Outcome of Microsurgical Clipping of Ruptured Intracranial Aneurysms at a University Hospital in Saudi Arabia

Saleh S Baeesa, MBChB, FRCSC

Division of Neurosurgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
sbaeesa@kau.edu.sa

Abstract: Objective: To describe treatment outcome in patients who had undergone microsurgery for clipping of cerebral aneurysm. **Methods:** A retrospective chart review of the clinical, radiological and operative records of patients who had undergone surgery for ruptured intracranial aneurysms (IAs) between January 2001 and December 2012 at King Abdulaziz University Hospital, Jeddah. The patient's demographic a clinical data, including their neurological status and graded according to the World Federation of Neurological Surgeons (WFNS), cerebral imaging findings, and surgical notes were reviewed. Outcome was assessed according the Glasgow outcome score (GOS). Fisher's exact and chi-square tests were performed to determine the association between GOS and the study variables. **Results:** Thirty-three patients were included; with a mean (SD) age of the patients was 43.5 (12.0) years (range, 17-65 years). Females constituted 63.6% of the sample. The average aneurysm size was 11.5 (5.2) mm, and they were, in most cases, located in the anterior communicating artery. Most patients (n=13; 39.4%) had a clinical grade of 1; only one patient (3.0%) had a clinical grade of 4. Approximately 60% of the patients showed evidence of SAH on CT scan; in about one third of the cases, the findings were normal. Twenty-eight patients (84.8%) had a good GOS. Good GOS were more likely in patients without postoperative vasospasm (P=0.04), hydrocephalus (P =0.021), and in patients with aneurysms < 10 mm in diameter (P =0.044). **Conclusion:** Patients who undergo surgery for clipping of IAs have a good outcome. Aneurysm size, and the presence of preoperative brain edema, hydrocephalus, and postoperative vasospasm were found to significantly affect the outcome in our patients.
[Saleh S Baeesa. **Outcome of Microsurgical Clipping of Ruptured Intracranial Aneurysms at a University Hospital in Saudi Arabia.** *Life Sci J* 2014;11(6):598-603]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 92

Key Words: Subarachnoid hemorrhage; Cerebral aneurysms, Clinical grading; Surgical clipping; Glasgow outcome score; Saudi Arabia

1. Introduction

Intracranial aneurysms (IAs) are relatively common, occurring in approximately 2% of the general population; however, the risk of subarachnoid hemorrhage (SAH) caused by a ruptured aneurysm is relatively low [1]. As a result, the risks associated with either surgical or endovascular treatment must be even lower for treatment to be justified.

As more cases of incidental unruptured IAs are being diagnosed owing to better diagnostic methods, it is critical to understand the evolving treatment paradigms for intracranial aneurysms. Recent data show that for ruptured IAs that can be managed by surgery or minimally invasive techniques, major treatment strategies mainly favor endovascular coiling over surgical clipping [2-5]. Although the findings of these studies cannot be readily extrapolated to patients with unruptured IAs, and no prospective, randomized trial has been performed for cases of unruptured IAs, several studies show that an increasing proportion of interventional radiologist or neurosurgeons perform endovascular coiling for patients with unruptured IAs [6-9]. In most of these studies, the authors demonstrated that the outcome was better in patients who had undergone endovascular versus surgical treatment. However, the overall outcome for unruptured IAs treatment was unchanged [9]. Besides the treatment, the following influences outcomes: patient factors, such as previous aneurysmal SAH, age, and coexisting medical conditions; aneurysm size, location, and morphology; and factors in management, such as the experience of the surgical team and the treating hospital [10].

In Saudi Arabia, few isolated studies [11-15], mainly case reports, describe the success of endovascular [11] and surgical treatment [12-15]. The author conducted this study on patients who had undergone surgery for ruptured IAs at King Abdulaziz University Hospital to describe treatment outcome.

2. Materials and Methods

The medical records of all patients with ruptured IAs who were treated at King Abdulaziz University Hospital (KAUH) between January 2001 and December 2012 were reviewed. Patients were included provided they had undergone microsurgical treatment for IAs. Patients were excluded in this study that had, unruptured IAs, endovascular treatment, infectious or traumatic IAs, or those who are transferred to another hospital or untreated.

