



Retrospective analysis of Anterior circulation aneurysm: A institute study

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ABSTRACT

BACKGROUND: Subarachnoid hemorrhage(SAH) from ruptured aneurysm carries poor prognosis; half of patients die within 1 month of hemorrhage. Approximately 15% of patients with aneurysmal SAH die before reaching the hospital. The initial and definitive management of ruptured cerebral aneurysm is evolving, with clipping and coiling being alternative treatments.

AIMS & OBJECTIVE: Our aim is to study outcome of surgery on ruptured aneurysms of anterior circulation and to study the factors influencing the same.

MATERIALS AND METHODS: A retrospective and prospective analysis of consecutive 110 patients comprising the Anterior communicating artery (Acom), Middle cerebral artery (MCA), the internal carotid artery (ICA), Anterior cerebral artery (ACA), Posterior communicating artery (PCOM) who have undergone surgery at our institute from January 2015 till January 2019 was performed. We have included patients who presented with SAH, only WFNS grade 1 and 2 diagnosed with ACOM OR MCA OR ICA OR ACA OR PCOM aneurysm and then underwent surgical management and Excluded Giant aneurysm; size > 2.5 cm, Multiple aneurysms, Should not be in a patient suffering from any connective tissue disorder. Or any other systemic disease e.g. Polycystic kidney disease which are associated with a high number of concomitant intracranial aneurysms and Operated by coiling. Neurological outcome was assessed using modified Rankin's scale (mRS) and post operative CTA.

Results: In our study, most common age group affected is 54.20 yrs. Aneurysms are common in female sex. According to criteria of size, 101 patients had aneurysm size of less than 14 mm. In anterior circulation aneurysm 20% ICA, 25.45% MCA, 2.75% ACA, 40.90% ACOM, 1.81% DACA, 9.09% PCOM presents. Vasospasm present in 14.2% of patients detected radiologically. Intraoperative rupture was happened in 15.45% patients. Post operative complications were faced like infarction (8%), hydrocephalus (14.8%), ICU stay < 7 days in 82.7%, post op de-compressive craniotomy (1%), On discharge - motor deficit (10%), speech deficit (6.1%), neurocognitive (6.7%), mortality (6.4%).



INTRODUCTION: Subarachnoid hemorrhage(SAH) from ruptured aneurysm carries a poor prognosis;half of patients die within 1 month of hemorrhage;approximately 15% of patients with aneurismal SAH die before reaching the hospital.

The initial and definitive management of ruptured cerebral aneurysm is evolving,with clipping and coiling being alternative treatments.The outcome of these treatment modalities are changing rapidly because of improved quality of microneurosurgery and the development of new endovascular technique as well as aggressive detection and management of vasospasm and other complications related to SAH itself.

AIMS & OBJECTIVES: Our aim is to study outcome of surgery on ruptured aneurysms of anterior circulation and to study the factors influencing the same.

MATERIAL & METHODS: A retrospective and prospective analysis of consecutive 110 patients comprising the Anterior communicating artery (Acom),Middle cerebral artery (MCA) ,the internal carotid artery (ICA),Anterior cerebral artery(ACA),Posterior communicating artery(PCOM) who have undergone surgery at our institute from January 2015 till january 2019 was performed.We have included patients who presented with SAH, only WFNS grade 1 and 2 diagnosed with ACOM OR MCA OR ICA OR ACA OR PCOM aneurysm and then underwent surgical management and Excluded Giant aneurysm; size > 2.5 cm,Multiple aneurysms,Should not be in a patient suffering from any connective tissue disorder. Or any other systemic disease e.g. Polycystic kidney disease which are associated with a high number of concomitant intracranial aneurysms and Operated by coiling.

OBSERVATION AND RESULTS: The patient characteristics and their surgical outcome and the factors affecting the outcome are described in following part.



