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Original Research Article

ENDOVASCULAR MANAGEMENT OF INTRACRANIAL ANEURYSMS -VARIOUS METHODS, EFFICACY AND COMPLICATIONS

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Abstract

Background: Spontaneous subarachnoid haemorrhage (SAH) accounts for 3-5% of all acute strokes, with 80% caused by ruptured intracranial saccular aneurysms. The risk increases with age and peaks between 40-60 years, and early identification and treatment can prevent rupture. The aim was to study the safety and efficacy of endovascular management of intracranial aneurysms and the various hardware used to observe procedural and immediate postprocedural complications and their management. **Materials and Methods:** This prospective study included 30 patients with subarachnoid haemorrhage at the Government Medical College, Nagpur, between December 2016 and November 2018. Demographic data and blood investigations, including CBC, KFT, LFT, PT/INR, HIV, HBsAg, and anti-HCV, were collected. The modified Fischer grade of subarachnoid haemorrhage and the modified WFNS scale were assessed for each patient. **Result:** Of the 30 patients, the most common age group was above 50-60, and the mean age was 55.26±9.43 years. The major procedural and postprocedural complications noted were aneurysm rupture, coil migration, and thromboembolic phenomenon (infarction). No significant association was found between vessel size, neck dimensions, and lobulation (p=0.130, p=0.658, and p=0.184, respectively). The time required for balloon-assisted coiling is significantly longer than for simple coiling. The mean operative time was not significantly associated with the risk of complications. Higher WFNS and modified Fischer scores were associated with poor outcomes (p=0.002 and p=0.008, respectively). **Conclusion:** The study found that Endovascular coiling is an effective and safe method for preventing rebleeding from intracranial aneurysms, with a survival rate of 93.4% at six months, despite the associated risks.

INTRODUCTION

Spontaneous (i.e. non-traumatic) SAH accounts for 3-5% of all acute strokes. Approximately 80% of these cases are caused by ruptured intracranial saccular aneurysms (ISA). The overall prevalence of aSAH is approximately 9.1/100,000 per year.[1] The overall incidence of aSAH increases with age, peaking between 40 and 60 years. The M: F ratio is 1:2, and aSAH is rare in children.[2] Regardless of their relative rarity, cerebral aneurysms cause the majority of spontaneous (non-traumatic) SAHs in children, accounting for approximately 10% of all childhood haemorrhagic strokes. Aneurysms typically form at branch points along the intracranial arteries, and haemodynamic stress on the wall between the existing branches weakens this region. The risk of intracranial aneurysms is increased among persons with a family history (defined as at least one first-degree relative who has had an intracranial aneurysm, with a greater risk if two or more first-degree relatives have had such an event), among persons with certain connective-tissue disorders (e.g., the Ehlers–Danlos syndrome), and persons with polycystic kidney disease.[1]

Factors associated with an increased risk of aneurysm rupture include black race, Hispanic ethnicity, hypertension, current smoking, alcohol abuse, use of sympathomimetic drugs, and an aneurysm larger than 7 mm.[3,4] The World Health Organization Multinational Monitoring Trends and Determinants in Cardiovascular Disease (WHO MONICA stroke study), a large observational study on 11 populations in Europe and China, reported a 30-day case fatality rate of 42%.[5] Among the patients with aneurysmal subarachnoid haemorrhage who survived, half suffered long-term neuropsychological effects and decreased quality of life. Early identification and treatment of the aneurysm can prevent rupture and address sequelae from the initial rupture.[6]

The primary objective of aneurysm treatment is to eliminate the risk of SAH and reduce symptoms related to mass effects. The most independent indicator of future aneurysm bleeding risk is the extent of occlusion.[7] Endovascular therapy can be deconstructive or reconstructive, depending on whether the parent artery must be preserved. Historically, ruptured aneurysms have been treated with electrothermic thrombosis or pilot injection. A new era in the treatment of IA began when Italian neurosurgeon Guido Gugliemi introduced electrolytically detachable platinum coils in 1991. Today, the focus is on measures to promote endothelialisation across the aneurysm neck after coiling to prevent regrowth and rebleeding.[8]

AIM

The aim was to study the safety and efficacy of endovascular management of intracranial aneurysms and the various hardware used to observe procedural and immediate postprocedural complications and their management.

MATERIALS AND METHODS

This prospective study was conducted on 30 patients with subarachnoid haemorrhage referred from the Neurosurgery/Medicine Department for four-vessel DS Angiography and coil embolisation to the Department of Intervention Radiology at the Government Medical College, Nagpur, between December 2016 and November 2018.

Inclusion Criteria

Patients with an intracranial aneurysm on four-vessel angiography with suitable anatomy were included.

