Evaluation of the Prognostic Indicators of Giant Intracranial Aneurysms

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ABSTRACT

The indicators of poor outcome in giant intracranial aneurysms have been the subject of several studies in the literature. We conducted a retrospective analysis to evaluate the predictors of poor outcome in giant intracranial aneurysms. We studied consecutive cases with aneurysms admitted over a 9-year period in our institution. All the aneurysms were treated with clipping. Patient demographics, clinical profile, and aneurysm characteristics were evaluated in a multivariate analysis as probable indicators of Glasgow Outcome Scale (GOS) score. The outcome of the aneurysms (GOS score) was compared with the remaining non-giant aneurysms. A total of 41 giant and 348 non-giant aneurysms were identified in our series. In the multivariate analysis, the indicators of poor outcome were identified as poor clinical grade ($p < 0.0004$), intraoperative rupture ($p < 0.007$), and posterior circulation of the aneurysms ($p < 0.01$). Non-giant aneurysms had a better outcome compared with the giant aneurysms ($p < 0.01$). Giant aneurysms impose a relatively higher risk of morbidity and mortality to the patients. The predictors of the postsurgical outcome of the giant aneurysms include the clinical condition of the patient, location of the aneurysm, and intraoperative rupture.

KEYWORDS: Aneurysms, intracranial, giant, prognosis, clipping

Many studies have investigated the morbidity and mortality associated with the surgical clipping of intracranial aneurysms with the application of micro-neurosurgical techniques.^{1–3} The effect of different variables on the surgical outcome of such patients has also been evaluated. The proposed unfavorable factors include increasing age, lower Glasgow coma score (GCS), higher Hunt and Hess (H&H) grade,⁴ presence of intracerebral or intraventricular hemorrhage, preexisting medical conditions, aneurysm, location and size, preoperative rebleeding, and vasospasm^{2,3,5} or presence of motor deficit.⁶

Giant unruptured intracranial aneurysms can have high mortality and morbidity because of mass effect, ischemia, or subarachnoid hemorrhage (SAH). According to the International Study of Unruptured Intracranial Aneurysms study, the risk of the rupture of these aneurysms is as high as 50% in 5 years.⁷ Treatment of giant aneurysms might be challenge because of size, wide neck, thrombosis, and calcification.⁸ Additionally, obliteration of such aneurysms might need temporary clipping^{9–11} or permanent occlusion of the proximal vessel.^{12,13} So the risk of ischemic complications of the giant aneurysms are higher than the smaller

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lesions and even more so in the acute phase following SAH due to the disturbance of the cerebrovascular autoregulation.^{14–16}

We conducted a study on the giant aneurysms that were operated on at our institution. The possible contributors of the outcome were evaluated in a logistic regression model. We also compared the outcome of surgical obliteration of the giant (>25 mm) with that of smaller (<25 mm) aneurysms.

MATERIALS AND METHODS

We performed a retrospective analysis of consecutive aneurysms admitted over 9-year period in our institution from 1996 to 2005. Institutional Review Board approval was obtained. Patient demographics, clinical profile, aneurysm characteristics and outcome, and Glasgow Outcome Scale (GOS) score were collected from database. All the variables were coded and entered into a univariate as well as a multivariate analysis using SAS software. A total of 41 giant aneurysms (more than 25 mm) were identified in our series. Because endovascular service was not available during the most of the study time, all cases underwent microsurgical management. The outcome of these aneurysms (GOS score) was compared with the remaining non-giant aneurysms using Student *t* test. A total of 348 non-giant aneurysms were also included, for comparison, in the study. All the aneurysms were obliterated by clipping.

RESULTS

The mean age of the patients was 52 ± 13 years old (range 24 to 75 years). Most of the patients were female (three times more than the males). Seventy-eight percent of the patients had carotid circulation aneurysms; in 22%, the posterior circulation was involved; and multiple aneurysms were observed in 27% of the patients. The majority of the giant aneurysms were observed in the ophthalmic artery (29.3%) and middle cerebral artery (MCA; 24.4%; Table 1). All of our cases had skull base approaches to provide better exposure and control for the giant and basal aneurysms. Bypass was done in one patient, so the analysis of the effect of bypass on the outcome was not possible.