The Biomedical Ethics Research Committee of King Abdulaziz University approved the study.

Ninety-six cases of cerebral aneurysm were identified. Of these, sixty-three patients were excluded: 53 patients, with mostly unruptured IAs, had endovascular treatment at KAUH or at another center, four declined to have any form of treatment, and six patients who presented with SAH were not candidates for intervention due to their poor health and neurological status.

The following data were collected for all patients included in the study: age, gender, clinical presentation and grade of SAH, as well as computed tomography (CT) findings of SAH and hydrocephalus. Each patient's neurological condition was graded according to the World Federation of Neurological Surgeons (WFNS) grading system [Table 1]. Aneurysm location, size, and a presence of vasospasm were identified based on cerebral angiogram findings. We retrieved intraoperative data for surgeries that were precluded by brain edema, ruptured aneurysm, and temporal clip application. Postoperative vasospasm was identified clinically and confirmed with imaging studies like CT and computed tomography angiography (CTA) scans and/or digital subtraction angiography (DSA). We also recorded postoperative outcome according to the Glasgow Outcome Score (GOS) [Table 2].

All cases of SAH were admitted to the Intensive Care Unit (ICU) for hemodynamic and electrolyte support and general clinical and neurological evaluation. Physicians performed initial investigations, including a complete blood count, electrolytes, renal and coagulation profiles, chest radiography, and an electrocardiogram. All patients had plain CT and CT angiography scans to demonstrate the presence of SAH and other types of hematoma, hydrocephalus, or ischemia, in addition, four-vessel DSA.

Preoperative external ventricular drains (EVD) were inserted at the ICU for patients with hydrocephalus, particularly those with WFNS grades 3 and 4. These patients were managed by mechanical ventilation until their neurological conditions improved. Oral nimodipine (60 mg was administered every six hours) for patients admitted with SAH within 72 hours onset.

Surgical intervention was considered for patients with WFNS grades 1 to 3 who were admitted within 48 hours [figure 1]. Patients with WFNS grades 4 and 5 underwent surgery if SAH was associated with other conditions that required surgical intervention, including intracerebral hemorrhage, or their symptoms improved after the placement of EVD. Surgery was delayed if the patient had WFNS grade 4 or 5 on admission, vasospasm, and/or was referred to our hospital more than three days after SAH.

Postoperative ICU care, including mechanical ventilation, was provided for all patients. Patients with preoperative WFNS grades 0-3 were weaned off ventilator after 24 hours, while unconscious patients were maintained on mechanical ventilation until their neurological conditions improved. Postoperative triple H therapy (hydration, hemodilution, and induced hypertension) was continued for three to seven days. Nimodipine was given for at least 10 days postoperatively.

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL), version 17. Descriptive statistics were calculated for all study variables. Fisher's exact and chi-square tests were performed to determine the association between GOS and the study variables. Statistical significance was set at $P < 0.05$. All results are expressed as frequency (percent) and mean (standard deviation [SD]).

3. Results

Thirty-three patients were included in this study with a mean (SD) age of the patients was 43.5 (12.0) years (range, 17-65 years). Females constituted over half of the sample [Table 3]. Of these, two (9.5%) were pregnant. All cases of SAH that were referred to our institution were received within eight hours to six days (mean, 2.4 days) from the onset of symptoms.

The average aneurysm size was 11.5 (5.2) mm, and they were, in most cases (39.4%), located in the anterior communicating artery. The proportion was highest for patients with a clinical grade of 1; the least cases were those with a clinical grade of 4. Approximately 60% of the patients showed evidence of SAH on CT scan; in about one third of the cases, the findings were normal. Regarding the GOS, a high proportion of the patients had a good score.

Temporary clipping was performed in about 21.2% of the patients (n=7). Intraoperative rupture was documented in only seven cases (21.2%). Similar proportions of patients had edema (n=9; 27.3%) or hydrocephalus (n=10; 30.3), and approximately 36.4% of the patients had postoperative vasospasm (n=12).

