ISSN 1220-8841 (Print)
ISSN 2344-4959 (Online)

ROMANIAN
NEUROSURGERY

Vol. XXXX | No. 2 June 2026

Experience with microsurgical clipping of ruptured intracranial aneurysms at a north Indian rural institution

S. Gupta

DOI: 10.33962/roneuro-2026-029

Romanian Neurosurgery (2026) XXXX (2): pp. 148-154
DOI: 10.33962/roneuro-2026-029
www.journals.lapub.co.uk/index.php/roneurosurgery

Experience with microsurgical clipping of ruptured intracranial aneurysms at a north Indian rural institution

S. Gupta

Department of Neurosurgery, UPUMS Saifai, INDIA

ABSTRACT

Background: Microsurgical clipping continues to be the benchmark treatment for managing intracranial aneurysms. Evaluating outcomes at the institutional level is crucial for identifying modifiable factors that can improve surgical success, especially in areas with limited resources where patients often present late due to lack of awareness. This study reviews our center's experience with the surgical management of ruptured intracranial aneurysms.

Materials and Methods: This retrospective analysis includes 40 patients with ruptured intracranial aneurysms who underwent clipping surgery at the Department of Neurosurgery, UPUMS, Saifai. All patients received comprehensive neurological assessments and continuous monitoring of vital signs. The study summarizes surgical outcomes and clinical progression following treatment.

Results: Among the 40 patients treated, 28 were female and 12 were male, showing a female-to-male ratio of 2.3:1. Most cases occurred in patients in their 50s and 60s. Headache with vomiting was the most frequent presenting symptom. The majority of patients were categorized as Hunt and Hess grade 2, and World Federation of Neurological Surgeons (WFNS) grade 1. On the Modified Fisher scale, most patients fell into grade 1, followed by grade 3. The anterior communicating artery (AComA) was the most common aneurysm location, followed by the middle cerebral artery (MCA).

Conclusion: There was a marked female predominance among the cases. AComA aneurysms were the most frequently encountered. Favorable outcomes were more likely in patients who received early intervention and did not experience intraoperative aneurysm rupture, highlighting the importance of timely and careful surgical management.

Keywords
Intracranial aneurysm,
Subarachnoid hemorrhage,
Aneurysm clipping,
Vasospasm,
Surgical outcomes

Corresponding author:
Sajag Gupta

Department of Neurosurgery,
UPUMS Saifai, India

sajag.gupta@yahoo.com

ISSN 2344-4959 (online)
ISSN 1220-8841 (print)

First published
June 2026 by
London Academic Publishing
www.london-ap.uk

INTRODUCTION

An intracranial aneurysm, also known as a cerebral aneurysm, is a cerebrovascular condition characterized by localized weakening in the wall of a cerebral artery, resulting in localized dilatation or ballooning of the blood vessel due to breakdown of the internal elastic lamina and tunica media. Intracranial aneurysms (IAs), particularly of the saccular or berry type, are acquired lesions that account for roughly 80% of non-traumatic subarachnoid hemorrhages (SAH) [1] and affect 5-10% of the general

population [2]. They are linked with high morbidity and death. The outcome of subarachnoid hemorrhage caused by aneurysmal rupture remains poor: fatality rates range from 40-50%, severe impairment occurs in 10-20%, and only about 40% achieve independent status [3,4]. Bleeding, re-bleeding, vasospasm, and cerebral ischemia all contribute to death and morbidity. The current study seeks to analyze the epidemiology of surgically clipped ruptured intracranial aneurysms and identify predictive parameters that impact prognosis and surgical outcome in these individuals.

Materials and Methods

This is a retrospective study of intracranial aneurysm cases operated on at the Department of Neurosurgery, UPUMS Saifai, Etawah, from January 2022 to September 2025. A total of 40 cases treated with microsurgical clipping were examined. A thorough analysis was performed using the available data, with a focus on the patient's preoperative, intraoperative, and postoperative conditions — specifically the location of the aneurysm, Hunt and Hess grade, WFNS grading, and Modified Fisher grade, side of approach, intraoperative events, postoperative events and complications, and the number of additional surgeries required. Clinical data, including risk factors, aneurysm features, surgical procedures, and follow-up data were collected consistent with the key concepts outlined in the Declaration of Helsinki.

