

Original Article

Age limit for surgical treatment of poor-grade patients with subarachnoid hemorrhage: A project of the Chugoku-Shikoku division of the Japan neurosurgical society

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Abstract

Objective: Management of elderly patients with poor-grade subarachnoid hemorrhage (SAH) remains controversial. The objective of this study was to investigate whether there is an age-dependent difference in the outcome of poor-grade SAH after surgical obliteration of the aneurysm.

Methods: Data were reviewed retrospectively for 156 patients with poor-grade aneurysmal SAH at multiple centers in Chugoku and Shikoku, Japan. Patients were divided into age groups of 65-74 and ≥ 75 years old. Factors influencing a favorable outcome at discharge (Glasgow Outcome Scale, good recovery or moderately disabled) were determined using multivariate logistic regression analyses.

Results: A favorable outcome at discharge was achieved in 37 of the 156 patients (23.7%). Advanced age (≥ 75 years old, $P < 0.01$), improvement of World Federation of Neurosurgical Societies (WFNS) Grade after admission ($P = 0.02$), Fisher grade ($P < 0.001$), and a low density area (LDA) associated with vasospasm on computed tomography (CT) ($P < 0.01$) were significantly associated with outcome. Multivariate analysis identified advanced age (≥ 75 years old, $P = 0.01$), Fisher group 4 ($P = 0.002$), and a new LDA associated with vasospasm on CT ($P = 0.007$) as predictors of a poor outcome in elderly patients with poor-grade SAH after surgical obliteration of the aneurysm. WFNS Grade V at admission ($P = 0.052$) was weakly associated with a poor outcome.

Conclusions: Advanced age (≥ 75 years old), Fisher group 4, and LDA associated with vasospasm on CT were independent predictors of clinical outcome in elderly patients with poor-grade SAH. A favorable outcome in these patients occurred more frequently after Guglielmi detachable coil embolization than after surgical clipping, but without a significant difference.

Key Words: Aneurysm, elderly, poor grade, subarachnoid hemorrhage

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INTRODUCTION

Patients with poor-grade aneurysmal subarachnoid hemorrhage (SAH) of World Federation of Neurosurgical Societies (WFNS) Grades IV and V have high mortality and morbidity, and the majority are treated conservatively.^[1,6,18,26] Several studies have shown that angiography and aneurysm surgery should be restricted to those who show clinical improvement.^[6,19] Previously, we have reported that advanced age, WFNS Grade V, improvement of WFNS Grade, and a low density area (LDA) associated with vasospasm on computed tomography (CT) were independent predictors of clinical outcome, whereas rebleeding, early aneurysm surgery, and treatment modality [surgical clipping or Guglielmi detachable coil (GDC) embolization] were not independently associated with outcome in patients with poor-grade SAH.^[22]

The annual incidence rate of aneurysmal SAH increases with age^[17] and increasing age is associated with a poor outcome in patients with SAH.^[25] However, elderly patients are under-represented in most reports of management of SAH and, to our knowledge, the influence of increased age on the outcome of patients with poor-grade aneurysmal SAH has not been examined. Therefore, we performed a retrospective review of patients with poor-grade aneurysmal SAH at multiple centers in Chugoku and Shikoku, Japan, to investigate whether there was an age-dependent difference in outcome.

MATERIALS AND METHODS

Study population

This study was performed retrospectively in a cohort with poor-grade SAH (WFNS Grades IV and V). The patients were recruited from January to December 2003 from 66 medical centers in Chugoku and Shikoku, Japan.^[22] The region in this study consists of 9 prefectures (Tottori, Shimane, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime and Kochi) and had a population of 11,803,000 in 2004. A total of 1470 patients with spontaneous SAH were registered in the project, of whom 559 (38.0%) were of poor clinical grade at admission. The crude annual incidence of SAH (WFNS Grades I-V) in this study was 12.45 per 100,000 population, and the crude annual incidence of poor-grade SAH (WFNS Grades IV and V) was 4.74 per 100,000. The age and sex-adjusted annual incidence for patients with poor-grade SAH (WFNS Grades IV and V) based on census data in Japan was 4.18 per 100,000, and this incidence adjusted to the United States population was 3.17 per 100,000.^[22]

