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Research Article

Outcome of intracranial aneurysm clipping: analysis of first 35 cases

Madhukar T. Nayak[1]*, Vidyashri Kamath[2]

[1]Department of Neurosurgery, [2]Department of Obstetrics and Gynaecology, Father Muller Medical College, Mangalore, Karnataka, India

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***Correspondence:**
Dr. Madhukar T. Nayak,
E-mail: madhukar1978@gmail.com

ABSTRACT

Background: Sub arachnoid hemorrhage due to ruptured intracranial aneurysm is a major healthcare concern because of its fatal consequence and also the potential to be fully treated if acted upon on time. The need for surgical expertise and robust perioperative intensive care remains an essential component for a good outcome. This study looks at the role of different constant and variable factors in the outcome of patients undergoing surgical clipping of aneurysm.
Methods: A retrospective analysis of first 35 cases of spontaneous SAH due to ruptured intracranial aneurysms who underwent craniotomy and clipping were included in this study. Patients were divided into good outcome and poor outcome groups based on Modified Rankin scale at 2 weeks and 6 months postoperatively. Other details obtained included Modified Fisher Grade of SAH, presence or absence of vasospasm, site of aneurysm and size of aneurysm (largest diameter).
Results: Good outcome modified Rankin score was 74.3% at 2 weeks postop, which increased to 80% at 6 months postoperatively. Variables which were found to have a statistically significant impact on the postoperative outcome were Modified Fisher grade, preoperative WFNS grade, duration of temporary clip placement, time of ictus to surgery, side of the aneurysm [left or right] and presence of hydrocephalus.
Conclusions: Surgical clipping is a safe and time-tested modality for treatment of sub arachnoid hemorrhage due to ruptured intracranial aneurysms. Elderly age group, higher modified Fisher grades, higher WFNS Grade preoperatively, larger size of aneurysm, presence of vasospasm and greater duration of temporary clip placement are factors, which lead to poor outcome in patients with ruptured intracranial aneurysm presenting with sub arachnoid hemorrhage.

Keywords: Cerebral aneurysm, Sub arachnoid hemorrhage, Overall outcome, Vasospasm, Aneurysm clipping

INTRODUCTION

Sub arachnoid hemorrhage due to ruptured intracranial aneurysm is a major healthcare concern because of its fatal consequence and also the potential to be fully treated if acted upon on time. It constitutes 85% of non-traumatic SAH cases.[1] The incidence of intracranial aneurysms have been found to be as high as 1% in males and 2% in females in the UK.[2] Although the incidence of patients presenting with routine headache, later found to have ruptured intracranial is very less, strikingly around 10% of patients who were otherwise intact, but had "severe and worst headache of their life", on further workup were found to have a ruptured intracranial aneurysm.[3]

In the recent decades, advances in micro neurosurgical techniques, clear understanding of 3 dimensional neurovascular anatomy and availability of tools for intraoperative evaluation of accuracy of the procedure (intraoperative indocyanine green angiogram, microvascular Doppler and conventional intraoperative angiography) have contributed in making this treatment modality safer and more favorable. The need for surgical

expertise and robust perioperative intensive care remains an essential component for a good outcome.