Inclusion criteria: patients of every age group and either sex, with signs and symptoms of spontaneous SAH and ruptured cerebral aneurysms of Hunt and Hess grades 1, 2, 3, or 4.

Exclusion criteria: patients with medical conditions deemed inappropriate for surgery; patients not willing to undergo surgical management; non-saccular aneurysms; traumatic SAH other than aneurysmal rupture; and Hunt and Hess grade 5.

Data for each enrolled participant were entered, cleaned, and coded in Microsoft Excel 2010. Prior to statistical analysis, the data were tested for normality. Descriptive and inferential statistical analyses were performed with IBM SPSS version 25. Continuous data were expressed as mean ± standard deviation (SD), while categorical variables were represented as absolute numbers and proportions.

Results

The study included 40 patients with intracranial aneurysms who were operated on with the primary goal of clipping the aneurysm. Owing to limited resources, only aneurysm clipping was available; endovascular treatment was not performed at this institution. This study covers the details of aneurysm treatment and outcome analysis following surgical clipping. Our series of 40 cases included 12 men and 28 women, a female predominance of 2.3:1. In terms of age distribution, the youngest patient was 28 years old and the oldest was 74. The majority of cases occurred in the sixth decade of life, with the fifth and seventh decades following closely behind (Table 1).

Table 1. Age and sex distribution.

Age (years)	Number	Percentage
<30	1	2.5%
31-40	3	7.5%
41-50	11	27.5%
51-60	15	37.5%
61-70	9	22.5%
>71	1	2.5%
Male	12	30%
Female	28	70%

Symptoms ranged from headache to motor impairment and comatose states. The most prevalent presentation was headache, reported by 24 patients as the worst headache of their lives, followed by vomiting, loss of consciousness, seizures, visual disturbances, motor deficits, and cranial nerve palsies. Cranial nerve deficits predominantly affected the third and sixth cranial nerves, which improved during postoperative follow-up (Table 2).

Table 2. Presenting symptoms.

Presentation	Number	Percentage
Headache	24	60%
Vomiting	22	55%
Loss of consciousness	15	37.5%
Seizures	6	15%
Visual disturbances	2	5%
Motor deficits	3	7.5%
Cranial nerve palsies	4	10%
Cranial nerve deficits (3rd/6th nerve predominant)	3	7.5%

The most prevalent risk factors were hypertension, diabetes, alcohol use, smoking, trauma, and coronary artery disease (CAD) treated with blood thinners, most commonly detected in patients over the age of 50. Patients were often using

antihypertensive and antidiabetic medication irregularly. Hypertension was the most prevalent comorbidity among aneurysmal SAH patients in this series (Table 3).

Table 3. Patients' comorbidities.

Comorbidity	Number	Percentage
Hypertension	18	45%
Diabetes mellitus	13	32.5%
Alcohol use	10	25%
Smoking	12	30%
CAD with blood thinners	3	7.5%

Only patients in Hunt and Hess grades 1, 2, 3, and 4 were included in the study; grade 5 patients were excluded owing to their poor overall condition. The majority of patients were assigned to grades 1 and 2 (Table 4).

Table 4. Hunt and Hess grade.

Hunt and Hess grade	Number	Percentage
1	13	32.5%
2	14	35%
3	11	27.5%
4	2	5%

Modified Fisher grading was based on the pattern of subarachnoid hemorrhage on CT and MRI. All cases showed some degree of SAH. Most patients were in Grade 1, followed by Grade 3, which reflected more significant hemorrhage (Table 5).

Table 5. Modified Fisher grade.

Modified Fisher grade	Number	Percentage
Grade 0	3	7.5%
Grade 1	17	42.5%
Grade 2	4	10%
Grade 3	14	35%
Grade 4	2	5%

At admission, all patients were assessed with a CT scan, and the location of hemorrhage was documented. The most common sites were the right and left Sylvian fissures, followed by the interhemispheric fissure and basal cisterns (Table 6).

