Original Article

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Mid-term outcome of unassisted endovascular coil embolization in spontaneously ruptured aneurysmal subarachnoid hemorrhage: A single center single performer experience

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Abstract:

Background: Although adjunctive techniques like stent/ flow diverters, or balloon-assisted techniques have become popular over last two decades, unassisted coil embolization remains a simple minimalist strategy, particularly in resource poor settings. But the safety and efficacy data from a real-world low-income country is very limited. This study was done to evaluate the long-term clinical outcomes of unassisted endovascular coil embolization in a large cohort of intracranial aneurysms treated at a single center by a single interventional neurologist.

Methods: This was an ambi-directional cohort study. We retrospectively have analyzed 235 intracranial aneurysms treated with unassisted coil embolization between January 2021 to December 2024. Demographic data, aneurysm characteristics, procedural details, complications, and clinical outcomes were reviewed. Mid-term follow-up clinical outcomes were evaluated using the modified Rankin Scale (mRS) at 12 months prospectively.

Results: A total of 235 aneurysms from 221 patients were selected for analysis according to inclusion criteria. Around two third of the patients (61%) were aged greater than 50 years with a mean age of 50.34 (±16.1) years and a male to female ratio were 1:2.25. Most common symptoms at presentation were sudden severe headache (90.9%), vomiting (35.7%), loss of consciousness (32.1%) and altered sensorium (28.1%). More than half of the patients (52.9%) had a WFNS grade of 1 and around 43.4% patients had modified fisher grade of 4. Around three fourth (75.2%) were small to medium sized that is from 3 mm to 10 mm with majority being narrow necked (70.8%). Most of the aneurysms (88.9%) were in anterior circulation of which Anterior communicating artery (AcoM) aneurysms (18.7%) and posterior communicating artery (PcoM) aneurysms (16.6%) were the most common. Among the posterior circulation aneurysms, Basilar tip was the most frequent location found in 11 patients, followed by posterior cerebral artery aneurysm in 5 patients. RROC class 2 and 1 were achieved among majority of the patients (94.4%). The rate of procedural complications was 9.4% (22 events) among which intraprocedural rupture of aneurysms was the most common event (3.4%), followed by thromboembolic complications in 2.9%. Majority of the patients (86.8%) had favorable outcome (mRS 0-2) at at 12 months. Total number of deaths at follow up were 10 (4.5%).

Conclusion: Unassisted endovascular coil embolization is a safe and effective treatment for selected intracranial aneurysms, providing durable long-term occlusion with acceptable complication and retreatment rates. A single-performer experience highlights the importance of patient selection and technical consistency in achieving favorable outcomes.

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Key words: Intracranial aneurysm; coil embolization; unassisted coiling; endovascular treatment; mid-term outcome

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Introduction:

Aneurysmal Subarachnoid Hemorrhage (aSAH) is the most devastating type of stroke with high mortality and morbidity with a case burden mostly in low-and middle-income countries[1].

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Over the last century primary goal in management of aSAH has shifted from the conservative to more robust approach focused on securing the aneurysm at the earliest possible time and prevention of rebleed. Although the surgical clipping was the mainstay of treatment in the early 1950s to 1980s, Endovascular coil embolization has become a cornerstone in the management of intracranial aneurysms following the results of large randomized trials demonstrating its efficacy and safety[2,3]. The International Subarachnoid Aneurysm Trial (ISAT) has demonstrated that, compared with surgical clipping, endovascular coiling reduced the absolute risk of death or dependency by 7.4% at one year[4]. Moreover, patients treated with coiling experienced better functional outcomes, with lower rates of mortality and long-term dependence. Together, these results established endovascular coiling as a standard of care for ruptured aneurysms and significantly accelerated the worldwide adoption of endovascular approaches in aneurysm management[4-8].

Over the past two decades, adjunctive techniques such as balloon-assisted coiling, stent-assisted coiling, and flow diversion have expanded the spectrum of aneurysms amenable to endovascular treatment[2]. Nevertheless, unassisted coil embolization remains a fundamental technique, particularly for narrow-neck aneurysms and in clinical scenarios where adjunctive devices may increase risk or require prolonged antiplatelet therapy. Despite its widespread use, the long-term and mid-term durability of unassisted coil embolization continues to be debated, particularly regarding aneurysm recurrence and retreatment rates[9]. Moreover, most published studies represent multicenter or multi-operator experiences, introducing variability in technique and decision-making[3,9].