Patients without postoperative vasospasm or edema were more likely to have a good GOS (P = 0.04 and 0.013, respectively) [Table 4]. Similarly, patients with aneurysms <10 mm in diameter and those without hydrocephalus were more likely to have a good GOS. Glasgow outcome scores were good in patients < 50 years, females, patients without intraoperative rupture, those who had temporary proximal clipping, non-pregnant women, and patients who had evidence of SAH on CT scan; however, the results did not reach statistical significance [Table 4].

Table 1. World Federation of Neurological Surgeons Grading Scale

Grade	Clinical Characteristics
1	Glasgow coma score 15, no motor deficit
2	Glasgow coma score 13 to 14, no motor deficit
3	Glasgow coma score 13 to 14, with motor deficit
4	Glasgow coma score 7-12, with or without motor deficit
5	Glasgow coma score 3-6, with or without motor deficit

Table 2. The Glasgow Outcome Scale

Level	Term	Definition
1	Dead	No life
2	Vegetative state	Unaware of self and environ
3	Severe disability	Unable to live independently
4	Moderate disability	Able to live independently
5	Mild disability	Able to return to work/school

Table 3. Demographic and Clinical characteristics of the patients

Variables	Frequency (percent)
Sex	
Male	12 (36.4)
Female	21 (63.6)
Age Group	
10-20	2 (6.1)
20-30	3 (9.1)
30-40	8 (24.2)
40-50	11 (33.3)
>50	9 (27.3)
Aneurysm Location	
ACA	13 (39.4)
Left ICAB	3 (9.1)
Left MCA	2 (6.1)
Right ICAB	2 (6.1)
Right MCA	6 (18.2)
Right PCA	6 (18.2)
Right PICA	1 (3.0)
Aneurysm Size	
<5mm	2 (6.1)
5-10mm	14 (42.4)
10-15mm	12 (36.4)
15-20mm	3 (9.1)
>20mm	2 (6.1)
Clinical Grade	
0	6 (18.2)
1	13 (39.4)
2	4 (12.1)
3	9 (27.3)
4	1 (3.0)
Computed Tomography Findings	
Normal	10 (30.3)
SAH	20 (60.6)
SAH-ICH	3 (9.1)
Glasgow Outcome Score	
Good	28 (84.8)
Poor	5 (15.2)

Abbreviations: ACA, anterior communicating artery; ICA, internal carotid artery; ICH, intracerebral hematoma; MCA, middle cerebral artery; PCA, posterior communicating artery; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage.

Table 4. Relationship between Glasgow Outcome Score and the variables

Variable	Glasgow outcome score		*P*-value
	Good	Poor	
Age Group			
<50 years	21	3	0.6
>50 years	7	2	
Sex			
Male	11	1	0.6
Female	17	4	
Vasospasm			
Yes	8	4	0.04
No	20	1	
Intraoperative rupture			
Yes	4	3	0.052
No	24	2	
Temporary clipping			
Yes	4	3	0.052
No	24	2	
Edema			
Yes	5	4	0.013
No	23	1	
Hydrocephalus			
Yes	6	4	
No	22	1	0.021
Pregnancy			
Yes	2	0	0.471
No	15	4	
Aneurysm size			
<10mm	16	0	0.044
>10mm	12	5	
Computed Tomography Findings			
Normal	10	0	
SAH	16	4	0.232
SAH-ICH	2	1	

Abbreviations: ICH, intracerebral hematoma; SAH, subarachnoid hemorrhage.