Table 6. Location of hemorrhage on CT scan.

Location of hemorrhage	Number	Percentage
Right Sylvian fissure	18	45%
Left Sylvian fissure	17	42.5%
Interhemispheric fissure	15	37.5%
Basal cisterns	13	32.5%
Suprasellar	8	20%
Intraventricular hemorrhage (IVH)	11	27.5%
Lobar	6	15%

All patients underwent routine hematological workup and surgical evaluation. CT cerebral angiography was performed in all 40 patients, and digital subtraction angiography (DSA) was performed in 22, excluding patients who were agitated or uncooperative. Four cases already assessed elsewhere and referred to our institution were completed with MR angiography (Table 7).

Table 7. Investigations performed.

Investigation	Number	Percentage
CT cerebral angiogram	40	100%
DSA	22	44%
MRA	4	10%

Patients were evaluated with CT angiography and 3D reconstruction after admission, and aneurysms were localized accordingly. Most aneurysms were located at the anterior communicating artery (AComA), followed by the right and left middle cerebral artery (MCA). One case each of distal anterior cerebral artery (DACA), basilar tip, and posterior inferior cerebellar artery (PICA) aneurysm was identified (Table 8).

Table 8. Aneurysm location on CT angiogram.

Aneurysm location	Number	Percentage
AComA	13	32.5%
Right MCA	7	17.5%
Left MCA	5	12.5%
DACA	1	2.5%
Right ICA	6	15%
Left ICA	4	10%
PCOM aneurysm	2	5%
Basilar tip	1	2.5%
PICA aneurysm	1	2.5%

The side of the surgical approach was based on aneurysm location, direction, and morphological features, with clipping performed in all cases. Craniotomies were performed predominantly through the pterional approach, while the DACA aneurysm was clipped using a bifrontal craniotomy and interhemispheric approach, and the PICA aneurysm was clipped via a suboccipital craniotomy (Table 9).

Table 9. Surgical approaches to the aneurysm.

Surgical approach	Number	Percentage
Bifrontal	1	2.5%
Right pterional	19	47.5%

Left pterional	19	47.5%
Suboccipital	1	2.5%

Intraoperatively, the aneurysm was inspected for a bled-like appearance on its surface after dissection, indicating the probable site of rupture. A total of 32 cases were clipped successfully without rupture, while 4 cases had rupture during dissection and 4 had rupture during clip application (Table 10).

Table 10. Intraoperative rupture during clipping.

Intraoperative event	Number	Percentage
No rupture	32	80%
Rupture during dissection	4	10%
Rupture during clipping	4	10%

WFNS grade at admission was compared against outcome at discharge using the Modified Rankin Scale (mRS) at three months of follow-up (Table 11). Grade 1 patients had the most favorable outcomes, while poorer grades were associated with progressively higher rates of poor outcome and in-hospital mortality.

Table 11. WFNS grade at admission and outcome (mRS) at three-month follow-up.

WFNS grade at admission	Number	Good outcome (mRS 0-2)	Poor outcome (mRS 3-5)	In-hospital mortality (mRS 6)
WFNS grade 1	25	19	5	1
WFNS grade 2	7	4	2	1
WFNS grade 3	4	1	1	2
WFNS grade 4	4	0	1	3

Both neurological and non-neurological postoperative complications were recorded. The most frequent complication was fever on the fifth postoperative day, followed by pneumonia, which was linked to cases requiring extended ventilation. Neurological complications included hydrocephalus and cranial nerve palsies. CSF leaks were treated conservatively with lumbar drains and repeated spinal tapping as needed, and meningitis was treated according to CSF culture sensitivity (Table 12).

Table 12. Postoperative complications.