1. Biographic Data:

Age groups	Frequency	Percent
< 30	4	3.6
31-40	12	10.3
41-50	30	27.3
51-60	36	33.0
61-70	25	23.0
>70	3	2.7
Total	110	100.0

Sex	Frequency	Percent
Male	46	41.8
Female	64	58.2
Total	110	100.0

Fischer's grade	Frequency	Percent(%)
1	66	60
2	26	23.63
3	15	13.63
4	3	2.74
Total	110	100

Fischer grade	No of patients(n)	Vaospasm (%)	Post operative infarct	Icu stay (<7 days)	Icu stay (>7days)	Deficit on discharge
1	66	8(12.12)	2(3.03)	64 (96%)	2	6(9.09%)



2	26	3(11.53)	1(3.84)	24	2	6(23.07%)
3	15	5(30%)	4(26%)	3	12 (80%)	9(60%)
4	3	0	2(66.66)	0	3	2(66%)
Total	110	16	8	91	19	

The mean age at diagnosis of the patients is 54.20 years, Sex distribution: more common in female

Fischer’s grade & Vasospasm: Patients with higher Fischer’s grade were seen to have higher chances of post- operative vasospasm. Tested by null hypothesis there was 30 % chances of occurrence of vasospasm in Fischer’s grade III SAH. However patients with grade 4 could not show significant effect which may be due to small frequency i.e. less number of patients in this group.

Fischer’s grade & postoperative ICU stay duration: Increasing ICU stay duration was seen for higher Fischer’s grade with grade I patients showing 96% chance of not requiring ICU stay > 7 days and 80% of grade IV patients requiring stay > 7 days.

Fischer’s grade & deficits on discharge(motor/speech/neurocognitive): Patients with higher Fischer’s grade showed increasing trend for deficit at discharge cases of Fischer’s grade III.

Fischer’s grade & postoperative infarct: Trend of increasing occurrence of postoperative infarct was seen with higher Fischer’s grade.

Fischer grade	No. of patients	Re-exploration (decompressive craniectomy)	Post operative ventilator support	Csf diversion
1	66	1	10	10
2	26	0	5	5
3	15	0	1	1
4	3	0	1	0



Fischer’s grade & Postoperative CSF diversion/ need for re-exploration, postoperative Ventilatory support, Reexploration: No significant correlation was seen.

5. Preoperative hydrocephalus:

Preoperative Hydrocephalus	Frequency	Percent
present	16	14.8
absent	94	85.2
Total	110	100.0

7. Aneurysm location: Mc site of aneurysm is ACOM (40.90%) followed by MCA aneurysm(25.45%) and least common found is DACA aneurysm(1.81%).

Location	Frequency	Percent(%)
ACOM	45	40.90
MCA	28	25.45
ICA	22	20
ACA	3	2.75
PCOM	10	9.09
DACA	2	1.81
Total	110	100.0



Location and interval between ictus and admission/ surgery: Comparing the time interval from occurrence of ictus till presentation/ admission/ surgery among the three locations no significant difference could be seen for which Chi square analysis was performed.

LOCATION	PRE OP TIME SINCE BLEED			
	< 7 DAYS	7-14 DAYS	>14 DAYS	
ACOM	17(38.2%)	18(41.8%)	10(20%)	45(100%)
MCA	9(33.3%)	12(40.7%)	7(25.9%)	28(100%)
ICA	7(31.7%)	10(40.7%)	5(25%)	22(100%)
ACA	2(40%)	2(40%)	1(20%)	5(100%)
PCOM	3(30%)	5(50%)	2(20%)	10(100%)
TOTAL	38(34.5%)	47(44.2%)	25(24%)	110(100%)

Location and method of securing the aneurysm: Significantly more cases of ICA communicating segment aneurysms as compared to MCA and ACOM had to be wrapped or wrapping superimposed on clipping. total clipping done in 100 patients, only wrapping done in 2 ICA naeurysm, clipping with wrapping done in 2 ACOM, 2 MCA and 4 ICA aneurysm patients.

Location	Clipping	Only Wrapping	Clipping + Wrapping
ACOM	43	0	2
MCA	26	0	2
ICA	16	2	4
ACA	5	0	0
PCOM	10	0	0
	100	2	8



Location and intraoperative temporary clipping: No significant difference could be found among the three location.

Temporary clipping	Frequency	Percentage
Yes	64	58.18%
No	46	41.82%
Total	110	100%

Location and intraoperative rupture of the aneurysm : Total intraoperative rupture seen in 28 cases in which 9, 7 & 9 cases of Acom, MCA & ICA communicating segment aneurysms had intraoperative aneurysm rupture. However no statistical significance was seen in the difference of intraoperative rupture of the aneurysm among the three locations.