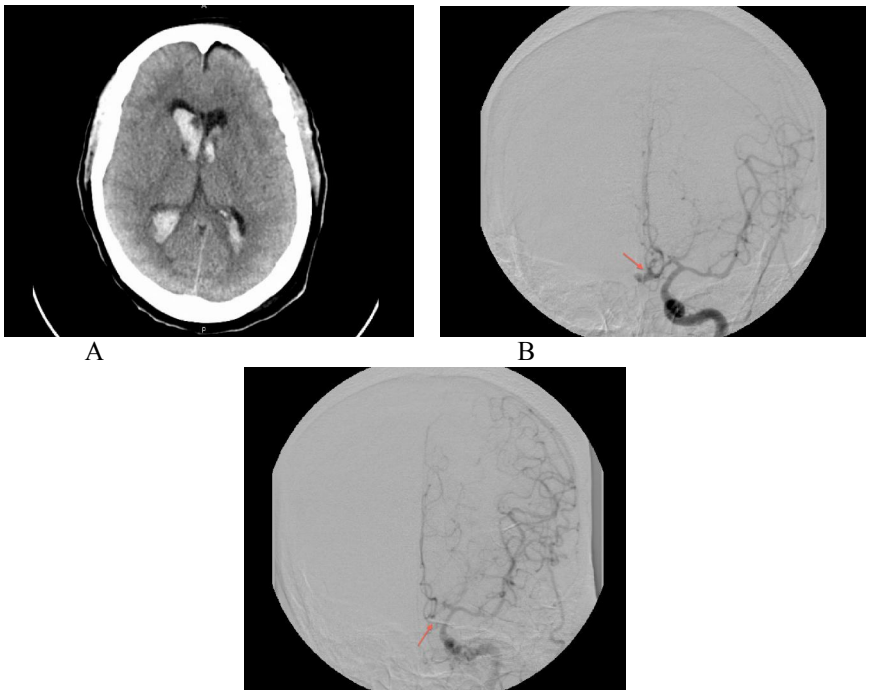

Figure 1: Case illustration: a 64-year-old female with clinical WFNS grade of 3 presented with headache and decreased level of consciousness. Axial plain CT scan of the brain **(1A)** demonstrated SAH and intraventricular extension with hydrocephalus. DSA **(1B)** of the left carotid artery demonstrated an anterior communicating artery aneurysm (arrow). The patient underwent craniotomy and microsurgical clipping of the aneurysm with complete resolution of the aneurysm (arrow) in postoperative DSA study **(1C)**

4. Discussion

Most studies of outcome after surgery for unruptured IAs involve case series [16-18], and there is practically no uniformity regarding the definition of good versus poor outcomes, making it difficult to compare outcome measures across studies. In the current study, treatment outcome was assessed using the GOS, which has been used in other reports [6,17,18] that assessed outcomes in patients who had undergone surgery for cerebral aneurysm. Our analysis shows that surgical outcome was good in patients if they had no evidence of preoperative brain edema, hydrocephalus, and postoperative vasospasm, and if the aneurysm size was < 10 mm.

Although difficult to assess with certainty without a previous arteriography, the occurrence of angiographic vasospasm within 48 hours of aneurysm rupture has been correlated with a higher risk for later symptomatic vasospasm and a poor outcome [19]. Treatment options for cerebral arterial vasospasm that have been proved by many studies to reverse vasospasm include intra-arterial papaverine administration and percutaneous transluminal balloon angioplasty [20], which were unfortunately not offered in our cases. For all cases admitted to our institution, we administered triple H therapy (hydration, hemodilution, and induced hypertension) and nimodipine postoperatively, which are measures that have been reported to protect the brain from ischemic injuries (calcium channel blockers such as nimodipine) [21, 22] or reverse ischemia (hypervolemia, hemodilution, and hypertension) [18, 22]. Although patients presented to our institution eight hours to six days after the onset of SAH symptoms, surgery was offered to cases with WFNS grades 1 to 3 within 48 hours of admission and delayed in those that had WFNS grade 4 or 5 on admission, vasospasm, and/or was referred to our hospital more than three days after SAH. According to a previous report [23] aneurysmal surgery (within 3-12 days following SAH) in the presence of asymptomatic pre-operative angiographic vasospasm has been associated with a good outcome.