Good clinical grade (H&H grade 1 and 2) was observed in 80.6% of the patients, and poor grade (H&H score of 3 and 4) was identified in 19.4% of the patients. GCS was 15 in 68%. Atypical presentations were as follow: three patients presented with cerebrovascular accident, one with visual impairment (detected during medical checkup for a driver's license), two with neck pain (patients received chiropractic treatment initially), one with spinal meningitis (patient received treatment), and four with warning leaks. Temporary control of the parent vessel was obtained electively in 68.3% of the

Table 1 Distribution of Giant Aneurysms in Different Vascular Locations

Location	Number	Percentage
Posterior communicating artery	3	7.3
Ophthalmic artery	12	29.3
Internal carotid artery	3	7.3
Anterior cerebral artery	2	4.9
Middle cerebral artery	10	24.4
Basilar artery	7	17
Posterior inferior cerebellar artery	3	7.3
Vertebrobasilar junction	1	2.4
Total	41	

aneurysms, and intraoperative rupture (IOR) occurred in 11 patients (26.8%): four ophthalmic, two each MCA and basilar, two internal cerebral artery, and one posterior inferior cerebellar artery (PICA). Without IOR, 65.5% patients had a good outcome, whereas with an IOR, good outcome was reduced to 18.2%, with mortality of 6.9% and 9.1%, respectively.

Intraoperative angiography was positive in 17% (seven patients: three basilar, two ophthalmic, one MCA, and one PICA). Good outcome or minimal disability was achieved in 84% of giant anterior circulation aneurysms, whereas with a posterior circulation giant aneurysm, this result was seen in 55.6% cases (Figs. 1, 2). Similarly, mortality was 11.1% in posterior circulation aneurysms and 6.4% in anterior circulation aneurysms. A GOS score of good or fair (GOS score of 1 or 2) was detected in 31 patients (75.6%), 5 patients were identified as GOS 3 (12.2%), and 3 patients died (GOS 5 in 7.3%).

The result of the univariate analysis showed the association between the H&H grade and GOS ($p < 0.001$; Fig. 3), GCS and GOS ($p < 0.001$), H&H grade and age ($p < 0.04$). In the multivariate analysis (logistic regression), the indicators of poor outcome were identified as poor clinical grade ($p < 0.0004$), IOR ($p < 0.007$), and posterior circulation of the aneurysms ($p < 0.01$; Figs. 4, 5, 6). Non-giant aneurysms had a better outcome (GOS score = 1.504) compared with the giant aneurysms (GOS score = 1.87; *t* test $p < 0.01$).

DISCUSSION

Hauck et al studied the indicators of poor outcome in a multivariate analysis on 62 patients with unruptured anterior circulation aneurysms larger than 20 mm who underwent surgery. The predictors included age of 50 years or older, the presence of a preoperative disability, presentation with a transient ischemic attack, aneurysm size ≥ 25 mm, and occurrence of either an ischemic or hemorrhagic stroke.¹⁷ In Orz et al's study on 310 patients with unruptured aneurysms, aneurysm size

Figure 1 Bar chart depicting the distribution of Glasgow Outcome Scale score of the patients with giant aneurysms in anteriorly located lesions.

Figure 2 Bar chart depicting the distribution of Glasgow Outcome Scale score of the patients with giant aneurysms in posteriorly located lesions.

Figure 3 Bar chart depicting the distribution of Glasgow Outcome Scale (GOS) score of the patients with giant aneurysms in different groups of Hunt and Hess score, which is an indicator of patient's clinical condition.

larger than 15 mm, presence of single aneurysm, and posterior location of the aneurysm were identified as the contributors of poor outcome.¹⁸

