Outcome of microsurgical clipping of ruptured intracranial aneurysms: An early experience

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Abstract

Introduction: Rupture of intracranial aneurysm is a catastrophic event with a mortality rate of 25% to 50%. Despite recent advances in endovascular techniques, microsurgical clipping is the standard modality of treatment due to its relative low cost and feasibility. We prospectively analyzed the cases of microsurgically clipped aneurysms with an aim to evaluate the overall outcome and the pretreatment variables predicting outcomes.

Methods and Materials: This is the prospective study of 15 consecutive microsurgical clippings of ruptured intracranial aneurysms conducted in the Department of Neurosurgery at the College of Medical Sciences Teaching Hospital, Chitwan, Nepal from April 2018 to March 2020. Patients were followed up for at least three months and assessed according to modified Rankin Scale (mRS).

Results: The mean age of patients was 55.47 years with female predominance. The most common location of aneurysms was middle cerebral artery bifurcation (53%). Favorable outcome (mRS score 1 to 3) was achieved in 60% of patients whereas 40% had unfavorable outcome (mRS score 4 to 6). Poor Hunt and Hess at presentation and presence of vasospasm/infarction were associated with poor outcome. Overall mortality rate was 27%. Three patients required VP shunt whereas three patients each had vasospasm/delayed ischemic neurological deficit (DIND) and intraoperative rupture.

Conclusion: Microsurgical clipping of aneurysms is a standard treatment modality with good results despite recent advances in endovascular techniques. Favorable outcomes can be achieved in patients with good Hunt and Hess grade at presentation and without clinical vasospasm/delayed ischemic neurological deficit.

Key words: Aneurysms, Endovascular, Hunt and Hess grade, Microsurgical clipping, Modified Rankin Scale.

Introduction

Aneurysms of the cerebral vasculature are relatively common with prevalence of 0.4% and 3.6% in retrospective and prospective autopsy studies respectively, and 3.7% and 6.0% in retrospective and prospective angiographic studies respectively.[1] About 89% of patients present with features of SAH, 7% present with local mass effect and 4% of aneurysms are detected as an incidental finding.[2] Digital Subtraction Angiography (DSA) is the gold standard imaging for the diagnosis. However, Multidimensional multislice CT Angiogram is gradually replacing conventional angiogram due to its easy availability and accessibility.[3]

Rupture of an aneurysm is associated with high mortality and morbidity. Despite recent advances in diagnostic imaging, endovascular and microsurgical techniques, as well as perioperative intensive care unit management, up to 31% of patients are either severely disabled or dead .[4,5] Among patients surviving the initial hemorrhage treated without surgery, re-bleed is the major cause of morbidity and mortality, the risk is approximately 15–20% within 2 weeks.[2] The goal of early surgery is to reduce this risk. Of those reaching neurosurgical cares, post-subarachnoid hydrocephalus (20%), vasospasm and delayed ischemic neurological deficit (symptomatic in 30%) are other major causes of morbidity and mortality.[6,7] Approximately 66% of those who have successful aneurysm clipping never return to the same quality of life as before the SAH.[8]

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The initial and definitive management of ruptured cerebral aneurysm is evolving because of the improved quality of microsurgery and the development of new endovascular technologies as well as aggressive detection and management of vasospasm and other complications related to SAH itself. The latter being less invasive but an expensive procedure is not feasible for every patient in our set-up. The development of endovascular techniques has offered extraordinary therapeutic opportunities to treat intracranial aneurysms. However, mainly for anterior circulation aneurysms, no clear superiority of these techniques compared with microsurgical clipping has been shown in terms of morbidity, mortality, aneurysm occlusion rate, and long-term protection from recanalization and re-bleeding. In fact, in a subset of patients (aneurysm located in the anterior circulation and <12 mm), microsurgical clipping appeared to be as safe as endovascular treatment and can obtain a very high complete occlusion rate.[9]

We prospectively collected and analyzed the data from 15 consecutive microsurgically clipped aneurysms by the author with an aim to evaluate the overall outcome and the pretreatment variables predicting outcomes.