Postoperative complication	Number	Percentage
Pneumonia	5	12.5%
Vasospasm	6	15%
CSF leak	7	17.5%
Cranial nerve palsy	6	15%
Cerebral edema	4	10%
Hydrocephalus	6	15%
Infarct	5	12.5%
Hemiplegia	4	10%
Meningitis	5	12.5%
Fever	18	45%

Postoperative complications requiring additional surgical intervention included infarct, hydrocephalus, and extended ventilator support. Procedures performed included conversion of pterional craniotomy to decompressive craniectomy, ventriculoperitoneal (VP) shunt placement, tracheostomy, and evacuation of extradural hematoma (EDH).

Of the 40 cases operated on, there were 7 deaths, and 33 patients were discharged. Of the 7 deaths, 2 were non-neurological (1 related to myocardial infarction and 1 to aspiration pneumonia), while the remaining 5 were related to neurological complications (Table 13).

Table 13. Postoperative outcome and causes of death.

Postoperative outcome	Number	Percentage
No death	33	82.5%
Neurological-related death	5	12.5%
Non-neurological-related death	2	5%

The Glasgow Outcome Scale (GOS) was used for comprehensive evaluation of postoperative outcome. Most patients were in GOS 5 (22 patients), while 7 were in GOS 1, 5 in GOS 2, 4 in GOS 3, and 2 in GOS 4 (Table 14).

Table 14. GOS at discharge.

GOS at discharge	Number	Percentage
GOS 1	7	17.5%
GOS 2	5	12.5%
GOS 3	4	10%
GOS 4	2	5%
GOS 5	22	55%

Following surgery, all discharged patients were monitored at two weeks, four weeks, two months, and then monthly. Owing to the surgical technique used, the majority of patients experienced temporal wasting over the follow-up period. Two cases of free bone flap insertion resulted in bone flap osteomyelitis, requiring further antibiotic administration guided by culture and sensitivity. Three cases had less severe wasting because the skin and muscle flaps were elevated jointly rather than separately, while eighteen monitored cases exhibited temporal wasting. During follow-up, hemiparesis persisted in four individuals despite physiotherapy (Table 15).

Table 15. Postoperative complications during follow-up.

Follow-up complication	Number	Percentage
Temporal wasting	18	45%
Ventriculomegaly	3	7.5%
Hemiparesis	4	10%
Osteomyelitis	2	5%
Altered sensorium	2	5%

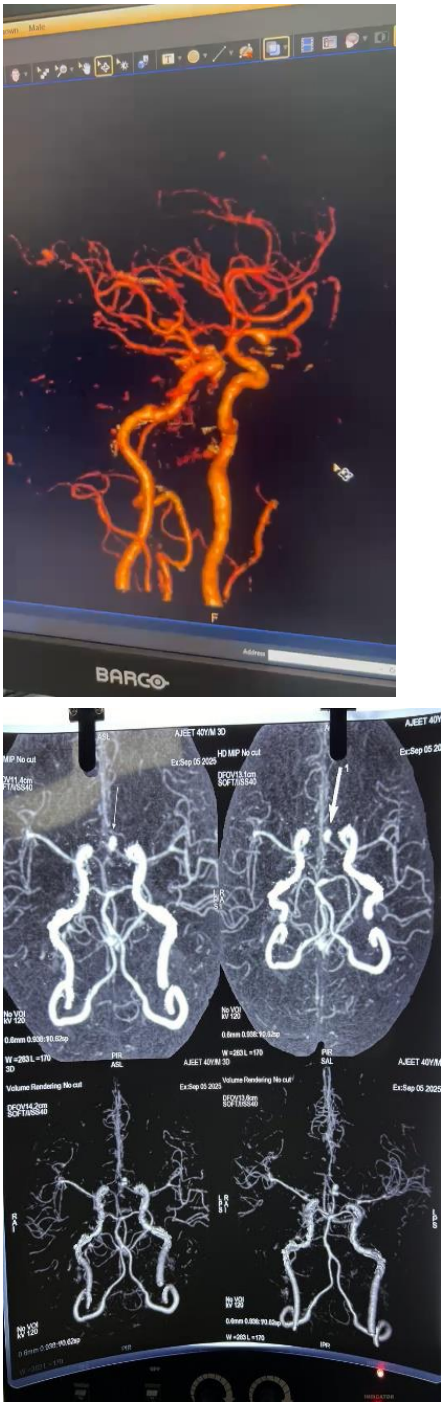

Figure 1-2. Representative case imaging from the study series. [No figure legend was supplied in the manuscript; author to provide modality, plane, and case details.]