Our previous retrospective study on 297 intracranial aneurysms that evaluated outcome by GOS score demonstrated that significant indicators of poor outcome were hypertension, increasing age, worsened clinical grade, posterior aneurysm location, and large aneurysm size.¹⁹ Raaymakers et al evaluated the ruptured and unruptured aneurysms as separate groups. For ruptured aneurysms, younger age, lower H&H grade, and lower maximum intraoperative systolic blood pressure were associated with better GOS score. For unruptured aneurysms, no preoperative or intraoperative factor discussed above significantly predicted the outcome in multivariate analysis.²⁰ However, in Ogilvy and Carter's study on unruptured aneurysms (434 aneurysm operations), patient age, size of aneurysm, severity of SAH (Fisher Scale evaluation on the computed tomography, and H&H grade) were associated with long-term outcome. In addition, there was a trend for increased risk with larger (>25 mm) posterior circulation lesions.²¹ In another study (493 patients treated with clipping of 604 unruptured aneurysms), the same authors demonstrated that aneurysm size, patient age, and vertebrobasilar location were significant predictors of poor outcome or death.²²

Piepgas et al studied 109 patients, with direct surgery on 84% of patients. A favorable outcome was achieved in 72% of the surgically treated patients with ruptured anterior circulation. No regression analysis was done. The mortality rate directly due to SAH among all the patients was 8.3%, and it was 8.6% due to surgical

complications. Fifty-six percent of these deaths were attributed to ischemic complications of surgical treatment, and the rest were due to the complicated ischemia including delayed ischemia of vasospasm.¹⁵

In Khanna et al's study, multivariate logistic analysis of several risk factors in 172 patients with unruptured intracranial aneurysms showed that aneurysm size and location were independent predictors of surgical outcome. Ischemic cerebrovascular disease did not have a higher risk of poor outcome.²³ Also for ruptured aneurysms, size is an independent predictor of outcome.²⁴ The indicators of poor outcome or death in 24 cases of vertebrobasilar junction and basilar trunk aneurysms included aneurysm location at the basilar trunk, large aneurysm size, fusiform aneurysm type, and severe SAH.²⁵

Giant Aneurysms

Almost 3 to 13% of intracranial aneurysms are giant aneurysms, and the average incidence is 5% in various studies.²⁶⁻²⁸ Giant aneurysms have been reported by several authors to have higher risk of poor outcome than small aneurysms, even in the hands of the most experienced surgeons.¹¹ This also includes the unruptured aneurysms.²³ Giant aneurysms usually bear morbid complications due to hemorrhage, neural compression, and thromboembolic episodes. The consequences of aneurysm growing to giant size include widening of the neck and incorporation of the efferent arteries. The lumen usually contains a thrombus, and calcification may appear in the lumen. The constellation of these features might preclude simple clipping.^{29,30}

Figure 4 Bar chart depicting the distribution of Glasgow Outcome Scale score of the patients with giant aneurysms with intraoperative rupture of the aneurysm.

Figure 5 Bar chart depicting the distribution of Glasgow Outcome Scale score of the patients with giant aneurysms without intraoperative rupture of the aneurysm.

Figure 6 Regression model of Glasgow Coma Scale (GCS) versus Glasgow Outcome Scale (GOS) score of the patients with giant aneurysms.

Hosobuchi³¹ found that 30 to 80% of patients with giant aneurysm present with SAH. Unruptured giant aneurysms have a higher possibility of rupture and thrombosis than the small aneurysms.^{9,32} The probability of attaining a favorable outcome for ruptured giant aneurysms ranges from 30 to 85%.^{33,34} In Solomon et al's study, the morbidity and mortality of unruptured aneurysms were 0% for aneurysms less than or equal to 10 mm in size, 6% for aneurysms between 10 and 25 mm, and increase to 20% for aneurysms greater than 25 mm.³⁰

The majority of the giant aneurysms are seen in the ophthalmic artery (29.3%) and MCA (24.4%). Non-giant aneurysms demonstrated a better outcome compared with the giants ($p < 0.01$).²¹ Sundt et al³⁵ reviewed their operative results in 178 cases of unruptured aneurysms, 83 of which were > 15 mm. The complication rate in patients harboring large or giant aneurysms was reported to be 19%.