Methods and Materials

This is the prospective study conducted in the Department of Neurosurgery at College of Medical Sciences Teaching Hospital, Chitwan, Nepal from April 2018 to March 2020 after ethical clearance from the ethical committee (College of Medical Sciences). Patients included in the study were ruptured intracranial aneurysms of both sexes, Age < 70 years and Hunt and Hess grade of I to IV. Whereas, patients more than 70 years of age, Hunt and Hess grade V and patients with coagulopathy were excluded from the study. An informed consent was taken from the patients after explaining the details of the procedure, outcome and risks. Fifteen consecutive microsurgical clippings of ruptured intracranial aneurysms by the author over the period of two years were included in the study.

All the patients with ruptured aneurysms were admitted and treated in the neurosurgical intensive care. Detailed neurological assessment including GCS (Glasgow Coma Scale) score at presentation and grading of the patient according to Hunt and Hess was done. Prophylactic volume expansion therapy and Nimodipine were given to all patients who could tolerate it without pulmonary edema. CT angiography was done to locate the aneurysms and CT scan brain was used to grade the extent of SAH according to Fisher's scale. All patients underwent standard pterional craniotomy with head fixation using the Sugita clamp system. Clipping was done using an operating microscope. Proximal control with use of temporary clips was used if necessary with maximum occlusion time of five minutes at one clipping. Ten patients underwent early clipping (within 72 hours of ictus) whereas five patients underwent delayed clippings after the duration of vasospasm subsided (after tenth post-ictal days). EVD placement was done in six patients with swollen brain or hydrocephalus and/or intra-ventricular bleed and deteriorating GCS, out of which three patients subsequently required placement of VP shunt. However, fenestration of lamina terminalis in patients with associated IVH or evolving hydrocephalus was not done routinely. Post-operatively, patients were managed in an ICU set-up with assessment of patients' GCS, post-operative neurological deficits, development of hydrocephalus, Delayed ischemic neurological deficits (DIND) and electrolyte abnormalities. Any complications developed were managed accordingly. Patients were followed up in OPD for at least three months. Assessment was made according to modified Rankin Scale (mRS) and development of any delayed complications was also noted during follow-up.

Statistical analysis

Statistical analysis is done using IBM SPSS 26. Continuous variables are presented as mean and standard deviation (SD). Categorical data like gender, Hunt and Hess grade at presentation, Fisher's grade, location of aneurysms, hydrocephalus, clinical vasospasm and mRS (modified Rankin Scale) are presented as percentage. Fisher's exact test is used to see the association between different categorical data and mRS post-operatively. P value <0.05 is considered statistically significant.

Sample size was calculated using the formula $N= [Z^2 \times p (p-1)]/E^2$ and later using $N/[1+(N-1)/Population]$ for 40 people to give an adjusted sample size of 15, keeping margin of error (E) 5%.

Results

Fifteen patients underwent microsurgical clipping, out of which nine were female and six were male. The mean age of patients was 55.47 years with a range of 35 to 70 years. Sudden severe headache associated with altered level of consciousness was the most common presentation. Majority of the patients (73%) presented with a good Hunt and Hess grade (grade III or less) whereas four patients (27%) were in grade IV. Twelve patients presented with SAH with or without intra-ventricular extension, two patients had intra-parenchymal hemorrhage whereas one patient with MCA bifurcation aneurysm presented with entirely intra-ventricular hemorrhage. More than half of the patients (53%) had grade IV SAH on Fisher's CT scale. Out of seven patients with pre-existing comorbidities five were hypertensive, one was diabetic and one patient was chronic alcoholic.

All fifteen aneurysms involved anterior circulation. The most common location was Middle cerebral artery (MCA) bifurcation (eight patients) followed by Anterior communicating artery in five patients and one each involving Posterior communicating artery and Internal carotid artery (ICA) bifurcation. Ten patients underwent early clipping (within 72 hours of ictus) whereas five patients underwent delayed clipping after 10th post-ictal days.

Intraoperative rupture was present in three cases. Three patients developed DIND/ clinical vasospasm post-operatively. Immediately following clipping of MCA aneurysm, one patient experienced contra-lateral upper arm weakness whereas another developed post-operative aphasia. Similarly, hemiparesis was observed in one patient following clipping of Anterior communicating artery aneurysm. All three patients had various degrees of infarction on post-operative CT scan. Persistent Hydrocephalus was present in three patients which subsequently required VP shunting. One patient developed ventilator associated pneumonia.

