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Management of aneurysmal subarachnoid hemorrhage with surgical clipping: A single center perspective

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Abstract

Background/Aim: There is no consensus on the optimal treatment for intracranial aneurysm rupture due to subarachnoid hemorrhage (SAH). In this study, we analyzed a series of ruptured intracranial aneurysms treated with the clipping method at our center.
Methods: In this retrospective cohort study; we searched our patient database for patients who developed SAH due to ruptured intracranial aneurysm treated at the Neurosurgery Clinic of Sivas Cumhuriyet University. A total of 304 patients who underwent the clipping operation due to aneurysmal SAH between 2010 and 2020 were included in the study. Cases with aneurysmal SAH who underwent endovascular coiling which is consisted of 22 patients were excluded.
Results: A significant inverse correlation was found between age and Glasgow coma scores (GCS) (r=−0.137, P=0.017). Hunt–Hess and Fisher grades increased significantly with increasing age (r=0.187, P<0.001 and r=0.185, P<0.001). The mean age of men was significantly lower than that of women (P=0.005). Aneurysms located in the anterior communicating artery were significantly more frequent in men than in women (P<0.001). There was no significant difference in the distribution of other aneurysm locations by gender (P>0.05). No significant differences were observed in GCS scores and Hunt–Hess and Fisher grades between genders (P>0.05). There were no significant effects of aneurysm locations on mortality (P>0.05). Conversely, GCS scores were significantly lower and Hunt–Hess and Fisher grades were significantly higher in the surviving group than in the deceased group (P<0.001).
Conclusion: Our study presented the outcomes of patients treated in our clinic with surgical clipping. Based on our findings, we believe that surgical clipping is still a safe and valid treatment method.

Keywords: Subarachnoid hemorrhage, Surgical clipping, Aneurysm, Vasospasm

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Ethics Committee Approval
The study was approved by the research ethics committee of Sivas Cumhuriyet University (2021-08/08). Signed statements of informed content to participation and publication were obtained from participants before the study.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Introduction

Subarachnoid hemorrhage (SAH) due to intracranial aneurysm rupture is a serious health issue with high mortality and morbidity. SAH accounts for approximately 5% of all strokes, mortality within the following month is 36%, and the incidence is 9/100,000 per year [1–3]. SAHs due to intracranial aneurysm rupture constitute 75%–85% of SAHs from nontraumatic causes [4].

In the post bleeding period, neurological complications such as further hemorrhage, vasospasm, cerebral edema, hydrocele, epileptic seizures and systemic complications such as pulmonary edema, cardiomyopathy and infections may occur. There is no consensus on the optimal treatment for intracranial aneurysm rupture due to SAH. Endovascular coiling and transcranial clipping are the preferred methods in various centers based on experience or individual cases [1-3].

In this study, we analyzed a series of ruptured intracranial aneurysms treated with the clipping method at our center.

Materials and methods

We retrospectively searched our patient database for patients who developed SAH due to ruptured intracranial aneurysm treated at the Neurosurgery Clinic of Sivas Cumhuriyet University. A total of 304 patients who underwent the clipping operation due to aneurysmal subarachnoid hemorrhage between the years 2010 and 2020 were included in the study. Cases with aneurysmal SAH who underwent endovascular coiling which is consisted of 22 patients were excluded.

All surgical procedures were performed by the same team with experience in neurovascular surgery. The data analyzed was demographic information, aneurysm location and size, preoperative Glasgow coma scores (GCS), Hunt–Hess grades, Fisher grades, morbidity and surgical mortality (mortality in the 30 days after surgery, during the same period of hospitalization) and neurological complications such as temporary or permanent hydrocephalus and vasospasm.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics software, v.25.0 (IBM Corporation, Armonk, NY, USA). The Kolmogorov–Smirnov test was used to examine the distribution of continuous and discrete numerical variables. Levene's test was used to determine the homogeneity of variances. For continuous and discrete numerical variables, descriptive statistics were expressed as mean (SD) or median (25th to 75th percentile), while categorical variables were shown as the number of cases and (%). As a result of the goodness-of-fit tests, the differences between the groups for continuous numerical variables in which the parametric test criteria were met were evaluated with the student's t-test. The differences between the groups for continuous numerical variables in which the parametric test criteria were not met were examined using the Mann–Whitney U test. We used 2 × 2 crosstabs and, if the expected frequency was below five in at least 25% of the cells, the categorical data were evaluated with Fisher's exact probability test. When the expected frequency was between five and 25, the $\chi2$ test with continuity correction was used. Otherwise, Pearson's test was used. The examination was performed using the $\chi2$ test. Correlations between GCS, Hunt–Hess and Fischer scores were investigated with Spearman's ordinal number correlation test. Results with $P<0.05$ were considered statistically significant.

