Original Article

Clinicoradiological Profile and Outcome of Microsurgical Clipping of Ruptured Anterior Circulation Aneurysms: A Single-Institute Experience

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Abstract

Introduction: Prevalence of intracranial aneurysms is estimated to be from 1% to 5% of population, most of them are small and located in the anterior circulation. The real danger is when an aneurysm ruptures, leading to a subarachnoid hemorrhage (SAH). SAH is a catastrophic event with a mortality rate of 25% to 50%. Permanent disability occurs in nearly 50% of the survivors. Fifteen percent of patients expire before reaching the hospital and 25% die within 24 h. The purpose of our study is to report the clinicoradiological data and outcome of microsurgical clipping of ruptured anterior circulation aneurysms in our center. **Materials and Methods:** This study included ruptured anterior circulation aneurysms admitted to tertiary care hospital in northern India from January 2018 to June 2020. The final outcome of patients was analyzed with Glasgow Outcome Score (GOS) at the time of discharge from the hospital. **Results:** A total of 53 patients with ruptured anterior circulation aneurysm underwent microsurgical clipping comprising 25 (47.2%) males and 28 (52.8%) females. The mean neck size of all aneurysms was 3.43 ± 1.66 mm. The mean hospital stay was longer in patients having preoperative intraventricular hemorrhage (IVH) (35.96 ± 27.27 days) and postoperative complications (43.36 ± 29.76 days) compared to patients who did not have IVH (21.10 ± 15.47 days) and postoperative complications (18 ± 6.54 days). *P* value was ≤0.05. Patients with preoperative hydrocephalus had GOS 3.44 ± 1.20 at discharge compared to nonhydrocephalus who had GOS 4.32 ± 1.07 (*P* = 0.009). Patients with Intracerebral Hemorrhage (ICH) and non-ICH had GOS 3.31 ± 1.38 and 4.28 ± 1.01, respectively (*P* = 0.009). **Conclusion:** Poor outcome at the time of discharge after the surgical treatment of anterior circulation aneurysms was associated with poor world federation of neurological surgeons grade on admission, presence of IVH, hydrocephalus, intracerebral hemorrhage, and postoperative cerebral infarcts.

Keywords: *Aneurysm, clipping, infarct, outcome, world federation of neurological surgeons*

Introduction

The prevalence of intracranial aneurysms is estimated to be from 1% to 5% of population, most of them are small and located in the anterior circulation. Anterior Circulation Aneurysms (ACA) arise from the internal carotid artery (ICA) or from any of its branches. The most common type is a saccular aneurysm, which is approximately 85% of ACA. Unruptured aneurysms may cause symptoms mainly due to mass effect, but the real danger is when an aneurysm ruptures, leading to a subarachnoid hemorrhage (SAH).[1] The risk of rupture is around 1% per year. Size is a major risk factor for this complication, the rupture rate for ACA <7 mm was 0% per year in patients with no prior SAH and 0.3% per year in previous SAH; this risk rises considerably to 8% per year in patients with giant aneurysms.[1] Among ACA, the most frequent site is the anterior communicating artery (ACOM).[2] SAH is a catastrophic event with a mortality rate of 25% to 50%. Permanent disability occurs in nearly 50% of the survivors. Fifteen percent of patients expire before reaching the hospital and 25% die within 24 h. Only one-third of patients who suffer a SAH have a positive outcome.[3] Rebleed has a catastrophic morbidity from 48% to 78%.[4] Recent guidelines recommend early and ultra-early securing of the aneurysm by means of surgical clipping or endovascular coiling to avoid rebleeding.[5] However, this may not be possible for all patients, especially in developing countries due to late transportation to specialized neurosurgery units. Late admission

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for patients with aneurysmal SAH during the period of vasospasm forced the neurosurgeons to secure the aneurysms during that period which historically carries a bad outcome. The purpose of our study is to report the clinicoradiological data and outcome of microsurgical clipping of ruptured anterior circulation aneurysms in our center.

Materials and Methods

A study of patients with ruptured anterior circulation aneurysms admitted to tertiary care hospital in northern India from January 2018 to June 2020 were enrolled after approval from the institutional ethical board. Age of patients, gender, Glasgow coma scale (GCS), world federation of neurological surgeons (WFNS) grade, size of neck and sac of aneurysm, projection and location of the aneurysm, comorbidities, type of surgery, postoperative complications, hospital stay, and mortality of all ruptured aneurysms were recorded. The final outcome of patients was analyzed using Glasgow outcome score (GOS) at the time of discharge from the hospital. The statistical analysis was done using SPSS (Version 17,2006, SPSS Inc. , Chicago, IL, USA). Student's *t*-test and Chi-square test were used.