METHODS

A retrospective analysis of 35 cases of spontaneous subarachnoid hemorrhage due to ruptured intracranial aneurysms that were treated surgically by performing craniotomy and clipping were included in this study. All the patients were thoroughly evaluated clinically by conducting a detailed General and systemic examination with emphasis on Neurological examination and to look for neck stiffness. Preoperative CT scan brain that demonstrated the presence of spontaneous subarachnoid hemorrhage was the baseline investigation. A further investigation for reaching a diagnosis was CT angiogram brain or a conventional digital subtraction angiogram or both. Detailed study of anatomy of the Circle of Willis was done at the CT console using 3D volume rendering software. Presence or absence of vasospasm, extent of SAH, presence of anatomical variations, size of neck, direction of fundus, presence or absence of atherosclerosis, intracerebral and or intraventricular bleed were looked for and noted down. The patient along with close caregivers were counseled regarding available options including possible neuroendovascular techniques, risks, options and possible outcomes of surgical clipping. After obtaining a detailed, informed consent, patient was taken up for craniotomy and clipping of aneurysm. Head fixation devices were used to stabilize the head position. We prefer slight extension and no rotation during head fixation for most anterior circulation aneurysms, as it helps in the frontal lobe naturally falling back and thereby limiting the need for retraction and easier identification and correlation of anatomical landmarks. Any further rotation is obtained by tilting the table if required. C shaped frontotemporal skin incision was placed behind the hairline and scalp flap raised. Pterional or frontotemporal craniotomy is performed in all the cases. The craniotomy is more medial to include inferomedial part of frontal bone in the craniotomy for Acom Artery aneurysms. For internal carotid artery (ICA) and middle cerebral artery (MCA) aneurysms, the frontotemporal key burr hole suffices, which can be used as a starting point for raising the craniotomy flap using a craniotome and cutter of a high speed Neuro drill. The sphenoid ridge is drilled or nibbled using rongeour till it is flat with the base. Temporal bone may sometimes be nibbled to expose the floor of middle cranial fossa. Dura is opened in a c shaped fashion based on sphenoid ridge. The brain is very often, angry red and swollen in acute SAH. We aim to make the brain temporarily lax by either using antioedema measures (inj. mannitol, inj. furosemide etc.) along with controlled hyperventilation. Sometimes, tapping the frontal horn using Dandy's brain cannula helps to drain CSF and make brain lax. Wide opening of sylvian fissure is performed under highest magnification of an operating microscope. Identification of optic nerve by gently retracting the frontal lobe using a self-retaining retractor is the key. The arachnoid dissection advances to expose the ICA. ICA is traced distally to the circle of Willis, depending on the type and location of aneurysm. After sufficient exposure of proximal artery over which temporary clip is placed in 1 or more shorter spells till the neck of aneurysm is dissected and clip placed. We used Inj. propofol and Inj. methyl prednisolone 1 gm i.v. before venturing into placing the temporary clip. This is one of the cerebroprotective measures employed. HHH therapy is initiated as soon as the aneurysm is secured by placing a clip across the neck. Lamina terminalis fenestration is routinely performed to open up the CSF pathway. As we have no access to intraoperative indocyanine green angiogram or intraoperative micro Doppler, visual analysis to look for distal arterial pulsations under high magnification is a good feedback tool for determining adequate patency of distal arteries. Inj. papaverine is instilled locally in the subarachnoid space and a thorough lavage given to washout as much blood as possible. Postoperative intensive care is provided in collaboration with neurointensivist. Regular monitoring of fluid electrolyte balance, nutrition, physiotherapy along with pharmacological measures like anticonvulsants, steroids, antibiotics and nimodepine (initially i.v. at 2ml/hour) tablet at 60mg 4th hourly for 21 days. Repeat CT Angiogram brain is done before discharge or at follow up at 6 weeks. All cases were operated by a single neurosurgeon (first author) between January 2012 to July 2014 were included in the study. Data was entered and analyzed by using Microsoft Excel and SPSS version 17 software. Details obtained included name, age, sex, history of hypertension, location, side and site of aneurysm, presence or absence of hydrocephalus, subarachnoid blood clot thickness measured by Modified Fisher Grade, presence or absence of vasospasm (clinical/radiological/intraoperative findings), WFNS grades before surgery, at 2 weeks and 6 months postoperatively. Patients were divided into good outcome and poor outcome groups based on Modified Rankin scale at 2 weeks and 6 months postoperatively. Other details obtained included time duration from ictus to surgery, presence or absence of intraoperative rupture and duration of temporary clip placement. Data were compared and statistically analyzed.

RESULTS

The most common age group was <60 yrs. which was 60% and 40% cases were >60 yrs. age group. The Male: Female ratio was 3:4. The commonest WFNS grade preoperatively was Grade 1, which was seen in 40 % of patients. The data was segregated into good outcome group (WFNS Grade 1,2,3) and bad outcome group (WFNS Grade 4,5). This data was compiled and analyzed using modified Rankin scale at 2 weeks and 6 months postoperatively. Poor Fisher grade (4 and 5) were seen in 60% cases. 2.9% cases did not have imaging evidence of SAH, but strong clinical suspicion prompted further evaluation, which led to detection of intracranial aneurysm. All these cases had demonstrable

intraoperative evidence of rupture and old subarachnoid bleed. Intraoperative rupture occurred in 22.9% (n=8) cases. All these ruptures were during the exposure or dissection of aneurysm, after wide opening of sylvian fissure and exposing the parent vessel for proximal control. Temporary clipping was employed in all the cases but to a variable extent and frequency. Continuous temporary clip duration was below 10 minutes in 82.9% of the cases. In most of the cases in which temporary clip was kept for >10 minutes, it was found not possible to remove the temporary clip intermittently, due to genuine impediments like, torrential bleed filling the field due to intraoperative rupture, a perforator vessel which got torn while taking out the temporary clip started bleeding torrentially and in 2 cases, gushing venous ooze from an adjacent vein which seemed like an intraoperative aneurysm rupture leading to prolonging of the temporary clip duration. Good postoperative outcome increased from 60% at 2 weeks to 91.4% at 6 months postoperatively.