Results

A total of 304 patients who underwent the clipping operation for aneurysmal SAH between January 1, 2010, and December 31, 2020, were included in this study. Data on the demographic and clinical characteristics of these 304 patients were collected and are shown in Table 1. A statistically significant inverse correlation was found between age and GCS scores (r=−0.137, P=0.017), Hunt–Hess and Fisher grades increased significantly with increasing age (r=0.187, P<0.001 and r=0.185, P<0.001) (Table 2).

Table 1: Demographic and clinical characteristics of patients

	n=304
Age (years) mean (SD)	53.2 (13.0)
Age range (years)	11–86
Gender	
Male n (%)	117 (38.5%)
Female n (%)	187 (61.5%)
Aneurysm location	
MCA n (%)	133 (43.8%)
ACOM n (%)	132 (43,4%)
PCOM n (%)	32 (10.5%)
ACA n (%)	23 (7.6%)
AChA n (%)	6 (2.0%)
ICA n (%)	6 (2.0%)
PICA n (%)	3 (1.0%)
Basilar n (%)	1 (0.3%)
Mean dimension of aneurysms (mm)	5.0 (4.0–7.0)
Multiple aneurysms n (%)	29 (9.5%)
Surgery day (range)	8.0 (4.0–12.0)
GCS score	14.0 (13.0–15.0)
Hunt–Hess grade (range)	2.0 (2.0–2.0)
Fisher grade (range)	3.0 (2.0–4.0)
Hydrocephalus n (%)	22 (7.2%)
Vasospasm n (%)	70 (23.0%)
Vasospasm day after surgery (range)	7.0 (5.75–10.0)
Morbidity n (%)	67 (22.0%)
Mortality n (%)	34 (11.2%)

ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, ACOM: Anterior communicating Artery, GCS: Glasgow coma scale, ICA: Internal carotid artery, MCA: Middle cerebral artery, PCOM: Posterior communicating artery, PICA: Posterior inferior cerebellar artery, SD: standard deviation

Table 2: Correlation coefficients and significance levels between the ages of patients who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage and their Glasgow coma scale, Hunt–Hess and Fischer scores

	Correlation coefficient	*P*-value†
Glasgow coma scale	−0.137	0.017
Hunt–Hess	0.187	<0.001
Fisher	0.185	<0.001

† Spearman's ordinal correlation test

The mean age of men was statistically significantly lower than that of women (P=0.005). Aneurysms located in the ACOM were significantly more frequent in men than in women (P<0.001). There was no significant difference in the distribution of other aneurysm locations by gender (P>0.05). No significant differences were observed in GCS scores and Hunt–Hess and Fisher grades between genders (P>0.05) (Table 3).

Between the groups with and without morbidity, there were no significant differences in mean age or gender (P=0.069 and P=0.282). There was no significant effect of aneurysm location on morbidity (P>0.05). On the other hand, GCS scores were significantly lower and Hunt–Hess and Fisher grades significantly higher in the group with morbidity compared to the group without morbidity (P<0.001) (Table 4).

There were no significant differences between the surviving group and the deceased group in mean age or gender (P=0.355 and P=0.334). There were no significant effects of aneurysm locations on mortality ($P>0.05$). On the other hand, GCS scores were statistically significantly lower and Hunt–Hess and Fisher grades were significantly higher in the surviving group than the deceased group ($P<0.001$) (Table 5).