The establishment of neurointerventional services in a publicly funded hospital pose many challenges. These included a shortage of adequately trained personnel to operate a biplane digital subtraction angiography (DSA) suite, limited availability of nursing staff experienced in stroke care and catheterization laboratory workflows, and difficulties in ensuring a consistent supply of neurointerventional equipment [7,8]. This study was done to evaluate the long-term clinical outcomes of unassisted endovascular coil embolization in a large series of 235 aneurysms treated at a single center by a single experienced neurointerventionist, thereby minimizing technical variability and providing insight into the durability and feasibility of this technique.

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Materials and Methods

Study Design and Patient Population

This ambi-directional cohort study included patients aged 18 years and above who underwent simple endovascular treatment for ruptured intracranial aneurysms at the Department of Interventional Neurology, National Institute of Neurosciences and Hospital between January 2021 to December 2024 by single operator. A total of 268 case records were found among which 235 aneurysms in 221 patients treated with unassisted coil embolization, were selected for the study. Patients with unruptured, dissecting or mycotic aneurysms were excluded. Consecutive sampling technique was used. Demographic, clinical, and imaging data were collected and analyzed retrospectively from hospital record. Data related to aneurysms, including size, shape, neck size, aspect ratio, rupture status, and location, were meticulously documented. The severity of aSAH was assessed using the modified Fisher grade, while the World Federation of Neurosurgical Societies (WFNS) grading scale was used to evaluate clinical status at presentation. Endovascular procedures were performed under general anesthesia. Following catheterization of the vertebral or internal carotid artery, a contrast agent was injected to establish a navigational roadmap. Using a coiling microcatheter and appropriate guidewires, the aneurysm is cannulated. The simple coiling technique was used. The angiographic outcomes were evaluated using the Modified Raymond–Roy Classification (MRRC) grading scale to assess the degree of aneurysm occlusion.

Patient outcomes at discharge were classified using the modified Rankin Scale (mRS) as follows: good outcome (mRS 0–2), poor outcome (mRS 3–5), or death. Procedure-related complications were thoroughly recorded. Follow-up. Long-term functional outcomes were also measured by mRS scores. The primary safety end points were the rate of peri procedural bleeding, thrombo-embolic complications and peri procedural mortality and the secondary safety end points being post procedure mortality and morbidity after discharge. Raymond Roy grade of aneurysm occlusion was the primary efficacy end point and the post procedure rate of re bleed was assessed as secondary efficacy end point.

Ethical approval was taken from the Institutional Review Board (IRB) at National Institute of Neurosciences and Hospital. Descriptive statistics were used to summarize demographic, procedural, and outcome data. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

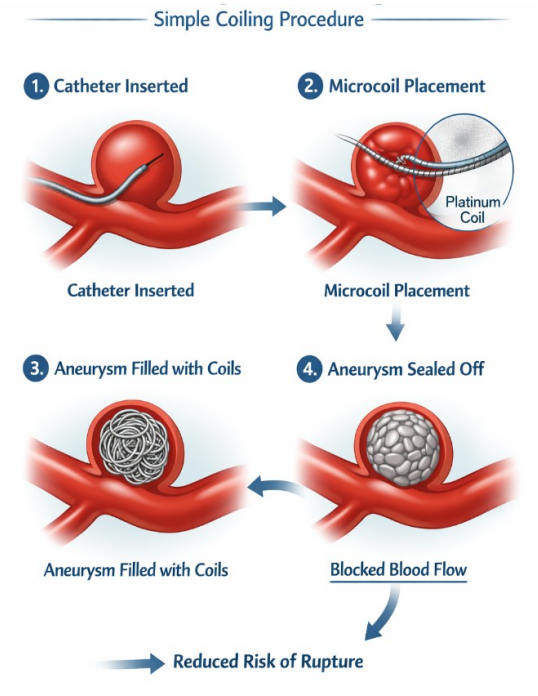

Figure 1: Diagram for unassisted (simple) endovascular aneurysm coiling

Result

Patient Demographics and presentation

A total of 221 patients were selected for analysis according to inclusion criteria. Around two third of the patients (61%) were aged greater than 50 years with a mean age of 50.34 (±16.1) years. The male to female ratio were 1:2.25 (Table-1). Sudden severe headache (90.9%), vomiting (35.7%), loss of consciousness (32.1%) and altered sensorium (28.1%) were the most common symptoms at presentation. Around half of the patients (53.4%) were hypertensive and 19.5% had diabetes. More than half of the patients (52.9%) had a WFNS grade of 1, followed by grade 2 among 24%. In imaging analysis of CT scan of head, around 43.4% patients had modified fisher grade of 4, followed by grade 1 in 27.6% (Table-2).

Table-1: Distribution of patients by age and sex (n=221).