Table 1: Analysis of variables affecting outcome of patients with spontaneous aSAH showing odds ratio (with 95% CI) for each variable (with P values) at 2 weeks postoperatively.

Variable	Sub group	Outcome at 2 weeks postop - Bad	Outcome at 2 weeks postop – Good	Chi square test/fishers exact test p value		Odds ratio*	95% CI
Mod Fisher grade	Bad	7 (77.8%)	2 (22.2%)	0.000	**p<0.01,HS**	42	4.9753-354.5509
	Good	2 (7.7%)	24 (92.3%)				
Intraop rupture	No	5 (18.5%)	22 (81.5%)	0.184	p>0.05,NS	0.2273	0.0418-1.2345
	Yes	4 (50%)	4 (50%)				
WFNS grade preop	Bad	6 (85.7%)	1(14.3%)	0.000	**p<0.01,HS**	50	4.3917-569.2496
	Good	3(10.7%)	25(89.3%)				
Vasospasm	No	1 (7.1%)	13 (92.9%)	0.097	p>0.05,NS	8	0.8719-73.4004
	Yes	8 (38.1%)	13 (61.9%)				
Aneurysm size	Small	7 (28%)	18 (72%)	0.951	p>0.05,NS	0.6429	0.1086-3.8065
	Large	2 (20%)	8 (80%)				
Age group	< 60yrs	4 (19%)	17 (81%)	0.477	p>0.05,NS	2.3611	0.5045-11.0492
	>60yrs	5 (35.7%)	9 (64.3%)				
Temporary clip Duration	0 - 10 min	4 (13.8%)	25 (86.2%)	0.002	**p<0.01,HS**	31.25	2.8563-341.8952
	> 10 min	5 (83.3%)	1(16.7%)				
Time of ictus To surgery	0- 4 days	0 (0%)	12 (100%)	0.035	**p<0.05,Sig**	∞	NaN - ∞
	> 4 days	9 (39.1%)	14 (60.9%)				
Side of aneurysm	Left	9 (75%)	3 (25%)	0.000	**p<0.01,HS**	∞	NaN - ∞
	Right	0 (0%)	23 (100%)				
Hydrocephalus	No	5 (17.2%)	24 (82.8%)	0.045	**p<0.05,Sig**	9.6	1.3634-67.5981
	Yes	4 (66.7%)	2 (33.3%)				
Hypertension	No	6 (28.6%)	15 (71.4%)	0.937	p>0.05,NS	0.6818	0.1391-3.3414
	Yes	3 (21.4%)	11 (78.6%)				

Based on statistical analysis using the Chi square test and Fishers exact test p value, the parameters found to be statistically highly significant ($p < 0.01$) in determining postoperative good or bad outcome at 2 weeks were modified Fisher grade, preoperative WFNS Grade, temporary clip duration and side of the aneurysm. Time of ictus to surgery and the presence or absence of hydrocephalus at 2 weeks were the parameters showing a significance level of $p < 0.05$. The parameters that could not be shown to be significantly associated with postoperative outcome at 2 weeks were presence or absence of intraoperative rupture, vasospasm, aneurysm size, age group, and hypertension. At 6 months postoperatively, parameters like presence of vasospasm and intraoperative rupture have gained significance ($p<0.05$), whereas the preoperative WFNS Grade becomes non-significant ($p>0.05$). Variables that were found to have a statistically significant impact on the postoperative outcome were modified fisher grade, preoperative WFNS grade, duration of temporary clip placement, time of ictus to surgery, side of the aneurysm and presence of hydrocephalus. At 6 months follow up; role of intraoperative aneurysm rupture seems to have developed statistically significant correlation to postoperative outcome. On the other hand, preoperative hydrocephalus becomes statistically less significant in determining outcome at 6 months follow-up. Figure 1 shows the Odds ratio (=1) for reference group, which comprises of Good Modified Fisher grade (0,1,2), No intraoperative aneurysm rupture, Good preoperative

WFNS grade (1,2,3), absence of vasospasm, age group <60 years, temporary clip duration up to 10 minutes, time of ictus to surgery up to 4 days, right sided aneurysm, absence of hydrocephalus, absence of hypertension.