Table 3: Demographic and clinical characteristics of patients who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage by gender

	Male (n=117)	Female (n=187)	*P*-value
Age (years) mean (SD)	50.6 (12.5)	54.9 (13.1)	0.005†
Aneurysm location			
MCA n (%)	47 (40.2%)	86 (46.0%)	0.320‡
ACOM n (%)	65 (55.6%)	67 (35.8%)	<0.001‡
PCOM n (%)	7 (6.0%)	25 (13.4%)	0.064¶
ACA n (%)	7 (6.0%)	16 (8.6%)	0.547¶
AChA n (%)	0 (0.0%)	6 (3.2%)	0.086¥
ICA n (%)	1 (0.9%)	5 (2.7%)	0.412¥
GCS score (range)	14 (14–15)	14 (13–15)	0.260§
Hunt–Hess grade (range)	2 (1.5–2)	2 (2–2)	0.084§
Fisher grade (range)	2 (2–4)	3 (2–4)	0.265§

† Student's t-test, ‡ Pearson's χ2 test, ¶ Continuity corrected χ2 test, ¥ Fisher's exact probability test, § Mann–Whitney U test, ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, ACOM: Anterior communicating Artery, GCS: Glasgow coma scale, ICA: Internal carotid artery, MCA: Middle cerebral artery, PCOM: Posterior communicating artery, SD: standard deviation

Table 4: Demographic and clinical characteristics of patients with and without morbidity who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage

	Morbidity (−) (n=237)	Morbidity (+) (n=67)	*P*-value
Age (years) mean (SD)	52.5 (12.8)	55.8 (13.5)	0.069†
Gender			0.282‡
Male n (%)	95 (40.1%)	22 (32.8%)	
Female n (%)	142 (59.9%)	45 (67.2%)	
Aneurysm location			
MCA n (%)	100 (42.2%)	33 (49.3%)	0.304‡
ACOM n (%)	105 (44.3%)	27 (40.3%)	0.559‡
PCOM n (%)	22 (9.3%)	10 (14.9%)	0.270¶
ACA n (%)	20 (8.4%)	3 (4.5%)	0.412¶
AChA n (%)	5 (2.1%)	1 (1.5%)	>0.999¥
ICA n (%)	3 (1.3%)	3 (4.5%)	0.123¥
GCS score (range)	14 (14–15)	13 (10–14)	<0.001§
Hunt–Hess grade (range)	2 (2–2)	3 (2–4)	<0.001§
Fisher grade (range)	2 (2–4)	4 (2–4)	<0.001§

† Student's t-test, ‡ Pearson's χ2 test, ¶ Continuity corrected χ2 test, ¥ Fisher's exact probability test, § Mann–Whitney U test, ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, ACOM: Anterior communicating Artery, GCS: Glasgow coma scale, ICA: Internal carotid artery, MCA: Middle cerebral artery, PCOM: Posterior communicating artery, SD: standard deviation

Table 5: Demographic and clinical characteristics of patients who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage with and without subsequent mortality

	Alive (n=270)	Dead (n=34)	*P*-value
Age (years) mean (SD)	53.0 (13.0)	55.2 (13.2)	0.355†
Gender			0.334‡
Male n (%)	107 (39.6%)	10 (29.4%)	
Female n (%)	163 (60.4%)	24 (70.6%)	
Aneurysm location			
MCA n (%)	120 (44.4%)	13 (38.2%)	0.614‡
ACOM n (%)	115 (42.6%)	17 (50.0%)	0.524‡
PCOM n (%)	27 (10.0%)	5 (14.7%)	0.378¶
ACA n (%)	20 (7.4%)	3 (8.8%)	0.731¶
AChA n (%)	6 (2.2%)	0 (0.0%)	>0.999¶
ICA n (%)	5 (1.9%)	1 (2.9%)	0.512¶
GCS	14 (14–15)	13 (8.75–15)	<0.001¥
Hunt–Hess	2 (2–2)	2 (2–4)	<0.001¥
Fisher	2 (2–4)	4 (3–4)	<0.001¥

† Student's t-test, ‡ Pearson's χ2 test, ¶ Fisher's exact probability test, ¥ Mann–Whitney U test, ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, ACOM: Anterior communicating Artery, GCS: Glasgow coma scale, ICA: Internal carotid artery, MCA: Middle cerebral artery, PCOM: Posterior communicating artery, SD: standard deviation

There were no significant differences in the mean age according to the location of the aneurysm ($P>0.05$). There were no significant differences in GCS scores or Hunt–Hess and Fisher grades according to the location of the aneurysm ($P>0.05$), with the exception that Fisher grades were significantly lower in those with aneurysms located in the ACA than those with aneurysms in other locations ($P=0.049$). There were no significant differences in the incidence of vasospasm according to aneurysm location ($P>0.05$). In addition, there was no significant difference in the postoperative day on which vasospasm occurred according to aneurysm location ($P>0.05$) (Table 6).