Discussion

This study was carried out at the Department of Neurosurgery, UPUMS Saifai. Of the 40 patients in our series, 28 (70%) were female and 12 (30%) were male, indicating a 2.3:1 female predominance. Patients were distributed by decade of life, with the majority of cases — roughly 65% of the total — occurring in the fifth and sixth decades. Prior investigations have suggested that a decline in estrogen levels may coincide with a peak in the incidence of intracranial aneurysms and consequent subarachnoid hemorrhage in women during the post-menopausal period [5]. Given estrogen's supporting role in the normal functioning of the arterial wall, it has been hypothesized that fluctuations in estrogen levels have substantial effects on vascular integrity [6].

Headache was the most frequent presenting symptom, in 24 cases (60%), followed by vomiting in 22 cases (55%), loss of consciousness in 15 cases (37.5%), and seizures in 6 cases, in addition to cranial nerve palsies and motor impairments. Hypertension was the most frequent comorbidity, present in about 45% of patients, followed by diabetes mellitus in 32.5% and smoking in 30%. Smoking's inflammatory effects on arterial walls are thought to impair vessel structural integrity and increase the risk of aneurysm development.

On Hunt and Hess grading, the majority of cases (35%, 14 patients) were grade 2, followed by grade 1 (32.5%, 13 patients), grade 3 (27.5%, 11 patients), and grade 4 (5%, 2 patients); no grade 5 cases were included by design (Table 4). On the WFNS classification, grade 1 accounted for around 25 cases, or 62.5% of the study group, while grade 4 had the fewest cases, at four. On Modified Fisher grading, grade 1 was most common (17 cases, 42.5%), followed by grade 3 (14 cases, 35%), with grades 0, 2, and 4 accounting for the remainder. In a study by Toader et al., around 41% of cases were Modified Fisher grade 3 [7].

Symptomatic vasospasm is a major contributor to delayed morbidity and mortality in patients with aneurysmal SAH [8]. There is a correlation between the extent and duration of exposure to SAH and the severity of such vasospasm. Between 40% and 70% of patients who survive the initial hemorrhagic episode after cerebral aneurysm rupture develop vasospasm, and 20-30% develop neurological impairment as a result [9,10]. Medical treatment for

vasospasm includes nimodipine, supported by class I evidence, and interventions such as chemical or balloon angioplasty using milrinone, supported by class II evidence [11].

The most frequent site of hemorrhage on CT brain in our series was the right and left Sylvian fissures, followed by interhemispheric bleeding, most consistent with an anterior communicating artery aneurysm; IVH, basal cisterns, and the suprasellar region were additional sites. The most frequent aneurysm location was AComA (32.5%), followed by MCA (30% combined right and left) and ICA (25% combined right and left). The right pterional approach was used in 47.5% of cases and the left pterional approach in another 47.5%; bifrontal and suboccipital craniotomies were each used once, for the DACA and PICA aneurysms respectively.

Aneurysms were clipped intraoperatively without rupture in 32 cases (80%), while 4 cases (10%) had rupture during dissection and another 4 (10%) had rupture during clip application. Fever was the most frequent postoperative complication observed, followed by CSF leak, pneumonia, hydrocephalus, and hemiplegia/hemiparesis. Five cases required conversion from craniotomy to decompressive craniectomy for postoperative infarct, along with VP shunt implantation and tracheostomy in selected cases. Of the seven deaths, two were non-neurological and the remainder were neurological in origin. GOS was used to evaluate patients at discharge: 22 patients had a GOS of 5, 7 had a GOS of 1, 5 had a GOS of 2, 4 had a GOS of 3, and 2 had a GOS of 4. Notably, a favorable prognosis was most strongly associated with Modified Fisher grade 1 in our series, broadly in keeping with recent studies examining predictive factors following microsurgical clipping of cerebral aneurysms [13].