Cerebral edema and hydrocephalus were documented in approximately 27.3% and 30.3% of our patients, respectively. In a previous report [24], only 8.0% and 8.6% of 374 patients with SAH had evidence of global edema and hydrocephalus on admission CT scans, respectively. Similar to our report, patients with edema had poor outcomes, and the authors further stated that CT finding of edema was not merely a secondary effect of extensive SAH or severe hydrocephalus. While their cohort comprised solely of patients who had SAH, we

included only patients who had undergone surgery for IAs, whether there was evidence of SAH or not.

Aneurysm factors that have been reported to contribute to surgical outcome include size, morphology, and specific location [10]. One report [25] that described outcome for surgically treated unruptured IAs found that small aneurysms in the anterior circulation of young patients were associated with a treatment risk of approximately 1%, while treatment in patients ≥ 70 years old who had aneurysms > 10 mm was significantly associated with poor outcomes (approximately 5% in the posterior circulation and 15% in the posterior circulation). In our study, although age was one of the variables that were analyzed, we did not specifically assess the relationship between aneurysm size and outcome based on age groups.

This study is the first cohort study in Saudi Arabia to describe the surgical outcome of ruptured ICs. However, this study has some limitations because of the small sample and its retrospective nature. In addition, it is a single-center study. Hence, further multicenter studies should be performed to study the epidemiology of aneurysmal SAH in Saudi Arabia and treatment outcome.

5. Conclusion

Patients who undergo surgery for IAs at king Abdulaziz university hospital have a good GOS. While factors such as those related to the patient and the experience of the neurosurgeon or treating hospital may be important in determining the outcome, the aneurysm size, and the presence of preoperative brain edema, hydrocephalus, and postoperative vasospasm was found to significantly affect outcome in our patients. Thus, appropriate measures should be taken in identifying patients with IAs who might be at risk of rupture in order to improve their outcomes.

Correspondence:
Saleh S. Baeesa, MBChB, FRCSC
Division of Neurosurgery, Faculty of Medicine, King Abdulaziz University, P.O. Box 80215, Jeddah 21589, Saudi Arabia
Email: sbaeesa@kau.edu.sa

References

1. Wiebers DO, Whisnant JP, Huston J 3rd, Meissner I, Brown RD Jr, Piepgras DG,Forbes GS, Thielen K, Nichols D, O'Fallon WM, Peacock J, Jaeger L, Kassell NF, Kongable-Beckman GL, Torner JC. 2003. International Study of Unruptured Intracranial Aneurysms Investigators. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 12; 362(9378): 103-10.
2. Li H, Pan R, Wang H, Rong X, Yin Z, Milgrom DP, Shi X, Tang Y, Peng Y. 2013. Clipping versus coiling for ruptured intracranial aneurysms: a systematic review and meta-analysis. Stroke. 44 (1): 29-37
3. Molyneux A, Kerr R, Stratton I, Sandercock P, Clarke M, Shrimpton J, Holman R. 2002. International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group. International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. Lancet. 26; 360 (9342): 1267-74.
4. Molyneux AJ, Kerr RS, Birks J, Ramzi N, Yarnold J, Sneade M, Rischmiller J. 2009. ISAT Collaborators. Risk of recurrent subarachnoid haemorrhage, death, or dependence and standardised mortality ratios after clipping or coiling of an intracranial aneurysm in the International Subarachnoid Aneurysm Trial (ISAT): long-term follow-up. Lancet Neurol. 8 (5): 427-33.
5. Molyneux AJ, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, Sandercock P. 2005. International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. Lancet. 3-9; 366 (9488): 809-17.
6. Berman MF, Solomon RA, Mayer SA, Johnston SC, Yung PP. 2003. Impact of hospital-related factors on outcome after treatment of cerebral aneurysms. Stroke. 34 (9): 2200-7.
7. Cowan JA Jr, Dimick JB, Wainess RM, Upchurch GR Jr, Thompson BG. 2003. Outcomes after cerebral aneurysm clip occlusion in the United States: the need for evidence-based hospital referral. J Neurosurg. 99(6): 947-52.
8. Bardach NS, Olson SJ, Elkins JS, Smith WS, Lawton MT, Johnston SC. 2004. Regionalization of treatment for subarachnoid hemorrhage: a cost-utility analysis. Circulation. 11; 109 (18): 2207-12.
9. Andaluz N, Zuccarello M. 2008. Recent trends in the treatment of cerebral aneurysms: analysis of a nationwide inpatient database. J Neurosurg. 108 (6): 1163-9.
10. Bederson JB, Awad IA, Wiebers DO, Piepgras D, Haley EC Jr, Brott T, Hademenos G, Chyatte D,