There were no significant differences in the mean age or gender of those who had multiple aneurysms and those who did not ($P=0.390$ and $P>0.999$). In addition, no significant differences were observed in the Hunt–Hess and Fisher grades of those who had multiple aneurysms and those who did not ($P=0.863$ and $P=0.661$) (Table 7).

Table 6: Ages, GCS scores, Hunt–Hess grades, Fisher grades, vasospasm development and vasospasm development times according to aneurysm location in patients who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage

	n	Age mean (SD)	GCS score (range)	Hunt–Hess Grade (range)	Fisher Grade (range)	Vasospasm development n (%)	Vasospasm development time Post-operative day (range)
MCA							
No	171	54.0 (13.2)	14 (13–15)	2 (2–2)	3 (2–4)	39 (22.8%)	7 (5–10)
Yes	133	52.3 (12.7)	14 (13–15)	2 (2–2)	2 (2–4)	31 (23.3%)	7 (6–12)
P-value		0.283†	0.862‡	0.430‡	0.767‡	0.918¶	0.541‡
ACOM							
No	172	53.0 (13.2)	14 (13–15)	2 (2–2)	2 (2–4)	33 (19.2%)	7 (4.5–12)
Yes	132	53.6 (12.8)	14 (14–15)	2 (2–2)	3 (2–4)	37 (28.0%)	6 (7–9.5)
P-value		0.676†	0.860‡	0.750‡	0.289‡	0.069¶	0.603‡
PCOM							
No	272	53.0 (12.9)	14 (13–15)	2 (2–2)	3 (2–4)	63 (23.2%)	7 (5–10)
Yes	32	55.2 (13.7)	14 (13–15)	2 (1–2.75)	2 (2–4)	7 (21.9%)	10 (7–12)
P-value		0.383†	0.714‡	0.974‡	0.865‡	>0.999¥	0.183‡
ACA							
No	281	53.6 (12.9)	14 (13–15)	2 (2–2)	3 (2–4)	67 (23.8%)	7 (6–10)
Yes	23	49.0 (13.6)	14 (14–15)	2 (1–2)	2 (2–3)	3 (13.0%)	4 (4–7)
P-value		0.106†	0.721‡	0.503‡	0.049‡	0.355¥	0.102‡
AchA							
No	298	53.3 (13.1)	14 (13–15)	2 (2–2)	3 (2–4)	70 (23.5%)	7 (5.75–10)
Yes	6	53.2 (5.0)	14,5 (13.75–15)	2 (1.75–2)	2 (2–3.25)	0 (0.0%)	N/A
P-value		0.986†	0.494‡	0.612‡	0.406‡	0.342§	N/A
ICA							
No	298	53.3 (12.9)	14 (13–15)	2 (2–2)	3 (2–4)	69 (23.2%)	7 (5.5–10)
Yes	6	52.2 (16.9)	14 (9–15)	2 (0.75–4)	2 (1.5–4)	1 (16.7%)	N/A
P-value		0.836†	0.491‡	0.905‡	0.409‡	>0.999§	0.886‡

† Student's t-test, ‡ Mann–Whitney U test, ¶ Pearson's χ2 test, ¥ Continuity corrected χ2 test, § Fisher's exact probability test, N/A: Not applicable, ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, ACOM: Anterior communicating Artery, GCS: Glasgow coma scale, ICA: Internal carotid artery, MCA: Middle cerebral artery, PCOM: Posterior communicating artery, SD: standard deviation

Table 7: Demographic and clinical characteristics of patients who underwent surgical clipping for ruptured aneurysms due to subarachnoid hemorrhage with and without multiple aneurysms