Location	Frequency	Percentage
ACOM	9	8.18
MCA	7	6.36
ICA	9	8.18
ACA	1	0.90
PCOM	2	1.83
Total	28	25.45

Location	No.	vasospasm	Post op infarct	Icu stay (>7days)	Post op deficit
ACOM	45	3 (6.67%)	1 (2.22%)	8	6(13.33%)
MCA	28	8 (28.57%)	4 (14.28%)	5	10(35.71%)
ICA	22	3(13.6%)	2(9.09%)	3	4(18.18%)
ACA	5	1	1	1	1
PCOM	10	1(10%)	0	2	2
	110	16	8	19	23

Location and postoperative vasospasm: Comparing the occurrence of vasospasm by Chi square analysis among the three locations, it was seen to be significantly higher in MCA aneurysms in almost 28.57% cases.



Location and postoperative infarct: Trend of increasing occurrence of postoperative infarct was seen in aneurysms in MCA location (14.28%).

Location and Postoperative CSF diversion/ need for re-exploration, postoperative ICU stay duration: No significant correlation seen.

Location & deficits on discharge (motor/speech/neurocognitive): Patients with MCA aneurysms had significantly higher deficit at discharge (35.71%)

8. Aneurysms size:

Our results pointed out that aneurysmal size did not change postoperative outcome significantly. The cause of such disagreement could be the fact that literature data compared mainly post-operative results of aneurysms smaller than 10 mm with those after the occlusion of giant aneurysms, which were excluded from our series.

Aneurysm Size	Frequency	Percentage
</=7 mm	72	65.5
8-14 mm	29	26.1
>14 mm	3	3.3
No Data	6	5.2
Total	110	100.00

9. Intraoperative rupture of aneurysm:

Intraoperative Rupture	Frequency	Percent
Yes	28	25.45
No	82	74.55
Total	110	100.0

10. Postoperative vasospasm:

Postoperative vasospasm	Frequency	Percent
Yes	16	14.2
No	94	85.5
Total	110	99.7

11. Postoperative reexploration/ decompressive craniectomy

reexploration/ decompressive craniectomy	Frequency	Percentage
Yes	1	1.5
No	109	98.5
Total	110	100.0



12. Duration of ICU stay

ICU stay	Frequency	Percent
<= 7 Days	91	82.7
>7 Days	19	17.3
Total	330	100.0

13. Outcome at discharge:

Outcome at discharge was evaluated in the form of deficits at discharge viz. motor, speech and neurocognitive impairment.

On Discharge-Motor deficit:

Motor deficit	Frequency	Percentage
Yes	13	10.9
No	97	89.1
Total	100	100

On Discharge-Speech deficit:

Speech deficit	Frequency	Percent
Y	3	6.1
N	107	93.3
Total	110	99.4

On Discharge Neurocognitive impairment

	Frequency	Percent
Y	7	6.7
N	103	92.7
Total	110	99.4
No data	0	.6

Factors correlating with the presence of motor deficit on discharge

Factors correlating with motor deficit were presence of postoperative infarct and ICU stay for more than 7 days and postoperative vasospasm.



Factors correlating with the presence of speech deficit on discharge

Factors correlating with speech deficit were ICU stay for more than 7 days, presence of post-operative early infarct, need for postoperative CSF shunting.

Factors correlating with the presence of neurocognitive impairment on discharge

Factors predicting neurocognitive impairment on discharge were need for CSF diversion postoperatively, postoperative ICU stay duration more than 7 days.

Patients with no follow up:

Total 10 patients out of 110 did not follow up after discharge. Therefore the 3 month follow up assessment did not include these 10 patients. Being a retrospective study this was a limitation of it which did not allow prospective follow up tracking of those 10 patients. Out of these 2 patients had deficits at discharge. And 8 patients were discharged in good condition with no neurological/ neurocognitive deficit and their outcome at discharge point was not significantly different from the patient group which had follow up. 80% of the patients which did not have follow up had good outcome at discharge point which is comparable to the total series at discharge point which had 84.50% patients with no deficits. So the outcome at discharge point among the non follow up group is not significantly different from the group with follow up. Hence their absence from follow up would not have affected the overall outcome.

Outcome at follow up

To know the outcome at follow up, the follow up data was recorded in the form of mRs score at 3 months and 1 year.

Follow-up mRs Score at 3 months

mRs Score	Frequency	Percentage
0	81	73.63
1	10	9.09
2	2	2.72
3	3	2.72
4	2	1.81
6	2	1.81
Total	100	91
No Data	10	9



Followup mRs Score at 1 Year

mRs Score	Frequency	Percentage
0	73	66.39
1	11	10
2	2	1.81
3	1	0.9
4	1	0.9
Total	88	80
No Data	22	20
Total	110	100

Factors correlating with the poormRs score at 3 months of follow up.