The inclusion criteria for the study were patients with poor-grade SAH (WFNS Grades IV and V) who were undergoing surgical treatment of surgical clipping or GDC

embolization. WFNS grades of patients were obtained at admission by the neurosurgeon before resuscitation, treatment of intracranial hypertension, and intracranial pressure control. Patients treated with other types of coils for endovascular treatment were excluded from the study. SAH was confirmed in all patients by head CT scans and classified based on the Fisher grade: Group 1, no blood detected; Group 2, a diffuse deposition or thin layer with all vertical layers of blood (interhemispheric fissure, insular cistern, ambient cistern) <1 mm thick; Group 3, localized clots and/or vertical layers of blood \geq 1 mm in thickness; and Group 4, diffuse or no subarachnoid blood, but with intracerebral or intraventricular clots.^[21] The presence and location of an aneurysm was diagnosed by three-dimensional CT angiography (3D-CTA) or cerebral angiography in all patients. Selected data for baseline characteristics, treatment, radiographic data, and postoperative hospital course were obtained from a retrospective review of patients with poor-grade aneurysmal SAH at multiple centers in Chugoku and Shikoku, Japan.^[22]

Clinical assessment

Age, sex, WFNS grade, improvement of WFNS grade, Fisher grade, aneurysm location, rebleeding, treatment modality (surgical clipping and GDC embolization), and time to intervention (\leq 24 h, 24-72 h, >72 h) were recorded as baseline characteristics. The outcome measures were symptomatic vasospasm, LDA associated with vasospasm on CT, shunt-dependent hydrocephalus, length of hospital stay, clinical outcome at discharge, and mortality. Symptomatic vasospasm was as previously defined based on clinical criteria of (1) onset of new neurological deficits such as confusion, disorientation, drowsiness, or focal motor deficit on days 4 to 14 after onset of SAH; (2) negative findings on CT scans obtained to rule out other causes of neurological deterioration, such as surgery, hydrocephalus, or intracranial rebleeding; and (3) no other identifiable cause of neurological deterioration, such as seizure, infection, electrolyte imbalance, or metabolic disturbances.^[22] Confirmation of vasospasm by angiography or transcranial Doppler ultrasonography was recommended, but not required. A new LDA associated with vasospasm on CT scans was defined as a new infarction if it had not been observed at admission and there was no cause other than vasospasm. Clinical outcome at discharge was assessed using the Glasgow Outcome Scale (GOS)^[7]: a favorable outcome was defined as good recovery or moderately disabled and a poor outcome as severely disabled, vegetative survival or death.

Statistical analysis

A χ^2 test and Student *t* test were used to compare variables between patients with favorable and poor outcomes. Factors found to be significantly associated with outcome were further examined by multivariate

analysis (Statistical Analysis System, SAS Institute, Cary, NC). These factors included demographic information (age and sex), SAH-related variables (WFNS Grade at admission, improvement of WFNS Grade within 72 h, Fisher grade, aneurysm location, rebleeding, time to intervention, treatment modality, symptomatic vasospasm, LDA on CT, and shunt-dependent hydrocephalus), GOS at discharge, and mortality. Data are shown as means \pm standard deviation. A *P* value less than 0.05 was considered significant in all analyses.

RESULTS

Cohort characteristics

The mean age of the 283 patients was 64.8 years old, 65.7% of the patients were female, 127 (44.9%) were <65 years old (mean age: 53.2 years old), and 156 (55.1%) were \geq 65 years old (mean age: 74.5 years). The characteristics of the patients are given for all patients and for the two age groups in Table 1. The goal of the study was to examine the outcome of surgical treatment of poor-grade geriatric patients with SAH. Therefore, we used 65 years old as the cut-off age for forming the two groups. Symptomatic vasospasm was significantly more common in patients aged \geq 65 years old compared to younger patients (*P* = 0.04). The outcome was significantly worse for patients aged \geq 65 years old compared to younger patients (*P* < 0.001). WFNS Grade IV/V at admission and improvement of WFNS Grade were not significantly associated with an increased age, but patients who only improved to preoperative Grade IV from Grade V at admission were significantly more likely to be \geq 65 years old (*P* < 0.05). There were no other significant differences between the age groups. The mean hospital stay of patients aged \geq 65 years old (79.3 days) was longer than that of younger patients (66.9 days), but the difference was not significant.