Exclusion Criteria

Patients with deranged coagulation profiles, those who were declared unfit on pre-anaesthetic checkups due to comorbidities, pregnant patients, allergies to contrast media, deranged KFT, and those who did not provide consent for the procedure were excluded.

Written informed consent was obtained from all patients after the procedure, and the complications were explained in detail. Ethical clearance was obtained from the institutional research and dissertation committee/ethics committee.

Demographic data and blood investigations, including CBC, KFT, LFT, PT/INR, HIV, HBsAg, and anti-HCV, were collected. Imaging Investigations were performed, including plain computed tomography (CT) of the brain and CT/MR Cerebral Angiography. The modified Fischer grade of subarachnoid haemorrhage and the modified WFNS scale were assessed for each patient. All patients with aSAH were assessed using brain CT (NCCT or angiography) before DSA. CT cerebral angiography was performed wherever feasible, thus providing a platform to plan further management. CT scan provided the severity and site of SAH, mass effect, and possible vessel involvement.

Before invasive intervention, the patient's coagulation profile was checked. Routinely, the prothrombin time (PT) and international normalised ratio (INR) are usually sufficient. PT values should preferably be less than four seconds above the control level and INR less than 1.5 for the procedure to be free of significant bleeding complications. If the PT/INR values decreased, the procedure was performed after normalising the PT-INR values. The procedure was performed after at least four hours of fasting. For patients with diabetes, the morning dose of the hypoglycaemic drug was stopped on the day of the procedure. However, the morning dose of the antihypertensive drugs was continued. 4 vessel angiography was performed in each patient before the procedure. A 3D rotational angiogram was also obtained in some cases. Aneurysm number, site, size, morphology, and neck dimensions were evaluated. Parent vessel anatomy was also assessed. The procedure was performed under general anaesthesia and was divided into two phases: vascular access and aneurysm treatment. Embolisation was assessed according to the modified Raymond Roy Occlusion Classification.

Post-embolisation care: Post-procedure patients were observed for 48-72 hours. Inj. Dexamethasone 4 mg qid was administered for two days. Antiepileptic therapy was started (Table Levetiracetam 500 mg bd × 3 months), or the previous antiepileptic therapy was continued before antiepileptic). Nimodipine 30 mg qid was continued to prevent vasospasm. Inj Mannitol 100 mg × tds × 3 days was administered to maintain the intracranial pressure. Antibiotic coverage is also provided. Strict immobilisation of the punctured lower limb for 12 hours was advised. BP/urine output was monitored. Postprocedural complications were monitored.

The patients returned for clinical visits at 1 and 6 months, which included clinical assessment, adverse events, and medication compliance. The modified Rankin scale score was then calculated. A score of 0–2 was considered to indicate a good outcome. Follow-up MR/DS angiography was performed at six months to identify recurrence or recanalisation of the aneurysm.

Statistical Analysis

Collected data were entered into a Microsoft Excel spreadsheet. Continuous variables are presented as Mean SD, and categorical variables are expressed as frequencies and percentages. Categorical variables were compared using the chi-squared test. For small numbers, Fisher's exact test was applied wherever applicable. The mean operative time and size between the two procedures were compared using an independent t-test. One-way ANOVA was used to compare the mean sizes across different vessel numbers. Statistical significance was set at $p < 0.05$. The statistical software STATA version 14.0 was used for data analysis.

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RESULTS

Among the 30 patients, the most common age group was above 50-60 years. Among them, 17 (56%) were between 51-60 years, and the mean age was 55.26±9.43 years. Three cases were reported in the fourth decade of life and four in 5th decade. Six cases have been reported beyond 6th decade. Women accounted for 76.6% of the population, and 23.3% were males. Thirteen patients were hypertensive (43.3%), and 9 were smokers/tobacco chewers (30%). Four patients (13.3%) had alcoholism, and none of the above risk factors were present in 4 patients. Eight patients (26.7%) had ACOM aneurysms, and 7 (23.3%) had ACA and ICA aneurysms. The most common vessel involved was ACOM, followed by ACA and ICA. Twenty-three patients (76.6%) had narrow-necked aneurysms, and seven (23.3%) had wide-neck aneurysms. Fifteen aneurysms (50%) were single-lobed, 11 (36%) were bilobed, and four were multilobed.

In 23 out of the 30 patients, 76.7% fell under Raymond Ray occlusion class I. Of the five patients, 16.7% fell under Class II, and 6.6% fell under Class III. Of the 30 cases, 22 aneurysms were embolised using simple (unassisted) coiling, and 8 cases were embolised using a balloon-assisted technique. The major procedural and postprocedural complications noted were aneurysm rupture, coil migration, and thromboembolic phenomenon (infarction). Of the 30 patients, one aneurysm ruptured (3.3%). Distal coil migration occurred in one case (3.3%). Three patients (10%) had infarction after the procedure. Most patients had MRS Grade 1 (56.7%), followed by grade 2 (16.7%) and grade 6 (6.7%) [Table 1].

