used to grade patients on admission and before any intervention.[14,15] Patients with aneurysmal SAH were divided into good grade (WFNS grades I–III) versus poor grade (WFNS grades IV–V) on admission. Only patients with poor-grade admission status were included for further analysis. Of 282 patients with poor-grade SAH, 34 patients presented in such critical clinical condition that further aneurysm treatment could not be justified. Endovascular coiling or surgical clipping was used to treat the remaining 248 patients with poor-grade SAH. The decision regarding treatment modality in patients with poor-grade SAH was based on an interdisciplinary consensus in each individual case. We followed an early treatment strategy (within 24–48 hours) in patients with SAH in all clinical grades.[4,8,16] CT scans were obtained 24 hours after aneurysm treatment to rule out procedure-related complications. Rebleeding was defined as a sudden clinical deterioration with a concomitant increase of subarachnoid, intracerebral, or intraventricular blood on the subsequent CT scan. Patients with acute hydrocephalus were treated by ventriculostomy for external cerebrospinal fluid diversion. All patients received nimodipine from the day of clinical admission. In cases of onset of symptomatic vasospasm, hypertension was induced with catecholamines during the treatment course.[17] Patients with aneurysm-related SAH with additional acute subdural hematoma or intracerebral hemorrhage were treated with surgical evacuation.[4,8,18] Patients with SAH and simultaneous space-occupying acute subdural hematoma or intracerebral hemorrhage were further analyzed in a conjoint fashion as patients with space-occupying hematoma. In patients with persisting brain swelling, decompressive craniectomy was performed to reduce intractable elevated intracranial pressure.[6] In survivors, autologous cranioplasty was performed as previously reported.[19–21] Outcome was assessed according to the modified Rankin Scale after 6 months and stratified into favorable (modified Rankin Scale score 0–2) versus unfavorable (modified Rankin Scale score 3–6).

Statistics

Data analyses were performed using the computer software package IBM SPSS Statistics Version 22. Unpaired *t* test was used for parametric statistics. Categorical variables were analyzed in contingency tables using Fisher's exact test. Results with $P < 0.05$ were considered statistically significant.

A multivariate analysis was performed to find independent predictors of unfavorable functional outcome in patients with poor-grade SAH using binary logistic regression analysis to find confounding factors between potentially independent predictors. Variables with significant *P* values in the univariate analysis were considered as potentially independent variables in a multivariate analysis. A backward stepwise method was used to construct a multivariate logistic regression model in relation to favorable outcome as a dependent variable with an inclusion criterion of a *P* value < 0.05.

RESULTS

Patient Characteristics

There were 282 patients with SAH identified with poor-grade neurologic status on admission. In 34 patients who were admitted in severe critical clinical condition, no further aneurysm treatment was performed. Our analysis included 248 patients with poor-grade SAH who underwent further aneurysm treatment. Of 248 patients, 114 underwent surgical clipping (46%), and 134 underwent endovascular coiling (54%).

Overall, a favorable outcome was achieved in 59 patients with poor-grade SAH (21%). A favorable outcome was not achieved by any patient who did not undergo aneurysm treatment. A favorable outcome was achieved in 24% of patients with poor-grade SAH who underwent subsequent aneurysm treatment. The overall mortality of patients with poor-grade SAH was 42%. The mortality rate was 34% in patients who underwent aneurysm treatment. Age, sex, clinical status, angiographic and radiologic findings, treatment modality, and clinical outcome of patients who underwent subsequent aneurysm treatment are listed in **Table 1**. Patients with poor-grade SAH who achieved a favorable outcome were significantly younger than patients who had an unfavorable outcome (51 years ± 12 vs. 56 years ± 13; $P = 0.005$, 95% confidence interval [CI] = 1.6–9.3).

Table 1. Characteristics of Treated Patients with Poor-Grade Subarachnoid Hemorrhage

	Favorable Outcome (mRS Score 0–2)	Unfavorable Outcome (mRS Score 3–6)
Number of patients	59	189
Mean age (years)	51 ± 12*	56 ± 13*
Female sex	44 (75)	134 (71)
Mean WFNS grade	4.2 ± 0.4	4.5 ± 0.5
Signs of cerebral herniation	9 (15)†	80 (42)†
Mean aneurysm size (mm)	6.6 ± 3.7‡	9.1 ± 6.1‡
Aneurysm location		
ACA	1 (2)	9 (5)
AcomA	23 (39)	59 (31)
ICA	11 (19)	42 (22)
MCA	15 (25)	49 (26)
Posterior circulation	9 (15)	30 (16)
Treatment modality		
Surgical clipping	26 (44)	88 (47)
Endovascular coiling	33 (56)	101 (53)
Space-occupying hematoma	21 (36)§	115 (61)§
Rebleeding before treatment	— (0)	11 (6)

Values represent number of patients (%) unless otherwise indicated.
mRS, modified Rankin scale; WFNS, World Federation of Neurological Surgeons; ACA, anterior cerebral artery; AcomA, anterior communicating artery; ICA, internal carotid artery; MCA, middle cerebral artery; CI, confidence interval; OR, odds ratio.
*$P = 0.005$, 95% CI = 1.6–9.3.
†$P = 0.0002$, OR = 4.1, 95% CI = 1.9–8.8.
‡$P = 0.004$, 95% CI = 0.8–4.1.
§$P = 0.0009$, OR = 2.8, 95% CI = 1.5–5.2.