Factors associated with outcome

Factors with a potential association with clinical outcomes at discharge (age, sex, WFNS Grade at admission, improvement of WFNS Grade within 72 h, Fisher grade, aneurysm location, rebleeding, treatment modality, symptomatic vasospasm, LDA on CT, shunt-dependent hydrocephalus, and time to intervention) in the 156 patients aged \geq 65 years old were examined by univariate analysis [Table 2]. Of these patients, 37 (23.7%) achieved a favorable outcome at discharge, including 24 Grade IV (65.0%) and 13 Grade V (35.0%) cases. The percentages of Grade IV and V patients with a favorable outcome were 28.9% and 17.8%, respectively. The outcome was significantly worse for patients aged \geq 75 years old compared to younger patients (*P* < 0.01). LDA associated with vasospasm on CT (*P* < 0.01) was significantly associated with a poor outcome, and improvement of WFNS Grade (*P* = 0.02) was significantly

associated with a favorable outcome. Patients with WFNS Grade IV at admission improved to preoperative Grades I, II and III in 1, 5 and 3 cases, respectively, and 77.8% of patients with preoperative WFNS Grade I-III had a favorable outcome. Patients with WFNS Grade V at admission improved to preoperative Grades I, II and III and IV in 0, 4, 2 and 19 cases, respectively. There was a favorable outcome in 33.3% of patients with preoperative WFNS Grades II and III, but in only 21.0% of those with preoperative WFNS Grade IV. A favorable outcome occurred in a higher percentage of patients with WFNS Grade IV at admission (65.0%) compared to those with WFNS Grade V at admission (35.0%), but the difference was not significant. Fisher grade (*P* < 0.001) showed a significant association with outcome. Rebleeding was not significantly associated with outcome, and a significant number of cases of rebleeding occurred on day 0 (88.1%) or within 6 hr (70.5%) of the onset of SAH. We also examined a sub-group of 138 patients who underwent surgical obliteration of the aneurysm and in whom the time to intervention was known accurately. However, the time to intervention in this sub-group was not significantly associated with outcome. Among all patients recruited into the original study, 178 were \geq 65 years old and did not receive surgical treatment. Of these patients, 2 (1.1%) had a favorable outcome at discharge. The mortality rate was 93.8% (167 / 178), including 28 Grade IV (15.7%) and 150 Grade V (84.3%) cases (data not shown).

Factors associated with treatment modality

The treatment modality (surgical clipping or GDC embolization) in the 156 patients aged \geq 65 years old was examined by univariate analysis [Table 3]. Posterior circulation (basilar artery, vertebral artery, and posterior cerebral artery) aneurysms were present in only 7 (5.9%) of the 118 patients treated with clipping, but in 14 (36.8%) of the 38 patients who received GDC embolization (*P* < 0.001). A favorable outcome was obtained in a higher percentage of patients treated with GDC embolization (28.9%) compared to those who underwent surgical clipping (22.0%), but the difference not significant. There were no other significant differences between the treatment sub-groups.

Multivariate analysis and outcome prediction

The four factors with a significant effect on outcome identified in univariate analysis in patients aged \geq 65 years old (age, Fisher grade, improvement of WFNS Grade, LDA on CT) and a factor with a significant effect on outcome identified in univariate analysis in patients of all ages (WFNS grade at admission)^[22] were further examined by multivariate analysis to determine the degree to which each variable was independently correlated with outcome. In this analysis, age (especially \geq 75 years old, *P* = 0.01), Fisher group 4 (*P* = 0.002), and LDA on CT (*P* = 0.007) emerged as predictors of a poor outcome in patients aged \geq 65 years old [Table 4]. This analysis also

Table 1: Demographic and clinical characteristics for all patients and for patients aged <65 and ≥65 years old