Inclusion criteria:

1. Anterior circulation saccular aneurysms only
2. WFNS all grades. Patients those with WFNS Grade 1, 2, 3, and 4 on clinical assessment after resuscitation and optimization of the patient were taken up for clipping of aneurysm within 24 h of ictus. The patients with WFNS Grade 5 were managed conservatively with supportive measures in the intensive care unit (ICU) and observed for improvement in clinical status. Any cause for poor neurological status was addressed; for example, hydrocephalus was managed with either a ventriculoperitoneal shunt or external ventricular drainage (EVD). If they improved to Grade 4 or better, these patients were then taken up for clipping. Those who did not improve were managed accordingly in the hospital.

Exclusion criteria:

1. Patients with absent brainstem reflexes
2. Posterior circulation aneurysms
3. Patients with SAH due to trauma, intracranial arteriovenous malformations, hypertension, and coagulopathy.

Results

A total of 53 patients with ruptured anterior circulation aneurysm underwent microsurgical clipping, comprising 25 (47.2%) males and 28 (52.8%) females. There were 5 (9.4%) patients below 40 years, 18 (34%) patients between 41 and 50 years, and 9 (17%) patients above 60 years of age. Maximum patients, i.e., 21 (39.6%), were from 51 to 60 years of age group. The mean age of patients was 52.43 ± 8.6 years in our study. Twenty-seven (50.9%) patients were in WFNS Grade 1, 4 (7.5%) patients were in Grade 2, and 2 (3.7%) and 14 (26.4%) patients were in Grade 3 and 4, respectively, at admission time. Six (11.3%) patients were in WFNS Grade 5. Among the comorbidities, hypertension and diabetes mellitus were present in 45 (84.9%) and 12 (22.6%) patients, respectively, whereas 3 (5.7%) patients had hypothyroidism. Single aneurysms were present in 46 (86.8%) patients and two aneurysms were present in 6 (11.3%) patients, whereas only one patient had three aneurysms.

ACOM aneurysm was the most common and was present in 31 (50.8%) patients. Right and left middle cerebral artery (MCA) bifurcation aneurysms were present in 12 (19.7%) and 8 (13.1%) patients, respectively. Five (8.2%) patients had distal anterior cerebral artery (DACA) aneurysms, 3 (4.9%) patients had posterior communicating artery (PCOM) aneurysm, and only 2 (3.3%) patients had ICA bifurcation aneurysm. Among 31 ACOM aneurysms, 10 (32.3%) had anterosuperior projection, 8 (25.8%) had anterior projection, 6 (19.4%) had superior projection, and 4 (12.9%) had anteroinferior projection. Posterior and inferior projections were in 2 (6.5%) and 1 (3.2%) aneurysms, respectively. Three (60%) DACA aneurysms had anterosuperior projection, 1 (20%) had anteromedial projection, and superior projection was also seen in 1 (20%) patient. Lateral projection was most common in MCA bifurcation aneurysm. Seven (87.5%) left MCA bifurcation aneurysms and 7 (58.3%) right MCA bifurcation aneurysms had lateral projections, whereas only 1 (12.7%) left MCA bifurcation aneurysm had posterolateral projection. Three (25%) right MCA bifurcation aneurysms had superolateral projection and 2 (16.7%) had superior projection. One left PCOM aneurysm had lateral projection. Two (50%) right PCOM aneurysms had posterior projection and 2 (50%) had posteriorlateral projection. One (50%) right ICA bifurcation aneurysm had posterolateral and 1 (50%) had posterior–superior projection.

The smallest size of aneurysmal neck was 1 mm and largest was 10 mm. The mean neck size of all aneurysms was 3.43 ± 1.66 mm, whereas the smallest aneurysmal sac was 2 mm and largest aneurysmal sac was 11 mm of size. The mean size of aneurysmal sac was 5.47 ± 2.11 mm. SAH was present in all patients. Intraventricular hemorrhage (IVH) was present in 23 (43.4%) patients. Preoperative hydrocephalus was found in 18 (36%) patients. Intracerebral hemorrhage (ICH) was seen in 13 (24.5%) patients.

Microsurgical clipping of 59 (96.7%) aneurysms was done, whereas 2 (3.3%) were not clipped as they were unruptured and on the opposite side to ruptured aneurysms. Lamina terminalis was opened in all the patients. EVD was done

in 11 (18%) patients intraoperatively due to preoperative hydrocephalus due to SAH. Intraoperative rupture of aneurysms was found in 4 (6.6%) aneurysms only. Temporary clipping was done in 23 (37.7%) aneurysms. Temporary clips were applied once in 14 (60.9%) aneurysms, twice in 6 (26.1%) aneurysms, and thrice in 3 (13%) aneurysms.