No significant association was found between vessel size, neck dimensions, and lobulation (p=0.130, p=0.658, and p=0.184, respectively) [Table 2].

The mean time for simple coiling was 76.81± 20.50 minutes, whereas the meantime for balloon-assisted coiling was 107.5 ± 15.81 minutes. The time required for balloon-assisted coiling is significantly longer than for simple coiling. There was no significant difference between the balloon-assisted and simple coiling groups. The mean operative time was not significantly associated with the risk of complications. The mean operative time for complications was 97±32.51, and without complication was 82.6±73.74.

Of the 30 patients, three (10%) had no symptoms and grade 0. Seventeen patients (56.7%) had no significant disability and could perform all usual activities despite some symptoms (Grade 1). Five patients (16.7%) had a slight disability and were able to look after their affairs without assistance but were unable to carry out all previous activities, which was Grade 2. Three patients (10%) had a moderate disability. Requires some help but can walk unassisted. i.e. Grade 3. Two Patients died during the follow-up period (grade 6) [Table 3].

Higher WFNS and modified Fischer scores were associated with poor outcomes (p=0.002 and p=0.008, respectively) [Table 4].

Table 1: Demographic data of the study

		No. of Cases	Percentage
Age in years	31 – 40	3	10
	41 – 50	4	13.3
	51 – 60	17	56.6
	61 – 70	5	16.6
	71 – 80	1	0.03
Sex	Male	7	23.3
	Female	23	76.6
Risk factor	Hypertension	13	43.3
	Alcohol	4	13.3
	Tobacco/Smoking	9	30
	None of the above	4	26.7
Vessel involved	ACA	7	23.3
	ACOM	8	26.7
	ICA	7	23.3
	MCA	5	16.7
	PCA	3	10
Neck	Narrow	23	76.6
	Wide	7	23.3
Raymond Roy Occlusion	1	23	76.7
	2	5	16.7
	3	2	6.6
Complication	Coil migration	1	3.3
	Rupture	1	3.3
	Infarct	3	10
	Headache	11	36.7
	GA related	3	10
	Puncture related	4	13.3
MRS grade	0	3	10
	1	17	56.7
	2	5	16.7
	3	3	10
	4	0	0

	5	0	0
	6	2	6.7

Table 2: Association of vessels involved between size, neck, and lobulation

Vessel involved		ACA	ACOM	ICA	MCA	PCA	P-value
Size of aneurysm		4.8 ±1.92	6.37 ± 0.74	7.42 ± 1.81	5.32 ± 2.41	6.67 ± 2.30	0.130
Neck	Narrow	6	7	4	4	2	0.658
	Wide	1	1	3	1	1	
Lobulation	Single	2	5	3	2	3	0.184
	Bilobed	5	1	2	3	0	
	Multilobed	0	2	2	0	0	

Table 3: Association of mean operative time, Raymond Roy occlusion, complication and MRS grade between procedure

		Procedure		P-value
		Balloon	Simple Coiling	
Mean operative time		107.5±15.81	76.81 ±20.50	<0.001
Raymond Roy occlusion	1	5	18	0.075
	2	1	4	
	3	2	0	
Complication	GA related	2	1	1.000
	Coil migration	1	0	
	Rupture	1	0	
	Headache	2	9	0.672
	Infarct	2	1	0.166
	Puncture related	0	4	0.267
MRS grade	0	0	3	0.378
	1	0	17	<0.001
	2	4	1	0.011
	3	2	1	0.166
	6	2	0	0.066

Table 4: Association of WFNS score and modified Fischer score between outcome

Score		Outcome		P-value
		Good	Poor	
WFNS	1	7	0	0.002
	2	13	0	
	3	5	5	
MFisher	1	16	0	0.008
	2	2	0	
	3	7	4	
	4	0	1	

DISCUSSION

In our study, the most common age group for subarachnoid haemorrhage was 40-70 years, with 17 cases aged 51-60 years. The mean age was 55.26 ± 9.43 years, and the incidence decreased beyond the sixth decade. 76.6% of the population were females, and 23.3% were males. Thirteen (43.3%) out of 30 patients were hypertensive, 9 (30%) out of 30 patients were tobacco users, and 4 (13.3%) out of 30 patients were alcoholic. Four patients were absent of the above risk factors (13.3%). These results are comparable to those of a study by Qureshi et al. on risk factors for subarachnoid haemorrhage, which suggested that 54% of patients were hypertensive and 39% were previous smokers. Heavy alcohol consumption is associated with a higher risk of aSAH, as suggested.[10] Also, a meta-analysis by Yao et al. concluded that hypertension, tobacco consumption, and alcohol consumption increase the risk for the development of SAH.[11] Slight variations observed can be attributed to the cultural habits of the Indian population.