During three-month follow-up, 60% of patients had favorable outcome (mRS grade of 1 to 3) whereas 40% had unfavorable outcome with mRS grade of 4 and 6. No patients were in grade 5 post-operatively (Figure 1). Overall mortality rate was 27%.

During the three month follow-up, patients with poor Hunt and Hess at presentation had significantly higher unfavorable outcomes. All four patients with grade 4 Hunt and Hess at presentation were in poor mRS grade (4 and 6). Whereas, all patients with Hunt and Hess grade I and II had mRS score of 1 or 2 during three-month follow-up. Similarly, significantly higher mortality and morbidity was seen in patients with clinical vasospasm/DIND. Out of three patients with vasospasm/DIND two were in grade 6 whereas one was in grade 4 on mRS scale. Age, location of aneurysms and presence of co-morbidities didn't have significant association with mRS at three months. Though patients with higher Fisher's grade of SAH had a poor grade on mRS, the data was not statistically significant. Similarly, early and delayed clipping did not have significant association with outcome of patients in terms of mRS. Comparison of various parameters in terms of mRS outcome during three months follow up is shown in table 1.

Parameters	Number of patients	mRS at latest follow-up						P-value
		1	2	3	4	5	6	
Hunt and Hess grade at presentation:								
I	1	1						
II	5	2	3					
III	5		2	1	1		1	0.01
IV	4				1		3	
Age :								
35-49 years	3	1	2					0.471
50-65 years	9	2	2	1	1		3	
>66 years	3		1		1		1	
Fisher's grade of SAH :								
I	0							0.273
II	2	1	1					
III	5	2	1	1			1	
IV	8		3		2		3	
Location of Aneurysm :								
MCA bifurcation	8	3	2		1		2	
Anterior communicating	5		1	1	1		2	
Posterior communicating	1		1					0.86
ICA bifurcation	1		1					
Co-morbidities:								
Yes	7	1	2	1	1		2	1.0
No	8	2	3		1		2	
Clinical vasospasm/DIND/Infarction	3				1		2	0.044
Timing of Clipping:								
Delayed	10	2	3	1	2		2	1.0
Early	5	1	2				2	

Table 1: Analysis of various parameters with mRS at three months follow-up.

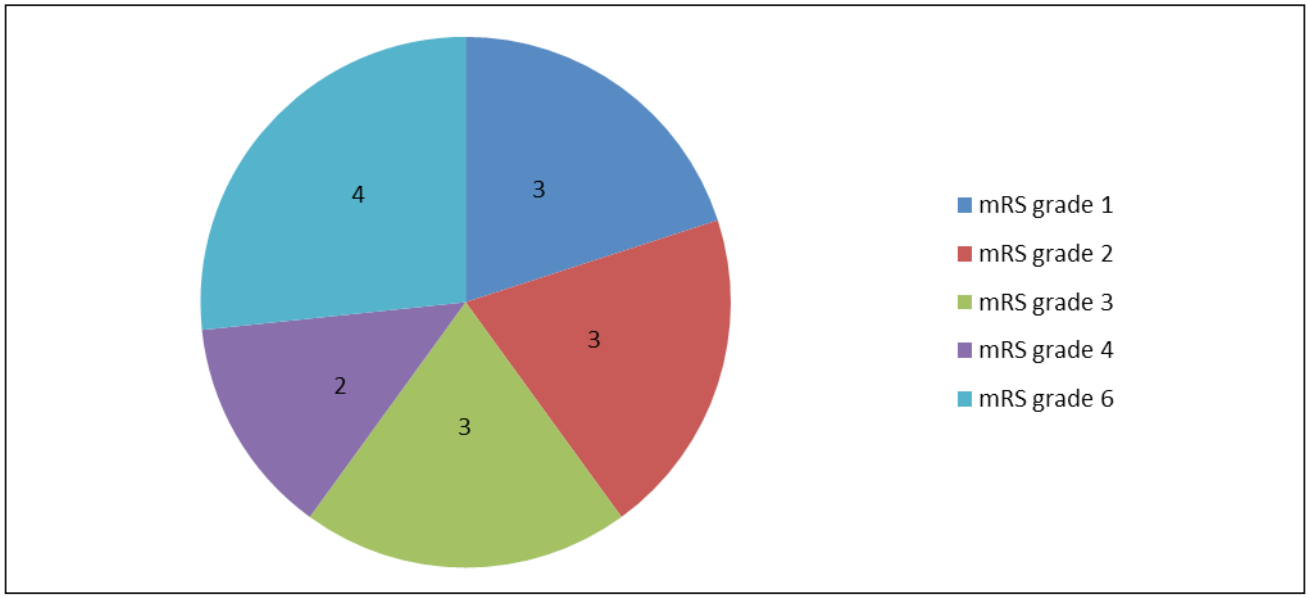

Figure 1: Modified Rankin Scale (mRS) score at three months follow-up.