Postoperatively, 12 (22.6%) patients had vasospasm that lead to cerebral infarcts in different territories. Ten (18.9%) patients had MCA infarcts. Among these, 6 (11.3%) patients were with left MCA territory infarcts and 4 (7.5%) patients developed right MCA territory infarcts. Anterior cerebral artery (Ant.CA) territory infarcts were seen in three patients(5.7%) , one each in Left Ant. CA and Right Ant.CA territory. Bilateral Ant. CA territory infarct was present in single patient. One patient had right posterior cerebral artery infarct. Postoperative hydrocephalus was present in 7 (13.2%) patients. Other rare complications such as meningitis, extradural hematoma, subgaleal hematoma, chronic subdural hematoma, and right lung empyema developed as single complication (1.9% each) in five different patients.

Decompressive craniectomy was done in 5 (9.4%) patients who had postclipping MCA territory infarcts. Of which 3 (5.7%) were with left MCA territory infarcts and 2 (3.8%) were with right MCA territory infarcts. Ventriculoperitoneal shunt was done in 6 (11.3%) patients for hydrocephalus during the hospital stay. Tracheostomy was done in 5 (9.4%) patients. Extradural hematoma and subgaleal hematoma evacuation each was done in two different patients.

The overall mean hospital stay was 27.55 ± 22.43 days. However, the mean hospital stay was longer in patients having preoperative IVH (35.96 ± 27.27 days) and postoperative complications (43.36 ± 29.76 days) compared to patients who do not have IVH (21.10 ± 15.47 days) and postoperative complications (18 ± 6.54 days). *P* value was ≤0.05 which was clinically significant. Similarly, the mean hospital stay was also longer in patients who had intraoperative aneurysm rupture (64.25 ± 33.02 days) compared to patients who did not have intraoperative aneurysm rupture (24.55 ± 18.86 days) with $P \leq 0.001$.

The overall mean GOS at the time of discharge from the hospital was 4 ± 1.17. Patients admitted with WFNS Grade 1, 2, 3, 4 , and Grade 5 at admission time had mean GOS at discharge 4.48 ± 0.84, 5.00 ± 0.00, 4.50 ± 0.70, 3.71 ± 0.99, and 2.00 ± 0.89, respectively, with *P* value 0.000. That was statistically significant. The mean GOS in IVH (preoperative) and non-IVH patients was 3.43 ± 1.24 and 4.50 ± 0.90, respectively ($P = 0.001$). Patients with preoperative hydrocephalus had GOS 3.44 ± 1.20 at discharge compared to nonhydrocephalus who had GOS 4.32 ± 1.07 ($P = 0.009$). Patients with ICH and non-ICH had GOS 3.31 ± 1.38 and 4.28 ± 1.01, respectively ($P = 0.009$). Four (7.5%) patients with intraoperative rupture of aneurysm had mean GOS 3.00 ± 0.81 compared to 49 (92.4%) patients with no intraoperative rupture of aneurysm who had mean GOS 4.12 ± 1.16 with *P* value 0.066. Patients who had developed postoperative complications had GOS 3+ 1.07, as compared to patients who did not develop complications (GOS 4.67 +- 0.67); *P* value 0.000. Two (3.8%) patients died during the hospital course and one (1.9%) patient left against medical advice on the 5th postoperative day with GOS 2.

Discussion

Endovascular intervention may not be applicable in many centers in developing countries due to expensive supplies that make surgical clipping the standard treatment modality for ruptured aneurysms in developing countries like India. Rinkel *et al*. found that the incidence of intracranial aneurysms increased with age, and the majority of cases occur among patients in their 50s.[6] Similarly, in our study, most of the patients were from 51 to 60 years of age group. Samandouras G found that females are more affected than males.[7] Our study also had more females (52.8%) compared to males (47.2%). Schöller *et al*. reported that outcomes clearly worsened with increasing age, and age was one of the strongest predictors of mortality and a poor outcome.[8] A multivariate regression analysis showed the independent effects of gender on the outcome at discharge in 108 young adult patients.[9] There are some reports suggesting that age and sex have no prognostic value [10,11]. In our study age and sex were not found to be predictors of poor outcome and mortality ($p >\_ 0.05$). The presence of hypertension as a comorbid illness was a major risk factor in our study. It was present in approximately 85% of patients. Hypertension is associated with increased risk of SAH and is also associated with poor outcomes in patients of a SAH. Feigin *et al*. in their study concluded that smoking, hypertension, and excessive alcohol remain the most important risk factors for SAH.[12]