Age Group (in years)	Number	Percentage
18-30	5	2.3
31-40	14	6.3
41-50	68	30.8
51-60	105	47.5
>60	29	13.1
Mean (±SD)	50.34(±16.1) years	24-76 years
Sex		
Male	68	30.7
Female	153	69.3

Table- 1 shows that about two third (61%) of the patients were elder than 50 years of age and mean age of the patients was 50.34 (±16.1) years at onset with a range of 24 to 76 years and there is a female predominance (69.3%) with M:F ratio of 1:2.25

Table-2: Presentation and co-morbidities at admission (n=221).

Presentation and comorbidity	Number	Percentage
Sudden severe headache	201	90.9
Vomiting	79	35.7
Altered sensorium	62	28.1
Loss of consciousness	71	32.1
Convulsion	9	4.1
Hemiparesis	12	5.4
Monoparesis	5	2.2
Hypertension	118	53.4
Diabetes	43	19.5
WFNS Grading		
Grade 1	117	52.9
Grade 2	53	24
Grade 3	12	5.4
Grade 4	31	14
Grade 5	8	3.6
Modified Fisher Grade		
Grade 1	61	27.6
Grade 2	41	18.6
Grade 3	23	10.4
Grade 4	96	43.4

Table-2 shows the clinical presentations imaging grading and co-morbidities at admission of the aSAH patients.

Aneurysm demographics

Our study analyzed a total of 235 aneurysms among 221 patients from the record. Around three fourth (75.2%) were small to medium sized that is from 3 mm to 10 mm. Around 7.2% were tiny (<3 mm) whereas 6.8% were giant aneurysms, Majority of the aneurysms (70.8%) had narrow neck (Table-3). Out of the 235 aneurysms, only 26 were in posterior circulation and the rest in anterior circulation. Anterior communicating artery (AcoM) aneurysms (18.7%) and posterior communicating artery (PcoM) aneurysms (16.6%) were the most common aneurysms treated with simple coiling technique. Middle cerebral artery (MCA) bifurcation aneurysm (12.4%), Cavernous paraclinoid internal carotid artery aneurysms (11.2%), Supraclinoid internal carotid artery aneurysms (8.1%) and Choridal internal carotid artery aneurysms (7.2%) were the next frequent aneurysms treated by the same technique. Among the posterior circulation aneurysms, Basilar tip was the most frequent location found in 11 patients, followed by posterior cerebral artery aneurysm in 5 patients.

Table-3: Size and location of the aneurysms (n=235).

Size of the aneurysm	Number	Percentage
Tiny (<3 mm)	17	7.2
Small (3-7 mm)	106	45.1
Medium (7-10 mm)	71	30.1
Large (10-25 mm)	25	10.6
Giant (>25 mm)	16	6.8
Aneurysm neck		
Narrow neck	166	70.6
Wide neck	69	29.4
Location of the aneurysm		
Anterior circulation		
Anterior communicating artery (AcoM)	44	18.7
Anterior cerebral artery (A1 and A2 junction)	16	6.8
Distal anterior cerebral artery (DACA)	12	5.1
Middle cerebral artery (MCA) bifurcation	29	12.4
Middle cerebral artery (M1)	3	1.2
Terminal internal carotid artery (ICA)	4	1.7
Supraclinoid internal carotid artery	19	8.1
Cavernous paraclinoid internal carotid artery	26	11.2
Choridal internal carotid artery	17	7.2
Posterior communicating artery	39	16.6
Posterior Circulation		
Basilar Top	11	3.6
Posterior cerebral artery (P1)	5	2.1
Superior cerebellar artery	3	1.2
Basilar non fusion	3	1.2
Posterior inferior cerebellar artery	2	0.8
V4 segment of vertebral artery	2	0.8

Table-3 shows the distribution of the aneurysm according to location and size.

Complications and outcome

The rate of procedural complications was 9.4% (22 events) among which intraprocedural rupture of aneurysms was the most common event (3.4%), followed by thromboembolic complications in 2.9% (Table-4). The percentage distribution of modified Rankin Scale (mRS) scores at 24 hours, discharge, and 6-month follow-up showed a progressive increase in favorable functional outcome (mRS 0–2) is observed over time, with a corresponding reduction in moderate-to-severe disability (mRS 3–5). Mortality (mRS 6) shows a gradual increase during follow-up (Figure-2). Five patients (2.2%) patients died within 24 hours and another two death (3.1%) were recorded during hospital stay. Total number of deaths at follow up were 10 (4.5%). But majority of the patients (84%) had favorable outcome that is mRS 0 to mRS 2 at 24 hour and discharge which further increased to 86.8% at 12 months (Table-5). Unfavorable outcome (mRS 3 to 5) except death were 13.5% at 24 hour and 8.5% at 12 months respectively.