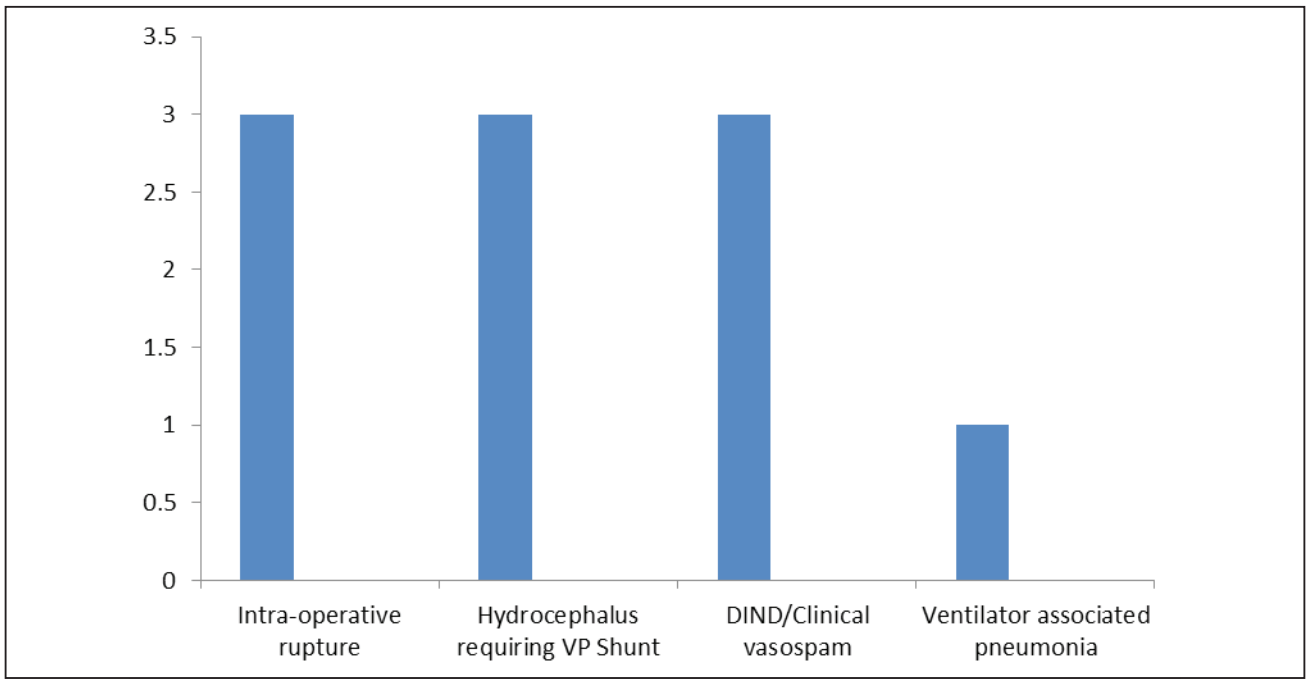

Figure 2: Associated complications.

Discussion

Despite several medical advances in the treatment of subarachnoid hemorrhage (SAH) due to aneurysm rupture, it remains a potentially devastating illness with a high mortality rate. The recent revolution in endovascular intervention with the introduction of detachable coils and flow diversion techniques in the last few years has led to rapid evolution of endovascular intervention in the treatment of cerebral aneurysms. [10,11] However; this may not be applicable in many centers in developing countries like ours due to expensive supplies and lack of expertise that make surgical clipping the standard treatment modality. Microsurgical clipping of aneurysms is technically demanding. This subspecialty of neurosurgery was limited to few centers within Kathmandu valley in the past, but in the last one decade many tertiary centers outside Kathmandu are routinely performing this procedure.