In this study, aneurysms were more common in the anterior and posterior circulation. These results are comparable to the findings of Keedy et al., which state that the anterior communicating artery (ACom) represents the most frequent aneurysm site (30–35%), followed by the internal carotid artery (ICA) (30%), including posterior communicating, carotid bifurcation, ophthalmic artery aneurysms, and the middle cerebral artery (MCA) (22%). Aneurysms of the posterior circulation account for 8–10% of aneurysms. These results are also in concordance with the study by Inagawa et al.[12,13]

Our study found no significant association between vessel involvement and neck dimensions. Of the 30 patients, 15 (50%) were single-lobed, and 15(50%) were multilobulated. Among the multilobulated aneurysms, 11 were bilobed, and four had more than two lobes. These results are comparable to a study by Abboud et al., which found that multilobulated aneurysm was the most frequent finding among ruptured aneurysms, followed by single sac with irregular margin, aneurysm with daughter sac and single sac with smooth margin, 44.9%, 25.9%, 18% and 11.2%, respectively.[14]

Classes I and II were achieved in more than 90% of the patients in our study. Similar results were reported by Gizewski et al., who found that complete occlusion (Raymond Class I) could be achieved in 80 (74%) aneurysms. However.[15] Our study suggests no significant difference (p=0.075) between the unassisted and balloon-assisted coiling occlusion rates. However, Shapiro et al. reported the rate of thromboembolic events was quite similar in patients treated with coiling (8.1%) and balloon remodelling (8%) and suggested better occlusion rates with balloon-assisted coiling.[16]

Our study showed no significant difference between the balloon-assisted and simple coiling groups. Mean operative time was not significantly related to the risk of complications. Layton et al., in their study, reported that the rate of thrombus formation/symptomatic thromboembolic events was not significantly different in patients treated with standard coiling compared with the remodelling technique (9% and 14%, respectively/5% in standard coiling and 7% in remodelling).[17]

In our study, of the 30 patients, the majority (56.7%) had no significant disability and could perform daily activities. However, a small percentage (1.6%) had slight disabilities and struggled with previous activities. The remaining patients (10%) had moderate disabilities and required assistance, whereas 6.6% died during follow-up. The study found favourable outcomes in 83.4% of the cases, and unfavourable outcomes were noted in 16.6% of the patients. The mortality rate at the end of six months was 6.6%. Our results are comparable to those of a study by Goel et al., and a good outcome was observed in 87.6% of patients, while a poor outcome was observed in 10.2% of patients, with a mortality rate of 2.2%. In comparison, the total rate of death or dependency in the ISAT trial was 23.7% at one-year follow-up.[18]

In our study, patients with better WFNS scores at presentation had better outcomes and favourable modified Rankin scores at six months. Patients with Poor WFNS scores had unfavourable modified Rankin scores at six months. Out of 10 patients with a WFNS score of 3, 5 had unfavourable outcomes, with a significant p-value of (p=0.002). These results align with the study by Zhao et al., which stated that a poor WFNS score is one of the indicators of poor outcomes.[19]

In our study, patients with lower modified Fischer scores at presentation had better outcomes, that is, favourable modified Rankin scores at six months. Patients with high modified Fischer scores had unfavourable modified Rankin scores at six months. Out of 12 patients with modified Fischer score of 3 or 4, 5 had unfavourable outcomes with a significant p-value of (p=0.008). These results align with the study by Zhao et al., which stated that a higher modified Fischer score is one of the indicators of poor outcomes.[19] There was recurrence at six months in our study. None of the surviving patients had recanalisation of aneurysms compared with a post-treatment angiogram. Miri et al. reported that (5.3%) of the patients in their study had new growth, and 5.3% had widening of the neck at six months follow-up.[20] In our study, no recurrence could be attributed to a small sample size.

CONCLUSION

Most participants were females, and hypertension, tobacco use, and alcohol intake were associated with these risk factors. The anterior communicating artery is the most commonly involved vessel. The anterior circulation is more commonly involved than the posterior circulation, and aneurysms of any size may rupture. However, aneurysms of the ACA rupture at smaller sizes than those of other vessels. Adequate occlusion of aneurysms can be achieved using endovascular coiling in > 90% of cases, with an acceptable rate of complications. Balloon-assisted coiling requires additional time. However, this was not associated with any additional complications. The WFNS and modified Fischer scale were predictors of outcomes, and survival at six months was 93.4%. Therefore, endovascular coil embolisation is an effective and safe method with acceptable complications to prevent rebleeding from intracranial aneurysms.

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