Rosenwasser R, Caroselli C. 2000. Recommendations for the management of patients with unruptured intracranial aneurysms: A statement for healthcare professionals from the Stroke Council of the American Heart Association. Circulation. 31; 102 (18): 2300-8.
11. Elgamal EA, Murshid WR, Abu-Rahma HM, Samir D. 2004. Aneurysmal subarachnoid hemorrhage in the first year of life: case report and review of the literature. Childs Nerv Syst. 20 (7): 489-93.
12. Orz Y. 2011. Surgical Strategies and outcomes for distal anterior cerebral arteries aneurysms. Asian J Neurosurg. 6 (1): 13-7.
13. Al-Said Y, Al-Rached H, Baeesa S, Kurdi K, Zabani I, Hassan A. 2013. Emergency excision of cardiac myxoma and endovascular coiling of intracranial aneurysm after cerebral infarction. Case Rep Neurol Med. 2013:839270.
14. Alshumrani GA, Al-Qahtani S. 2013. Endovascular embolization of a giant aneurysm in medial posterior choroidal artery with associated arteriovenous malformation. Ann Saudi Med. 33 (3): 307-9.
15. Alnaami I. 2013. Meningioma with Intra-tumoural Haemorrhage Secondary to Ruptured Distal Anterior Cerebral Artery Aneurysm, Case Report. Open Neuroimag J. Oct 18; 7:32-4.
16. Benes V 3RD, Mitchell P, Molyneux AJ, Renowden SA. 2010. Endovascular coiling in 131 patients with low complication rate justifies treating most unruptured intracranial aneurysms. Cent Eur Neurosurg. 71(1): 1-7.
17. Lin TK, Hsieh TC, Tsai HC, Lu YJ, Lin CL, Huang YC. 2013. Factors associated with poor outcome in patients with major intraoperative rupture of intracranial aneurysm. Acta Neurol Taiwan. 22(3): 106-11.
18. Kim YB, Hong CK, Chung J, Joo JY, Huh SK. 2014. Long-term clinical and angiographic outcomes of wrap-clipping strategies for unclippable cerebral aneurysms. Yonsei Med J. 55(2): 401-9.
19. Qureshi AI, Sung GY, Suri MAK, Straw RN, Guterman LR, Hopkins LN. 1999. Prognostic value and determinants of ultra-early angiographic vasospasm after aneurysmal subarachnoid hemorrhage. Neurosurgery. 44:967-974.
20. Findley J.M. Cerebral Vasospasm. In H. Richard Winn (Eds). Youmans Neurological Surgery Fifth Ed. (pp. 1839-1867). Philadelphia, Pennsylvania: Saunders Elsevier; 2004.
21. Greenberg MS. Handbook of Neurosurgery, Sixth Ed. Lakeland, Florida. Thieme Medical Publishers New York, NY; 2006.
22. Stefanescu F, Dima S, Vakilnejad R, Radoi M. 2013. Cerebral Vasospasm – A serious obstacle in a successful aneurysm surgery. Romanian Neurosurgery. 1:57-65.
23. McLaughlin N, Bojanowski MW. 2006. Aneurysmal surgery in the presence of angiographic vasospasm: an outcome assessment. Can J Neurol Sci. 33(2): 181-8.
24. Claassen J, Carhuapoma JR, Kreiter KT, Du EY, Connolly ES, Mayer SA. 2002. Global cerebral edema after subarachnoid hemorrhage: frequency, predictors, and impact on outcome. Stroke. 33(5): 1225-32.
25. Ogilvy CS, Carter BS. 2003. Stratification of outcome for surgically treated unruptured intracranial aneurysms. Neurosurgery. 52(1): 82-7.

5/12/2014