Characteristic	All	<65 years old	≥65 years old	P value
Patients, no. (%)	283 (100.0)	127 (44.9)	156 (55.1)	
Age (yr)				
Range	16-92	16-64	65-92	
Average	64.83	53.17	74.54	<0.001
Men:women, no. (% women)	97:186 (65.7)	56:71 (55.9)	41:115 (73.7)	
WFNS Grade, no. (%)				
Grade IV at admission	150 (53.0)	67 (52.8)	83 (53.2)	NS
Grade V at admission	133 (47.0)	60 (47.2)	73 (46.8)	
Improvement of WFNS Grade, no. (%)	56 (19.8)	22 (17.3)	34 (21.8)	NS
Preoperative WFNS Grade I/II/III/IV	3/15/13/25	2/6/8/6	1/9/5/19	
Fisher grade, no. (%)				
Groups 1 and 2	4 (1.4)	2 (1.6)	2 (1.3)	NS
Group 3	175 (61.8)	83 (65.4)	92 (59.0)	
Group 4	104 (36.7)	42 (33.1)	62 (39.7)	
Aneurysm location, no. (%)				
Anterior circulation	237 (83.7)	102 (80.3)	135 (86.5)	NS
Posterior circulation	46 (16.3)	25 (19.7)	21 (13.5)	
Rebleeding, no. (%)	36 (12.7)	19 (14.9)	17 (10.9)	NS
Treatment modality, no. (%)				
Clipping	225 (79.5)	107 (84.3)	118 (75.6)	NS
GDC embolization	58 (20.5)	20 (15.7)	38 (24.4)	
Symptomatic vasospasm, no. (%)	97 (34.3)	35 (27.6)	62 (39.7)	0.04
LDA on CT, no. (%)	98 (34.6)	40 (31.5)	58 (37.1)	NS
Hydrocephalus, no. (%)	135 (47.7)	56 (44.1)	79 (50.6)	NS
Hospital stay (days)	73.7	66.9	79.3	0.053
GOS at discharge, no. (%)				
Favorable outcome (GR, MD)	97 (34.3)	60 (47.2)	37 (23.7)	<0.001
Poor outcome (SD, VS, D)	186 (65.7)	67 (52.8)	119 (76.3)	
Mortality at discharge, no. (%)	67 (23.7)	27 (21.3)	40 (25.6)	NS

WFNS: World Federation of Neurosurgical Societies, GDC: Guglielmi detachable coils, NS: Not significant, LDA: low density area, CT: Computed tomography, GOS: Glasgow Outcome Scale, GR: Good recovery, MD: Moderately disabled, SD: Severely disabled, VS: Vegetative survival, D: Death, IC: Internal carotid artery, ACA: Anterior cerebral artery, AcomA: Anterior communicating artery, MCA: Middle cerebral artery, BA: Basilar artery, VA: Vertebral artery, PCA: Posterior cerebral artery. Aneurysm location (Anterior circulation) defined as IC, ACA, AcomA, and MCA. Aneurysm location (Posterior circulation) defined as BA, VA, and PCA. LDA on CT defined as LDA associated with vasospasm on CT. Hydrocephalus defined as shunt-dependent hydrocephalus. Favorable outcome defined as GOS (GR, MD) at discharge and poor outcome defined as GOS (SD, VS, and D) at discharge

showed that WFNS Grade IV at admission ($P = 0.052$) was weakly associated with a favorable outcome in these patients [Table 4].

DISCUSSION

In this report, we describe a retrospective study of 283 patients with poor-grade SAH who underwent surgical obliteration of the aneurysm at 66 medical centers in Chugoku and Shikoku, Japan. Of these patients, 156 were ≥65 years old. The crude annual incidence of SAH (WFNS Grades I-V) and the age and sex-adjusted incidence of poor-grade SAH (WFNS Grades IV and V) in this study indicated that most patients with SAH in Chugoku and Shikoku were included, and thus an accurate assessment of outcome for poor-grade SAH in these regions is provided in this one-year study.^[22]

Several studies have suggested that advanced age is associated with a poor outcome in patients with poor-grade SAH,^[1,11,13] but others have found no significant association between outcome and age.^[9,15] In our data, poor-grade SAH patients of all ages had a favorable outcome in 34.3% of cases. Further analysis indicated favorable outcomes in 47.2% and 32.9% of patients aged <65 and 65-74 years old, respectively, but in only 14.3% of patients aged ≥75 years old. Multivariate analysis identified advanced age (≥75 years old) as a predictor of a poor outcome. These results indicate an association between advanced age (especially ≥75 years old) and a poor outcome in patients with poor-grade SAH.

LeRoux *et al.*^[11] suggested that clinical grade (Hunt and Hess Grade V) at admission was independently

Table 2: Outcome for patients aged ≥ 65 years old based on demographic and clinical characteristics