Angiographic analysis was done with the Modified Raymond–Roy Classification (MRRC) grading scale to assess the degree of aneurysm occlusion. RROC class 2 was achieved among majority of the patients (52.3%), followed by class 1 in 42.1% cases (Table-5). We had to do partial coiling with RROC class 3 among only 5.6% cases.

Table-4: Procedure related complications (n=235).

Complications	Number	Percentage
Thromboembolism	7	2.9
Asymptomatic	1	
Symptomatic	2	
Transient neurologic deficit	2	
Permanent neurologic deficit	2	
Coil protrusion or migration	3	1.3
No flow compromise	2	
Flow compromise	1	
Intraprocedural ruptures	9	3.8
Slow leak	2	
Massive hemorrhage	7	
Device-related	2	0.8
Coil fracture	1	
Pre-mature coil detachment	1	
Access site complication	1	0.4
Femoral hematoma	1	
Total	22	9.4

Table-4 shows procedure related complications during unassisted endovascular coiling.

Discussion:

To the best of our knowledge this is the first large scale study assessing the long-term procedural outcome from a single center and single operator. There has been a dramatic shift from surgical clipping to endovascular coiling with the advent of newer devices like bridging stents, flow diverters and intra-saccular devices[10-14]. But the real-world scenario in a developing or under developed country like Bangladesh is quite different where the treatment modality is mostly guided by the economic capability of the patient. In our center, patients who can afford mostly undergo endovascular coiling and those can't undergo surgical clipping other than the issue of the neck morphology. In this study we have reported the clinical characteristics, radiological features, aneurysm characteristics and clinical outcome of a large cohort of Bangladeshi aSAH patients.

We reported the outcome of 235 simple aneurysm coiling among 221 patients. In a similar study Yadav N et al[15] from India, Khan Mk et al[16] from Pakistan and Harrichandprasad R et al[17] from South Africa have reported their experience of outcome of endovascular coiling in resource poor setting. Similar to the African cohort majority of the patients had sudden severe headache, followed by loss of consciousness, vomiting and seizure. In concordance with these studies majority in our series had WFNS grade 1 and a modified Fischer grade 4. With regard to the aneurysm size and morphology, around two third of the aneurysms were small to medium sized which matches the Indian experience. Quite expectedly, more than 80% of the aneurysms were located in anterior circulation in all these studies and AcoM and PcoM arteries were the most common location followed by ICA.

Although the rate of RROC grade 1 occlusion was lower in our series than those reported from India, Pakistan and South Africa, the RROC Grade 2 was much higher which means than the aneurysm occlusion with coiling was fair enough[15-17]. This could be explained by the fact that we considered only simple unassisted coiling in our study in contrast to the above-

mentioned reports where all kinds of assist devices were used. But the rate of overall complication and specifically the thromboembolic events were much lower in our series. The reported thrombo-embolic complications in literature varies from 4.7% to 12.5% whereas in our series it was only 2.9% [14-23]. This is probably due to the fact that we didn't use any assist device which is more prone to thrombo-embolic phenomenon[24]. The rate of intraprocedural rupture were within the range of published literature of 0.7% to 7.5%[25-27].

Closely aligning with the reported functional independence at most literatures including the ISAT study, around 86.4% of our patients undergoing simple endovascular coiling achieved mRS 1-2 at six months[15-17,28]. The overall mortality was also much lower (4.5%) than those reported in ISAT (8%) and different published literatures (up to 27.2%)[15]. The time trend graph showed significant improvement in functional status of these patients over six months.

Limitations

This study is limited by its retrospective design and lack of a control group treated with adjunctive techniques. Moreover, we could not do angiographic assessment at follow up. It is very hard in our socio-demographic and financial structure to convince these patients for a regular scheduled Follow-up. For this reason, only telephonic interview was done to assess the mRS status. There was also variation in duration among patients.

Conclusion:

Unassisted endovascular coil embolization remains a safe and effective treatment option for selected intracranial aneurysms. In this large single-center, single-performer series, favorable mid-term angiographic durability and clinical outcomes were achieved with low morbidity and mortality. Careful patient selection and operator experience are key determinants of success.

Conflict of Interest

The authors declare no conflicts of interest.

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Author Contribution

Dr ATM HH was associated with the concept, study design, performing the procedure, data collection, recording and outcome analysis, writing the manuscript. Rest of the authors were involved in design, manuscript editing.

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