Table 2: Analysis of variables affecting outcome of patients with spontaneous aSAH showing odds ratio (with 95% CI) for each variable (with P values) at 6 months postoperatively.

Variable	Sub group	Outcome at 6 months postop –bad	Outcome at 6 months postop -good	Chi square test/fishers exact test P value		Odds ratio*	95% CI
Mod fisher grade	Bad	5 (55.6%)	4 (44.4%)	.000	**P<0.01,HS**	15	2.1302-105.622
	Good	2 (7.7%)	24 (92.3%)				
Intraop rupture	No	3 (11.1%)	24 (88.9%)	.033	**P<0.05,Sig**	8	1.2789-50.0416
	Yes	4 (50%)	4 (50%)				
WFNS grade preop	Bad	4 (57.1%)	3 (42.9%)	.017	**P<0.05,Sig**	11.111	1.6338-75.5662
	Good	3 (10.7%)	25 (89.3%)				
Vasospasm	No	1 (7.1%)	13 (92.9%)	.010	**P<0.05,Sig**	5.2	0.5516-49.0186
	Yes	6 (28.6%)	15 (71.4%)				
Aneurysm size	Small	5 (20%)	20 (80%)	.665	P>0.05,NS	1	0.1599-6.2552
	Large	2 (20%)	8 (80%)				
Age group	< 60yrs	2 (9.5%)	19 (90.5%)	.072	**P>0.05,NS**	5.2778	0.8538-32.6252
	>60yrs	5 (35.7%)	9 (64.3%)				
Temporary clip Duration	0-10 min	2 (6.9%)	27 (93.1%)	.000	**P<0.01,HS**	67.5	5.0983-893.6757
	> 10 min	5 (83.3%)	1 (16.7%)				
Time of ictus To surgery	0- 4 days	0 (0%)	12 (100%)	.036	**P<0.05,Sig**	∞	NaN - ∞
	> 4 days	7 (30.4%)	16 (69.6%)				
Side of aneurysm	Left	7 (58.3%)	5 (41.7%)	.000	**P<0.01,HS**	∞	NaN - ∞
	Right	0 (0%)	23 (100%)				
Hydrocephalus	No	4 (13.8%)	25 (86.2%)	.145	P>0.05,NS	6.25	0.919-42.506
	Yes	3 (50%)	3 (50%)				
Hypertension	No	4 (19%)	17 (81%)	.865	P>0.05,NS	1.1591	0.2164-6.2076
	Yes	3 (21.4%)	11 (78.6%)				

* Odds ratio (=1) for reference group, which was Good Modified Fisher grade (0,1,2), No intraoperative aneurysm rupture, Good preoperative WFNS grade (1,2,3), absence of vasospasm, age group < 60 years, temporary clip duration upto 10 minutes, time of ictus to surgery upto 4 days, right sided aneurysm, absence of hydrocephalus, absence of hypertension.
P value < 0.01 is highly significant (HS), 0.05 – 0.01 is significant (Sig).

DISCUSSION

Analysis of outcome

Analysis of our data revealed a good outcome in 74.3% patients (26/35) and bad outcome in 25.7% patients (9/35), and mortality in 20 % patients (7/35) at 2 weeks postoperatively. At 6 months follow-up, good outcome was seen in 80% patients (28/35) and bad outcome in 20% (7/35), which were all the patients who had succumbed within the first 2 weeks after surgery. This emphasizes the need for good postoperative care in poor grade SAH patients who have been treated surgically. All patients who could survive the first 2 weeks postoperatively showed good improvement at 6 months follow-up and moved to the good outcome group.

Rosengart et al., in their study found that increased age, worse neurological grade, more blood on CT scan, intraventricular hemorrhage, and angiographic vasospasm were markers of poor outcome.[4] In our study, the presence of vasospasm very well matched with the extent of SAH as per modified Fisher grade.