Characteristic*	Favorable outcome	Poor outcome	P value
Patients, no. (%)	37 (23.7)	119 (76.3)	
Mean age (yr)	72.2	75.3	<0.01
Age (yr), no. (%)			
65-74 yr	26 (70.3)	53 (44.5)	<0.01
≥ 75 yr	11 (29.7)	66 (55.5)	
Men:women, no. (% women)	13:24 (64.9)	28:91 (76.5)	NS
WFNS Grade, no. (%)			
Grade IV at admission	24 (65.0)	59 (49.6)	NS
Grade V at admission	13 (35.0)	60 (50.4)	
Improvement of WFNS Grade, no. (%)	13 (35.1)	21 (17.6)	0.02
Preoperative WFNS Grade (Grade IV at admission) I/II/III	1/4/2	0/1/1	
Preoperative WFNS Grade (Grade V at admission) I/II/III/IV	0/2/0/4	0/2/2/15	
Fisher grade, no. (%)			
Groups 1 and 2	0 (0)	2 (1.7)	<0.001
Group 3	32 (86.5)	60 (50.4)	
Group 4	5 (13.5)	57 (47.9)	
Aneurysm location, no. (%)			
Anterior circulation	29 (78.4)	106 (89.1)	NS
Posterior circulation	8 (21.6)	13 (10.9)	
Rebleeding, no. (%)	7 (18.9)	10 (8.4)	NS
Treatment modality, no. (%)			
Clipping	26 (70.3)	92 (77.3)	NS
GDC embolization	11 (29.7)	27 (22.7)	
Symptomatic vasospasm, no. (%)	18 (48.6)	44 (37.0)	NS
LDA on CT, no. (%)	7 (18.9)	51 (42.9)	< 0.01
Hydrocephalus, no. (%)	18 (48.6)	61 (51.3)	NS
Time to intervention, no. (%) [†]			
≤ 24 hr	29 (85.3)	90 (86.5)	NS
24-72 hr	4 (11.8)	4 (3.8)	
> 72 hr	1 (2.9)	10 (9.6)	

*All characteristics refer to the patients described in Table 1 unless otherwise indicated; [†]n = 138 patients who underwent surgical obliteration of the aneurysm and in whom the time to intervention was known accurately

correlated with a poor outcome, and several studies have suggested that neurological improvement is associated with a favorable outcome in patients with poor-grade SAH.^[6,19,22,23] In our study, WFNS Grade IV at admission in poor-grade elderly patients with SAH was a weak independent predictor of a favorable outcome in multivariate analysis. Improvement of WFNS Grade was identified as a predictor of a favorable outcome in univariate analysis, but did not show an independent association in multivariate analysis. Although the rate of WFNS Grade IV/V at admission and improvement of WFNS Grade were not significantly associated with increased age, patients who only improved to preoperative Grade IV from Grade V at admission were significantly more likely to be ≥ 65 years old. We note that we previously found that most patients who only improved to preoperative Grade IV from Grade V at admission did not have a favorable outcome.^[22] The reason for the weak association of improvement of WFNS Grade

with outcome might be the small number of cases of improvement to preoperative WFNS grades II and III among the elderly patients.

LeRoux *et al.*^[11] and Shimoda *et al.*^[21] have suggested that intraventricular hemorrhage (Fisher group 4) in patients with poor-grade SAH is also associated with a poor outcome. In our study, the Fisher grade in elderly patients with poor-grade SAH was identified as an independent predictor of a favorable outcome in multivariate analysis. Thus, elderly patients might be resistant to recovery from initial damage such as intraventricular and/or intracerebral hemorrhage, as well as to improvement of WFNS Grade. Le Roux *et al.*^[11] also found that a LDA on CT was significantly correlated with a poor outcome in patients with poor-grade SAH, which is consistent with our findings for elderly patients with poor-grade SAH. However, this is not relevant to determining whether surgical treatment should be offered to patients with new SAH. Lanzio *et al.*^[10] found that

Table 3: Demographic and clinical characteristics in patients aged ≥ 65 years old according to treatment modality

Characteristic	Clipping	GDC embolization	P-value
Patients, no. (%)	118 (75.6)	38 (24.4)	
Mean age (yr)	74.6	74.3	NS
Men:women, no. (%)	29:89 (75.4)	12:26 (68.4)	NS
WFNS Grade, no. (%)			
Grade IV at admission	67 (56.8)	16 (42.1)	NS
Grade V at admission	51 (43.2)	22 (57.9)	
Improvement of WFNS Grade, no. (%)	24 (20.3)	9 (23.7)	
Fisher grade, no. (%)			
Groups 1 and 2	1 (0.8)	1 (2.6)	NS
Group 3	67 (56.8)	25 (65.8)	
Group 4	50 (42.4)	12 (31.6)	
Aneurysm location, no. (%)			
Anterior circulation	111 (94.1)	24 (63.2)	< 0.001
Posterior circulation	7 (5.9)	14 (36.8)	
Rebleeding, no. (%)	12 (10.2)	5 (13.2)	NS
Symptomatic vasospasm, no. (%)	47 (39.8)	15 (39.5)	NS
LDA on CT, no. (%)	45 (38.1)	13 (34.2)	NS
Hospital stay (days)	81.5	73.2	NS
GOS at discharge, no. (%)			
Favorable outcome (GR, MD)	26 (22.0)	11 (28.9)	NS
Poor outcome (SD, VS, D)	92 (78.0)	27 (71.1)	

symptomatic vasospasm was more frequent in elderly patients, whereas Ryttefors *et al.*^[16] suggested that age was not a significant predictor for cerebral vasospasm after SAH. In our study, symptomatic vasospasm was weakly associated with patients aged ≥ 65 years old compared to younger patients with poor-grade SAH.