Factors correlating with higher mRs score at 3 months of follow up were postoperative ventilator support duration, postoperative vasospasm, ICA location, need for postoperative re exploration/ decompressive craniectomy, postoperative infarct, need for CSF diversion postoperatively and age.

Factors correlating with the mRs score at 1 year of follow up.

Factors which predict poor outcome with respect to mRs score at 1 year of follow up- were location of aneurysms being at ICA communicating segment, need for CSF diversion postoperatively, postoperative vasospasm, preoperatively hydrocephalus.

Mortality

At 3 months follow up total 7 (6.4%) patients had expired .Out of these, 3 patients were having Acom aneurysms, 1 patient MCA aneurysm and 3 patients in ICA group.The causes for death were postoperative ventilator associated neumonia in patient with MCA. Whereas in Acom aneurysms one death was not related to the aneurysm surgery. In all 3 patients with ICA aneurysms who expired the cause was related to cerebral vasospasm and cerebral edema.

DISCUSSION :

The literature available internationally has revealed the improving surgical outcomes in the management of different simple and complex aneurysms.

Gender and age : In a study, Gail et al reported that although women suffering



from SAH ruptured aneurysms is the same 37. These findings were also confirmed by our results. Ruptured aneurysms are frequently diagnosed in elderly persons mostly older than 70 years. In our series, the mean age of the patients was 54.20 years: majority of the patients were between 51-60 years of age and least number of patients were between > 70 years of age. Male patients (46%) were less frequent than female patients (64%). Majority of the authors that the advanced age diminished the chance for successful outcome. This could be mostly due to associated medical conditions.

Aneurysms size : Our results pointed out that aneurysmal size did not change postoperative outcome significantly. The cause of such disagreement could be the fact that literature data compared mainly postoperative results of aneurysms smaller than 10 mm with those after the occlusion of giant aneurysms, which were excluded from our series.

Preoperative GCS score : In our series no significant correlation could be seen between preoperative GCS score/ WFNS grading and the outcome. However, our study was limited to great majority of our patients with WFNS grade 1 & 2. Number of patients in the WFNS grade II group (GCS 13/14) was just 9% i.e. 10 patients.

Fischer's grade : In a study by Browsers et al 8 the total amount of subarachnoid blood on the initial computed tomogram has been shown to have independent predictive power for the occurrence of delayed cerebral ischemia. In our study patients with higher Fischer's grade were seen to have higher chances of postoperative vasospasm which is in accordance with the literature. There was 30% chances of occurrence of vasospasm in Fischer's grade III SAH. However patients



with grade 4 could not show significant effect which may be due to small frequency i.e less number of patients in this group.

Also a trend of increasing occurrence of postoperative infarct was seen with higher Fischer's grade (26.66% occurrence in patients with Fischer's grade II and all 3 patients of Fischer's grade IV shows post operative infarct. Similarly, increasing ICU stay duration was required for higher Fischer's grade. Fischer's grade I patients showing 96.96% chance of not requiring ICU stay > 7 days and 80% of grade III and 100% of grade IV patients requiring stay > 7 days).

Fischer's grade & deficits on discharge (motor/speech/neurocognitive): Patients with higher Fischer's grade showed increasing trend for deficit at discharge. 53% of grade III and 66% of grade IV showing deficit.

Timing of surgery : However, according to our results, no significant influence of timing of surgery over the outcome could be drawn. This was possibly because, only good grade were included in the study which would not allow stratification of timing of surgery based on the clinical grade of SAH. Also, most of the patients in our series were often admitted late i.e. more than 3 days post SAH and the reason being these patients being primarily managed and investigated in other centre and referred to our institute after a delay already happened in the treatment and also there is a bias in terms of transferability to our centre. This could be a reason why the majority of patients in our operative series underwent surgery >7 days postictal.

Preoperative hydrocephalus and the postoperative need for CSF diversion : Jan Van et al 17 studied the consequences of acute hydrocephalus in patients with SAH and the outcome after shunting. They could not find significant benefit of shunting



and said that shunted patients were, on average, in a worse condition than unoperated patients and it could be expected that the outcome would also be worse in this group.

In our series 16 i.e. 14.54% patients had hydrocephalus preoperatively whereas only 9 i.e. 8.18% patients needed CSF diversion preoperatively. 7(6.36%) patients with preoperative hydrocephalus had persistent hydrocephalus postoperatively requiring CSF. In our study presence of pre-operative hydrocephalus was also seen to correlate with speech deficit, motor deficit, neurocognitive impairment at discharge and poor mRs score at both 3 months and 1 year of follow up Intraparenchymal/ intraventricular bleed.