Conclusion

In our analysis of 40 intracranial aneurysms, we observed a female preponderance compared with males. Age was predominantly in the fifth and sixth decades of life. Hunt and Hess grades 1 and 2 were most common. On Modified Fisher grading, grade 1 was most common, followed by grade 3. The predominantly associated risk factors were hypertension, smoking, and alcohol consumption. Non-contrast CT showed SAH in all cases performed within 24 hours of the ictus. CT angiography was used for 3D reconstruction and was useful for localizing the aneurysm and deciding the side of approach for clipping. The anterior communicating artery was the most common location, followed by MCA aneurysms. Cases were clipped intraoperatively and carried an increased risk of rupture where adhesions were present. Postoperative evaluation gave a comprehensive view of outcomes and mortality, allowing assessment of our surgical intervention. The Modified Rankin Scale (mRS) score highlighted a favorable outcome in most cases. While operative intervention demonstrated good surgical outcomes overall, it was associated with significant mortality in this series. Postoperative complications necessitated additional surgery, including decompressive craniectomy and ventilator support. During follow-up, most patients developed temporal wasting on the side of approach, and some developed bone flap osteomyelitis.

References

1. Brown RD Jr. Unruptured intracranial aneurysms. Semin Neurol. 2010;30:537-544. doi:10.1055/s-0030-1268858
2. Linn FH, Rinkel GJ, Algra A, van Gijn J. Incidence of subarachnoid hemorrhage: role of region, year, and rate of computed tomography: a meta-analysis. Stroke. 1996;27:625-629. doi:10.1161/01.str.27.4.625
3. Juvela S, Poussa K, Porras M. Factors affecting formation and growth of intracranial aneurysms: a long-term follow-up study. Stroke. 2001;32:485-491.
4. Juvela S, Porras M, Poussa K. Natural history of unruptured intracranial aneurysms: probability of and risk factors for aneurysm rupture. J Neurosurg. 2000;93:379-387.
5. Ellamushi HE, Grieve JP, Jäger HR, Kitchen ND. Risk factors for the formation of multiple intracranial aneurysms.
6. Jou LD, Wong G, Dispensa B, Lawton MT, Higashida RT, Young WL, Saloner D. Correlation between lumenal geometry changes and hemodynamics in fusiform intracranial aneurysms. AJNR Am J Neuroradiol. 2005;26:2357-2363.
7. [Reference text missing or corrupted in the submitted manuscript — author to supply.]
8. Toader C, Kakucs C, Dobrin N, et al. Cerebral aneurysm characteristics and surgical outcomes: an in-depth analysis of 346 cases operated using microsurgical clipping. Cureus. 2024;16(3):e56933. doi:10.7759/cureus.56933
9. Murayama Y, Malisch T, Guglielmi G, et al. Incidence of cerebral vasospasm after endovascular treatment of acutely ruptured aneurysms: report on 69 cases. J Neurosurg. 1997;87:830-835.
10. Mahaney KB, Todd MM, Torner JC. Variation of patient characteristics, management, and outcome with timing

of surgery for aneurysmal subarachnoid hemorrhage. J Neurosurg. 2011;114:1045-1053.
11. Yao PS, Chen GR, Zheng SF, Kang DZ. Predictors of postoperative cerebral ischemia in patients with ruptured anterior communicating artery aneurysms. World Neurosurg. 2017;103:241-247.
12. Bauer AM, Rasmussen PA. Treatment of intracranial vasospasm following subarachnoid hemorrhage. Front Neurol. 2014;5:72.
13. Huang ZQ, Meng ZH, Hou ZJ, Huang SQ, Chen JN, Yu H, Feng LJ, Wang QJ, Li PA, Wen ZB. Geometric parameter analysis of ruptured and unruptured aneurysms in patients with symmetric bilateral intracranial aneurysms: a multicenter CT angiography study.
14. Orakdogen M, Emon ST, Somay H, Engin T, Ates O, Berkman MZ. Prognostic factors in patients who underwent aneurysmal clipping due to spontaneous subarachnoid hemorrhage. Turk Neurosurg. 2016;26:840-848.