	Multiple aneurysms (−) (n=275)	Multiple aneurysms (+) (n=29)	*P*-value
Age (years) mean (SD)	53.5 (13.2)	51.3 (10.7)	0.390†
Gender			>0.999‡
Male n (%)	106 (38.5%)	11 (37.9%)	
Female n (%)	169 (61.5%)	18 (62.1%)	
Hunt–Hess grade (range)	2 (2–2)	2 (1,5–2,5)	0.863¶
Fisher grade (range)	3 (2–4)	2 (2–4)	0.661¶

† Student's t-test, ‡ Continuity corrected χ2 test, ¶ Mann–Whitney U test, SD standard deviation

Finally, the Fisher grades of those that developed vasospasms [median=4, (IQR: 2–4)] were significantly higher than those of the patients who did not [median=2, (IQR: 2–4)] ($P<0.001$). There was no significant correlation between the postoperative day of vasospasm and the Fisher scores of those who developed vasospasm ($r=-0.140$ and $P=0.249$).

Discussion

Aneurysmal SAH is a serious neurological issue with high mortality and morbidity rates. Depending on the patient, their clinical condition, aneurysm location and the clinical experience of the treating physicians, the treatment for this patient group varies. In this study, we analyzed 304 patients who underwent surgical clipping for aneurysmal SAH in our clinic. Approximately 5.6% of the patients were evaluated as having a poor grade of aneurysmal SAH. This rate is low compared to those reported in other studies [5, 6]. This may be explained by the fact that we only included patients that we surgically clipped in this study.

Aneurysmal SAH can occur at any age but is most frequently in the sixth decade of life. Women are more at risk than men [7]. In our study, the mean age and the gender distribution were in line with the literature. In addition, the frequency of anterior circulation aneurysms was high in our study, again in line with the literature [8, 9].

The mean aneurysm size in our study was 5 mm. In a study of 248 poor grade SAH patients evaluated by Patrick et al.

[8], the mean aneurysm size was 8.5 mm. A study of SAH patients under 35 years of age by Chalouhi et al. [10] found that more than half of the patients had an aneurysm size below 7 mm.

As is known, aneurysmal SAHs most commonly arise from anterior circulation aneurysms [7]. In our study, middle cerebral artery and anterior communicating artery aneurysms were the most common cause of SAH, with rates of 43.8% and 43.4%, respectively.

While other studies have reported mortality rates between 0% and 34% following treatment [8, 10], our surgical clipping patients showed total mortality and morbidity rates of 11.2% and 22%, respectively.

The timing of surgical intervention in aneurysmal SAH is a matter of debate. Although there is no consensus on this issue, different centers have different timing preferences. While early surgery has the advantage of preventing rebleeding, late surgery is better suited to combating vasospasms. A large multicenter study reported that the overall outcomes of early surgery were superior to late surgery, but better surgical outcomes were obtained in late surgery [11]. In another study of 32,048 patients (75.2% of whom received intervention within the first 48 hours), early treatment was found to shorten the length of hospital stay and the rate of disability at discharge was lower [4, 12]. The rate of rebleeding is nearly 40% in cases that do not receive early surgery [9, 13]. We performed surgical intervention within the first 48 hours in 50 (16.5%) of this patient group. Although we favor late intervention at our institute, patients with conditions such as acute hydrocephalus, intracerebral hematoma and diffuse cerebral edema are treated earlier. Our rebleeding rate was 1.6% in the group that underwent intervention after 48 hours. The reason this rate was low compared to the literature may be that only patients who underwent surgical clipping were examined in our study and patients who died without intervention but without rebleeding were not included. The mean time of intervention for all patients in our study was the eighth day of hospitalization. In those who suffered from vasospasm, the mean time of surgery was the seventh day of hospitalization. This is consistent with the literature.

In our study, 41.4% of the patients we examined had an admission GCS score of 15, 59.5% had a Hunt–Hess grade of 2, and 43.4% had a Fisher grade of 2. Morbidity and mortality were significantly higher in patients with low GCS scores and high Hunt–Hess grade and Fisher grades on admission. These rates may explain the lower mortality and morbidity rates seen in our study, compared to the literature, as the majority of aneurysmal SAH patients treated in our clinic were not poor grade.