Intraoperative rupture and temporary clipping : Sandalcioglu et al²⁹ in his study found that intraoperative aneurysm rupture has no impact on the outcome. Batjer et al^{3,4} found increased mortality rate after IOR and confirmed a worsened outcome after IOR in survivors.

In our study temporary clipping time was less than 10 minutes in almost all patients. No significant correlation found between intraoperative rupture/ temporary clipping and post operative deficit, poor mRs score.

Method of securing the aneurysm (clipping/ wrapping) : Ogawa et al⁵³ reported that saccular type aneurysms were safely clipped whereas treatment of blister-type aneurysms by clipping on wrapping material achieved good results, but ICA trapping, clipping , and wrapping were associated with much small (2 patients) which was not sufficient for a comparison worse results In this series the sample size for patients undergoing only wrapping was very small (2 patients) which was



not sufficient for a comparison.

Vasospasm and postoperative infarcts: Rosengart et al 66 in his study substantiated that variables present during hospitalization associated with poor outcome were temperature 38°C 8 days after SAH, use of anticonvulsants, symptomatic vasospasm, and cerebral infarction. The association of vasospasm with poor outcome was substantiated by the odds ratio of 1.75(95% CI 1.21–2.53, p: 0.004) on univariate analysis and on multivariate analysis with odds ratio of 1.72(95% CI:1.30–2.29, p: 0.0001). Use of prophylactic or therapeutic hypervolemia or prophylactic-induced hypertension were associated with a lower risk of unfavourable outcome.

In the present study postoperative vasospasm was seen to be a significant predictor of poor mRs score and seen in higher fischer grade. This higher mRs score could be explained by the vasospasm leading to infarcts in postoperative periods which in turn leading to neurodeficits causing disability.

Re-exploration/ decompressive craniectomy: Ana Rodriguez et al 65 demonstrated that worse outcomes were associated with aneurysm rupture, poor grade, giant size and hemicraniectomy.

In present series only 1 patients underwent re-exploration with decompressive hemicraniectomy for infarcts/ cerebral edema. However on linear regression it was seen to be one of the factor correlating with poor mRs score at 3 months which might just be due to the fact that same patients had extensive infarcts leading to disability and had poor mRs score. ICU stay of more than 7 days was seen to



correlate well with motor deficit, speech deficit and neurocognitive impairment during discharge time. Also it correlated with higher mRs score at 3 months. This findings infers that the patients lying in ICU for more time needed long monitoring which may be in view of vasospasm or other complications.

Location of the aneurysm: Lastly the location of aneurysm within the anterior circulation was seen to significantly differ in terms of deficits and outcome. ICA location of aneurysms was seen to significantly correlate with poor mRs score at both 3 months and 1 year follow up. ICA location showed poor mRs score at 3 months and 1 year follow up respectively. MCA location was seen to have better outcome i.e. mRs score at both 3 months and 1 year follow up as compared to other two locations. These findings were confirmed with Kruskal Wallis analysis.

In a study Rinne Jakko et al 64 correlated anatomical and clinical factors with the management outcomes, in which they found poor outcomes in MCA aneurysms than other anterior circulation aneurysms, 32% and 25% respectively. Multiplicity of aneurysms was one factor associated with poor outcomes. The author say that surgery should remain the treatment of choice for MCA aneurysms, and surgical morbidity was low, and poor outcomes were due to an inclusive policy that aggressively managed poor-grade patients and complex aneurysms.

In our study findings of poor outcome in ICA location of aneurysms may be due to intrinsic differences and structural differences of the aneurysm.

CONCLUSION :

On the basis of the obtained results, we may conclude the following:



The outcome after the operative treatment of non giant cerebral aneurysms with SAH of WFNS grade I or II depended significantly on patients age, Fischer's grade, preoperative hydrocephalus, aneurysm location (Poor outcome in the order ICA>Acom> MCA).

The postoperative parameters which significantly correlated with poor mRs score at 3 months and 1 year of follow up were vasospasm, postoperative infarct, ventilatory support duration and ICU stay duration > 7 days.

The outcome did not significantly depend on patients gender, preoperative GCS/ WFNS grade I or II, preoperative ICH/ IVH, timing for surgery i.e. interval between SAH and surgery, size of the aneurysm, intraoperative rupture or temporary clippingg, method of securing the aneurysm(clipping/wrapping).



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