The incidence of aneurysm rupture is highest during fifth and sixth decade of life and gradually increases with each decade and more common in females.[12] In our series majority of the patients were between 50-65 years of age with female predominance which is comparable with other international literatures.[13] More than half of the patients in our study presented with rupture of MCA bifurcation aneurysm which is different from various other studies which shows Anterior communicating artery aneurysms as the most common (35%) followed by MCA bifurcation (22%).[14] This variation might be due to small sample size.

The optimum timing of microsurgical clipping after aneurysmal SAH was a matter of controversy due to belief that surgery on swollen and vulnerable brains was dangerous and associated with a high rate of complications.[15] In this trial, there was no significant difference in outcome between early clipping (within 72 hours) and delayed clipping. However, microsurgical clipping during vasospasm period especially between days 5 and 10 is considered unsafe and associated with high risk of delayed cerebral ischemia.[16] Dorhout Mees and others evaluated the timing of aneurysm surgery within the International Subarachnoid Aneurysmal Trial and supported the current guidelines for early aneurysm treatment in subarachnoid hemorrhage patients. The authors did not recommend postponing treatment in patients between days 5 and 10 after subarachnoid hemorrhage.[17]

Sixty percent of patients in our series had a favorable outcome during the latest follow-up with an mRS score of 1 to 3. Three previous studies in Nepal by Devkota et al. (2001), Sharma et al.(2011) and Roka et al. (2012) had good recovery in 90%, 84% and 87% respectively.[18,19,20] Similarly, 69% of patients showed favorable outcome post-operatively in a study by Natarajan et al.[13]

In our study, we observed that preoperative clinical grading was the most important prognostic factor, and patients with good Hunt and Hess grade usually had good outcomes. Similarly, 20% developed clinical vasospasm/DIND post-operatively and had a poor outcome including two mortalities. In patients who survive the initial bleeding after rupture of the cerebral aneurysm, about 20–30% manifested with neurological deficit due to vasospasm. Prolonged clipping, intra-operative rupture and poor Hunt and Hess are associated with increased incidence of infarct.[21] Orakdogen and others reported that clinical grade at presentation, age, size of the aneurysm, and clinical vasospasm were the most important prognostic factors in patients undergoing surgery after rupture of cerebral aneurysm.[22] In another study by Dilvesi et al. showed that the Fisher grade is not significant in predicting the intensity of cerebral vasospasm.[23] Advanced age and higher fisher's grade were associated with poor outcome in our study as well but did not reach statistical significance due to small number of patients. Bohnstedt et al. reported that Hunt and Hess grade on admission was the primary prognostic factor of outcome. In his study more than half of patients with HH grade 4 and 5 expired during their hospitalization despite aggressive treatment whereas long-term functional outcome was poor in up to 85% of surviving patients with HH grade 4 and 5.[24] Thus, it may be beneficial to discuss these prognostic factors with the family before implementing aggressive measures.

Intra-operatively aneurysm ruptured in 20% (three) cases, which is comparable with Batjer et al. study (19%).[25] Most of the time rupture was during the dissection of an aneurysmal sac. Twenty percent (three) cases required VP shunting. Hydrocephalus following subarachnoid hemorrhage that need ventriculo-peritoneal shunt ranges from 20-30%. A large-scale meta-analysis by Li et al. reported that shunt-dependent HCP accounts for a proportion of 17.4%.[26]

Overall mortality rate was 27% (four patients). Among these two had post-operative infarction, one presented with poor Hunt and Hess (grade IV) whereas one developed pneumonia. Mortality rate in population based study by Britz et al. (2465 patients) varied from 13.4% to 22.4% during one month and one-year follow-up following microsurgical clipping of an aneurysm.[27]

Since this is an early experience of a young neurosurgeon on microsurgical clipping, study has some limitations. Sample size of 15 is relatively small and the follow-up period of three months is relatively short. Longer duration of follow up is required to assess long term prognosis for functional outcome. Postoperative cerebral CT angiography was not performed in all cases to check neck occlusion rate. Another limitation of the study is evaluation of the surgical outcome only and not the overall management for the patients with ruptured aneurysms.

Conclusion

Microsurgical clipping is the standard surgical management for intracranial aneurysms in developing countries like ours where endovascular treatment is in early stage and limited to few centers within Kathmandu valley. Patients with good Hunt and Hess grade at presentation and without clinical vasospasm/DIND have good recovery post-operatively; and our results are comparable with various national and international similar studies.

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