Although preoperative Neurological status (WFNS Grade) was found to be significantly influencing the outcome, it was not the case with age and vasospasm as factors in our study. Broderick et al., demonstrated that advanced age and poor WFNS score were significant predictors of poor postoperative outcome.[5] Chiang et al. demonstrated the importance of preoperative WFNS grade in predicting the postoperative outcome.[6] This was more so in the poor grade aneurysms that led to bad postoperative outcomes. There was a similar study by Kassell et al. of International Cooperative Study on the Timing of Aneurysm Surgery which emphasized the importance of preoperative WFNS grade in directly influencing the postoperative outcome.[7] Our findings are concordant with the above studies.

Feign et al., demonstrated the importance of smoking, hypertension, and excessive alcohol as risk factors for aSAH.[8] Kassell et al.,[7] and Juvela et al.,[9] depicted hypertension as a significant risk factor for poor outcome after aSAH. We did not find a significant correlation between hypertension and postoperative outcome. Role of smoking and alcohol were not included in the scope of our study.

Lagares et al.,[10] Rosengart et al.,[11] and Vergouwen et al.[12] showed that cerebral vasospasm plays an important role in determining outcome in aSAH. In their studies, cerebral infarcts presenting as hypo densities on postoperative imaging correlated with poor outcome. Darsaut et al.,[11,13] found in their study that aneurysms 10 mm or larger may have greater treatment- associated risks. In our study, vasospasm seems to play a significant role only at 6-month follow-up. Size of aneurysm does not seem to have a significant impact on outcome in our study. One more interesting finding in our study was the statistically highly significant difference in outcome based on the side of aneurysm location. Left sided aneurysms had poorer outcome compared to the right sided ones. However, the small sample size hinders us from drawing any sweeping conclusions.

Hamada et al., in their 1634 operated cases had an adverse outcome in 29.4 %, which was much better than the 94.3 % bad outcome seen in the 477 patients managed non operatively[14]. Nieuwkamp et al., did a metaanalysis of population based studies in which the case fatality rates was found to be more than 40% in most of the studies.[15] Sodhi et al., in their 307 patients who underwent surgical clipping, had an overall mortality was 27.7% at 3 months follow up compared to 85.5% in the conservatively treated group and 50.2% had good outcome, with a Glasgow Outcome Score (GOS) of 4 or 5.[16] In our study, poor outcome was seen in 25.7% (mortality in 20%) cases, which reduced to 20 % overall poor outcome at 6 months follow-up. The role of HHH therapy (hypertension, hemodilution and hypervolemia) along with oral nimodepine has long ago been established and still remains a time tested and key component in the medical management of aSAH.[17] We have administered HHH therapy to all our patients for 5-7 days postoperatively.

Our study observations are limited by the fact that the sample size is small, the study duration and follow-up is relatively short and the operating surgeon is in the initial part of his learning curve in Neurovascular surgery. Other factors, which might have contributed to the study outcome but were not considered, include the physiological changes in the perioperative period like hypotension, hypoglycemia, hyperglycemia, presence or absence of adequate collaterals during temporary clipping and role of blood transfusion. The extent of SAH, presence of significant intracerebral hematoma, the extent and degree of vasospasm and its evolution during course of treatment could have influenced the outcome of the study to a variable extent. The role of Apo lipoprotein E allele isoforms, demographic variation and genetic factors in outcome for aneurysmal SAH are in themself topics of discussion. These variables could not be analyzed in this study.

CONCLUSIONS

Surgical clipping is a safe and time-tested modality for treatment of sub arachnoid hemorrhage due to ruptured intracranial aneurysms. Elderly age group, higher modified Fisher grades, higher WFNS Grade preoperatively, poor modified Rankin score, larger size of aneurysm, presence of vasospasm and greater duration of temporary clip placement are factors which lead to poor outcome in patients with ruptured intracranial aneurysm presenting with sub arachnoid hemorrhage.

SAH due to ruptured intracranial aneurysm potentially being a completely curable disease, especially when treated definitively at the right time, and with the neuroendovascular techniques outside the reach of a large section of economically deprived population in developing countries, this study comes as a welcome note to young neurosurgeons to reenergize themselves, rededicate their efforts and galvanize their resources in nurturing the art and science of aneurysm clipping. With good preoperative workup and planning, optimum training and skill acquisition and reliable postoperative care, outcome of aneurysm clipping can be favourable most of the times even in centres like ours with a single neurosurgeon in the initial stage of his career in Vascular Neurosurgery.

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