The high number of patients we treat in our clinic, the fact that all patients are treated and followed up by the same surgical team and the fact that our data covers a period of ten years were strengths of our study.

Limitations

A limitation of our study was that, although endovascular aneurysm treatment has been possible in our center for the last few years, referrals for endovascular treatment cannot be made quickly due to the location of our clinic; therefore we could not compare surgical clipping and endovascular treatment due to the insufficient number of patients who have received endovascular treatment. Another limitation was that complications such as vasospasm and rebleeding, total mortality rates and the relationship between mortality and functional outcome were not included in our study. However, we hope to include these in future research.

Conclusion

Aneurysmal SAH is an important neurological condition. The need for sufficient expertise and experience in the medical personnel involved in treatment and follow-up is indisputable. The development and improvement of endovascular interventions in recent years has led to increased research into the outcomes of surgical clipping and endovascular treatment of aneurysmal SAH. Our study presented the outcomes of patients treated in our clinic with surgical clipping and, based on our findings, we argue that surgical clipping is still a safe and valid treatment method.

References

1. de Rooij NK, Linn FH, van der Plas JA, Algra A, Rinkel GJ. Incidence of subarachnoid haemorrhage: a systematic review with emphasis on region, age, gender and time trends. J Neurol Neurosurg Psychiatry. 2007;78:1365-72.
2. van Gijn J, Kerr RS, Rinkel GJ. Subarachnoid haemorrhage. Lancet 2007;369:306-18.
3. Sandvei MS, Mathiesen EB, Vatten LJ, Müller TB, Lindekleiv H, Ingebrigtsen T, et al. Incidence and mortality of aneurysmal subarachnoid hemorrhage in two Norwegian cohorts, 1984-2007. Neurology. 2011;77:1833-9.
4. D'souza, S. Aneurysmal subarachnoid hemorrhage. Journal of neurosurgical anesthesiology. 2015;27.3:222.
5. Molyneux A. International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group: International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 with ruptured intracranial aneurysms: a randomized trial. Lancet. 2002;360:1267-74.
6. Wang H-Y, Song J, Gao F, Duan XD, Gao X, Wang Y, et al. Outcomes of microsurgical clipping vs coil embolization for ruptured aneurysmal subarachnoid hemorrhage: a multicenter real-world analysis of 583 patients in China. Medicine. 2019;98.33.
7. Colby GP, Coon AL, Tamargo RJ. Surgical management of aneurysmal subarachnoid hemorrhage. Neurosurg Clin N Am. 2010;21:247-61.
8. Schuss P, Hadjiathanasiou A, Borger V, Wispel C, Vatter H, Güresir E. Poor-grade aneurysmal subarachnoid hemorrhage: factors influencing functional outcome—a single-center series. World Neurosurg. 2016;85:125-9.
9. Nouh CD, Samkutty DG, Chandrashekhar S, Santucci JA, Ford L, Xu C, et al. Management of aneurysmal subarachnoid hemorrhage: variation in clinical practice and unmet need for follow-up among survivors–a single-center perspective. World Neurosurg. 2020;139:e608-e617.
10. Chalouhi N, Teufack S, Chandela S, Dalyai R, Tjoumakaris S, Hasan DM, et al. Aneurysmal subarachnoid hemorrhage in patients under 35-years-old: a single-center experience. Clin Neurol Neurosurg. 2013;115:665-8.
11. Kassell NF, Torner JC, Jane JA, Haley EC, Adams HP. The International cooperative study on the timing of aneurysm surgery: Part 2: surgical results. J Neurosurg. 1990;73:37-47.
12. Siddiq F, Chaudhry SA, Tummala RP, Suri MFK, Qureshi AI. Factors and outcomes associated with early and delayed aneurysm treatment in subarachnoid hemorrhage patients in the United States. Neurosurgery. 2012;71:670-8.
13. Hijdra A, Vermeulen M, van Gijn J, van Crevel H. Rerupture of intracranial aneurysms: a clinicoanatomic study. J Neurosurg. 1987;67:29-33.

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