WFNS grade at presentation is the most important predictor of outcome, and this held true in our study. Orakdogen and others reported that WFNS grade and clinical vasospasm were the most important prognostic factors of outcome in patients with ruptured cerebral aneurysms.[13] Chiang *et al*. on studying 56 consecutive patients for prediction of outcome in a SAH found the patient's worst clinical grade to be most predictive of the outcome, especially when the patient is assessed using the WFNS or GCS.[14] In our study, patients with good WFNS grades at presentation had good outcomes ($P = 0.001$). In our study, mortality occurred in 3.8% of patients with WFNS Grade V only, which was statistically significant.

Vergouwen *et al*. concluded that cerebral infarcts after SAH contributed to poor outcomes by vasospasm-dependent and independent effects.[15] Similarly, in our study, those 12 (22.6%) patients had cerebral infarcts postoperatively,

of which 5 (9.4%) patients underwent decompressive craniectomy due to mass effect and 7 (13.2%) were managed medically. Among these five patients, 2 (3.7) died during ICU stay, 2 (3.7%) patients had GOS 2, and 1 (1.8%) patient had GOS 3 at discharge from hospital. None of seven patients were managed conservatively after cerebral infarcts achieved GOS 5.

In the present study, the relation of size of a ruptured aneurysm to the final outcome of the patient was not found in contrary to Shiue *et al*., who pointed out that the size of a ruptured aneurysm is an important determinant of outcome in SAH and should be used as a prognostic parameter in directing management.[16] We divided patients into three groups according to the size of aneurysm (≤4 mm, 5–7 mm and ≥7 mm) to compare outcomes and found *P* value statistically insignificant ($P = 0.45$). Chotai *et al*. also found that the size of the aneurysm and the presence of multiple aneurysms were associated with unfavorable outcomes.[9] Various projections of anterior circulation aneurysms and their relation to the outcome of patients were not found in our study ($P \geq 0.05$). In the study done by Orz and AlYamany,[17] the mean size of rupture was different for different locations of aneurysms. Sixty-three percent of ruptured aneurysms were smaller than 7 mm in diameter in their study. Seventy-three percent of ruptured ACOM aneurysms were <7 mm in diameter in their study. Forget *et al*.[18] also found that 44% and 94.4% of ruptured ACOM aneurysms were <5 mm and 10 mm in diameter in their study. In a study done by Joo *et al*.,[19] 71.8% of aneurysms ruptured before reaching a size of 7 mm. These studies are in concordance with our findings.

Schöller *et al*. reported hydrocephalus to be the weakest predictor of outcome, while Lagares *et al*. reported that the presence of hydrocephalus was related to a poor outcome.[8,20] In our study, we found that preoperative IVH and hydrocephalus were significant predictors of poor outcome ($P \leq 0.05$). Intracerebral hematoma (ICH) due to rupture of aneurysm was also found to be a predictor of poor outcome in the present study ($P \leq 0.05$). Bohnstedt *et al*. in their study concluded that Hunt and Hess (HH) grade is the primary prognostic factor for outcome among this patient population as more than half of patients with HH Grade IV and V expired during their hospital course despite the best treatment of their hematoma and aneurysm. Long-term functional outcome was poor in up to 85% of surviving patients with HH Grade IV–V.[10] IVH, hydrocephalus, and ICH were predictors of poor outcome in our study.

Sandalcioglu *et al*. concluded that intraoperative aneurysm rupture has no impact on the outcome neither in patients with good initial condition nor for poor grade patients.[21] The results of our study coincided with that as in our study, GOS difference at the time of discharge from hospital in patients with intraoperative ruptured aneurysm and in unruptured patients was not statistically significant ($P = 0.066$), although the length of hospital stay was quite longer in intraoperative ruptured aneurysm patients ($P = 0.001$).

Conclusion

This study has concluded that hypertension was the most common risk factor among the patients. Poor outcome at the time of discharge after the surgical treatment of anterior circulation aneurysmal was associated with poor WFNS grade on admission, presence of IVH, hydrocephalus, intracerebral hemorrhage, and postoperative cerebral infarcts, whereas other factors such as age, sex, diabetes mellitus, size and projection of aneurysmal sac, and intraoperative rupture of aneurysm were not associated with poor outcome of patients. The limitation of our study is the small number of patients; hence, further studies with a greater number of patients are required to corroborate our findings.

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Conflicts of interest

There are no conflicts of interest.

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