Treatment Modalities

Because of the aforementioned poor natural history of giant aneurysms, treatment is generally considered. Three therapeutic options are available: endovascular parent-vessel occlusion,^{36,37} direct surgical clipping,³⁸ and endosaccular packing with detachable coils.^{39,40}

Initial complete occlusion of giant aneurysms by coiling often cannot be done. Additionally, most of these aneurysms partially reopen due to coil compaction, thrombus resolution, impossibility of obtaining dense packing of giant aneurysms with coils, or coil migration into the intraluminal thrombus. In Sluzewski et al's study, 79% of the patients achieved a good clinical outcome at a median follow-up of 50 months. However, initial coil stability and aneurysm occlusion over time were poor. Even repeat coiling failed to occlude 40% (12 of 29) of the aneurysms.⁴¹

Clip reconstruction of the giant aneurysm might narrow or occlude the parent artery due to the thickened

aneurysm wall, aneurysm calcification, or clot. Intra-operative angiograph may assist in detecting these complications.^{7,42} Another option would be opening of the aneurysm and direct inspection to make sure that the parent vessel is patent. It can also be used for thrombectomy and lesion decompression; however, in Hauck et al's series, the results were not significantly better than simple clipping.¹⁷ Size of aneurysm has been shown to have a significant effect on the outcome following clipping but not after endovascular treatment.⁴³

Poor Neurological Grade

The clinical condition of a patient has been proven to be associated with the ultimate outcome.^{1,21,44,45} According to Hauck et al's study, the chance of poor outcome for giant aneurysms in patients older than 50 years exceeded 30% and 45% for anterior and posterior circulation aneurysms, respectively. They also mentioned that these age ranges typically present with a baseline disability and more comorbidities ($p < 0.05$) associated with dependence than the younger age group.¹⁷ Our results also showed that poor neurological grade had significant association with outcome following surgical obliteration of giant aneurysms. The result of the uni- and multi-variate analysis showed the association between the H&H grade and GOS ($p < 0.001$).

Aneurysm Location

According to Ogilvy and Carter's study, good outcome and minor disability have been reported to be 84% in anterior circulation aneurysms, compared with 56% in posterior circulation giant aneurysm. Likewise, the mortality rate was 11.1% in posterior and 6.4% in anterior circulation aneurysms. Posterior location of the aneurysms has been identified as an indicator of poor outcome. There was a trend for increased risk with giant posterior circulation lesions.²¹ Rice et al⁴⁶ reported a 4.2% morbidity and mortality rate associated with the surgical treatment of non-giant posterior circulation aneurysms. Solomon et al³⁰ observed 50% and 13% morbidity and mortality rates with surgical treatment of unruptured giant basilar and anterior circulation aneurysms, respectively.

Khanna et al mentioned that regardless of the size of the aneurysms, the posterior location is an independent predictor of poor outcome. The risk of poor outcome was 10-fold higher in posterior circulation aneurysms compared with anterior aneurysms. The poor outcome in basilar aneurysms might be due to the intimate association with perforating vessels, a surgically challenging location, and the loss of any proximal control.²³

IOR of aneurysms and vertebrobasilar aneurysms complicated the process of clipping and the postoperative result. The problem of operative dissection leading

to IOR in giant aneurysms is a poor prognostic indicator. Patients with very large or giant intracranial aneurysms need a multidisciplinary approach depending on many factors such as the clinical condition, the characteristics of the aneurysm, and the local expertise.⁴¹ Posterior circulation aneurysms require a multidisciplinary approach; participation of a neurosurgeon, an endovascular surgeon, and a neurocritical care specialist is mandatory. Although endovascular approaches are gaining popularity, in a variety of situations, surgical clipping provides the best outcome. Some of those instances are superior cerebellar artery, distal anterior inferior, and posterior inferior cerebellar artery aneurysms, as well as when endovascular therapy is unfavorable. In cases like giant basilar bifurcation aneurysms, the best treatment modality is still unclear.⁴⁷

In conclusion, the size of the aneurysm is a strong indicator of outcome (GOS score) following surgery. Giant aneurysms impose a relatively higher risk of morbidity and mortality to the patients. Endovascular clipping of these aneurysms might be complicated due to a variety of factors like coil migration, parent vessel occlusion after clipping, and the need for thrombectomy and atherectomy. Predictors of postsurgical outcome of the giant aneurysms include the clinical condition of the patient, location of the aneurysm, and IOR. Large prospective studies are necessary to compare the results of endovascular treatment versus clipping of giant aneurysms in high-risk groups, such as patients with poor clinical condition, the elderly, and posteriorly located aneurysms.

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