GDC embolization has been applied to poor-grade SAH patients in previous studies^[3,14,24] and is a major advance in terms of surgical obliteration of an aneurysm. The current evidence of a potential benefit of GDC embolization over surgical clipping is based mainly on the International Subarachnoid Aneurysm Trial.^[14] However, the number of patients with a poor grade SAH in this trial was small and the treatment effect of GDC embolization was heterogeneous and difficult to interpret based on the WFNS grade at baseline. Our study indicated that the percentage of favorable outcomes in patients with poor-grade SAH aged ≥ 65 years old treated with GDC embolization was higher than that for surgical clipping, but the difference was not significant. Recently, Horiuchi *et al.*^[5] suggested that advanced age was not a risk factor for a poor outcome of clipping surgery in elderly patients, and Karamanakos *et al.*^[8] suggested that integration of coil treatment in clinical practice has not improved the overall

Table 4: Independent prognostic factors of a poor outcome at discharge for patients aged ≥ 65 years old based on multivariate analysis of age, Fisher grade, World Federation of Neurosurgical Societies grade, improvement of World Federation of Neurosurgical Societies grade, and low density area on computed tomography

Characteristic	Odds ratio	95% CI	P value
Age (yr)			
65-74 yr	1		
≥ 75 yr	3.209	1.316-7.820	0.01
Fisher grade			
Groups 1,2 and 3	1		
Group 4	5.423	1.836-16.018	0.002
WFNS Grade			
Grade IV at admission	1		
Grade V at admission	2.613	0.992-6.882	0.052
Improvement of WFNS Grade			
Improvement (-)	1		
Improvement (+)	0.505	0.174-1.462	0.208
LDA on CT			
LDA (-)	1		
LDA (+)	3.991	1.452-10.966	0.007

outcome of SAH in the elderly. Although endovascular coiling has become a major form of treatment for SAH in elderly patients, not all ruptured aneurysms can be managed with an endovascular approach. Our study may provide criteria for selection of the surgical treatment modality in elderly patients with poor-grade SAH. We propose that this decision should be made based on the aneurysm features and general condition, and that clinical grade and age should be included as reference information.

Several studies have found that early surgery for poor-grade SAH is associated with a favorable outcome,^[4,9,12,20] but there is little available information on the optimum time at which such patients should undergo surgery. Furthermore, to our knowledge, the association of the time to intervention with a poor outcome has not been examined previously in elderly patients with poor-grade SAH. Our data did not indicate a significant association between the time to intervention and a poor outcome in these patients. One aim of early surgery is prevention of rebleeding, but the ultra-early rebleeding rate and risk of rebleeding are higher in poor-grade patients.^[24] In our study, most cases of rebleeding occurred on Day 0 (≤ 24 h) or within 6 h of onset of SAH, and ultra-early surgery (≤ 24 h) might not lessen the risk of rebleeding in elderly patients with poor-grade SAH.

CONCLUSIONS

Our analysis demonstrates that advanced age (≥ 75 years old), Fisher group 4, and a new LDA associated with vasospasm on CT are independent predictors of outcome

in elderly patients with poor-grade SAH. WFNS Grade V at admission may also be an independent predictor of outcome in this patient population. Improvement of WFNS Grade was identified as a predictor of a favorable outcome in univariate analysis, but did not show an independent correlation with outcome in multivariate analysis. The rate of a favorable outcome in elderly patients with poor-grade SAH treated with GDC embolization was higher than that with surgical clipping, but with no significant difference. Early aneurysm surgery was not found to be an independent predictor of outcome in elderly patients with poor-grade aneurysm. The results of this study should not be taken as proof of preoperative prediction of outcome in elderly patients with poor-grade SAH, since we only looked at patients who received surgical treatment and excluded those who were not treated. Proof of preoperative prediction of outcome in elderly patients with poor-grade SAH can only be accomplished in a randomized controlled trial in a large number of patients at multiple centers. However, our results do confirm previously identified trends for outcome in elderly patients with poor-grade SAH.

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