Turk Neurosurg 34(1):81-92, 2024

Original Investigation

DOI: 10.5137/1019-5149.JTN.41769-22.2

Received: 06.08.2022
Accepted: 30.11.2022

Published Online: 22.11.2023

Comparison of the Outcome of Ruptured Wide-Necked Anterior Communicating Artery Aneurysms Treated by Clipping and by Endovascular Therapy Performed by a Dual Trained Vascular Neurosurgeon: An Institutional Experience

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ABSTRACT

AIM: To compare the outcome of ruptured wide-necked anterior communicating artery (AcomA) aneurysms treated by clipping or endovascular therapy (EVT) by a dual trained neurovascular neurosurgeon.

MATERIAL and METHODS: Among 130 patients with ruptured AcomA aneurysms with neck size of ≥4 mm treated between July 2018 and December 2021, 60 patients with wide-necked AcomA aneurysms were enrolled to this study. They were divided into group 1, comprising those who underwent treatment with clipping (n=34), and group 2, comprising those who underwent treatment with EVT (n=26).

RESULTS: The average neck diameters of the EVT and clipping groups were 4.15 ± 1.11 and 6.66 ± 2.27 mm, respectively. Perioperative aneurysm rupture was found in five and two patients in the clipping and EVT groups, respectively (p=0.13). Good Glasgow Outcome Scale score at follow-up was observed in 84% and 79% of patients in the EVT and clipping groups, respectively (p=0.02). Raymond–Roy occlusion grade 1 was achieved in 84% and 90.6% of the patients in the clipping and EVT groups, respectively (p=0.483). The length of stay in the intensive care unit (ICU) (p=0.001) and hospital (p=0.001) was shorter in the EVT group.

CONCLUSION: The clinical outcome of patients with ruptured wide-necked AcomA aneurysm may be better in the EVT group than in the clipping group, with the procedures performed by a neurosurgeon with dual training in microsurgical clipping and EVT. Such training may help in ensuring timely intervention to minimize perioperative complications, such as rebleeding, vasospasm, infarction, and hydrocephalus, thereby reducing the length of ICU stay and making the treatment cost-effective in resource-starved patient populations.

KEYWORDS: Wide-necked, Ruptured, AcomA aneurysm, Outcome, Clipping vs. Endovascular therapy, Dual trained neurovascular surgeon

ABBREVIATIONS: CT: Computed tomography, **DSA:** Digital subtraction angiography, **EVD:** External ventricular drainage, **EVT:** Endovascular therapy, **GOS:** Glasgow outcome scale, **ICU:** Intensive care unit, **MC:** Microsurgical clipping

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INTRODUCTION

Anterior communicating artery (AcomA) aneurysms are one of the most common aneurysms, accounting for 40% of cases of subarachnoid hemorrhage due to ruptured aneurysms (10,11). These aneurysms are challenging to treat because of their variable anatomical configurations, such as a wide neck, multilobulations, the fundus being the origin of the branch artery, posterior projection, and so on. Ruptured wide-necked AcomA aneurysms with an unfavorable anatomical configuration is always challenging to treat either with microsurgical clipping (MC) or endovascular therapy (EVT), and it had been reported to have variable outcomes (5,12,13,17). Although wide neck is generally defined as a neck size of >4 mm, Defining wide neck AcomA aneurysms according to the fundus diameter and neck ratio is difficult as it is variably described by different authors in their studies as less than 1.5 or 2. (1,2,6) With the increasing demand for EVT and new hardware developments, treatment results of wide necked AcomA aneurysm with such a modality are improving (5). Different meta-analyses and systemic reviews have included patients treated with EVT performed by neurointerventionists and MC by neurosurgeons at different centers. The patient outcome in such a scenario may differ when neurosurgeons with dual training treat these cases (12,17). In resource-starved regions, similar to our country, a team of neurointerventionists and neurosurgeons are only found in few facilities. Thus, we aimed to compare the outcomes of patients with wide neck AcomA aneurysms treated at our center by MC and EVT performed by a single neurosurgeon with dual training in both procedures. We also aimed to assess the risk factors affecting the outcome, such as angiographic occlusion grade, perioperative complications, morphological variations, and length of stay in the intensive care unit (ICU).

MATERIAL and METHODS

We enrolled patients treated for ruptured wide-necked AcomA aneurysms between July 2018 and December 2021. Our Institutional Ethical Committee approved our study design (IEC No. 743/21). From a pool of 130 patients who had undergone treatment for ruptured AcomA aneurysms at our center, we identified 60 patients with wide-necked AcomA aneurysms.

We included all patients with ruptured AcomA aneurysms with a wide neck, defined as having a neck diameter of ≥4 mm, and treated by either MC or EVT. This criteria were adopted from earlier studies involving cases of wide-necked aneurysms (1,2,6). We excluded patients with features of dissecting aneurysms and those with infectious and traumatic etiologies that may have interfered with the outcomes.

We obtained patients' demographic details, such as age and sex, as well as clinical data, including Hunt and Hess grades, pre- and postoperative modified Rankin Scale (mRS) scores, the time between the onset of symptoms and treatment, comorbid conditions, treatment type (MC or coiling), and occurrence of perioperative events, such as intraoperative rupture, vasospasm, brain edema, postoperative infarct, and hydrocephalus from the medical records of our institution.

Patients and their relatives preferred treatment by either EVT or clipping, after we explained the advantages and disadvantages of the procedures. After obtaining their consent, we planned to perform the treatment by either clipping or EVT. We also obtained consent from the patients or their relatives to use their data for teaching and clinical research purposes.

The patients underwent computed tomography (CT) angiography and 3D image reconstructions followed by digital subtraction angiography (DSA) to evaluate the blood flow, collateralization, and configuration of aneurysms. We conducted postoperative CT angiography and DSA after 24 hours in each patient and followed up at 6 months and 1 year.

We performed pterional craniotomy in all patients who preferred MC. The side of the craniotomy was selected after considering the dominant feeding artery, projection of the aneurysm and its configuration, other vascular anomalies, and additional associated aneurysms on the same side. In some cases, gyrus rectus resection was required for AcomA aneurysms located high up in the interhemispheric fissure.

We performed the endovascular procedure under general anesthesia. We administered intravenous drip infusion of heparin by using a catheter pressure infusion system with continuous infusion of 1000-ml normal saline mixed with 1000-U heparin. We performed simple coiling with one or double microcatheter technique in patients treated without assistive devices, such as stents and balloons. For patients requiring stent assistance for wide-necked aneurysms, 180 mg of ticagrelor tab and 300 mg of ecosprin were used during induction through a nasogastric tube followed by 90 mg of ticagrelor every 12 hours and 150 mg of ecosprin daily for 6 months, followed by 90 mg ticagrelor tab every 24 hours and ecosprin 150 mg for 3 months and 150 mg ecosprin tab once a day to be continued subsequently.

We used the Raymond–Roy classification of aneurysm occlusion to assess the angiography obliteration results for clipping and EVT (9). We classified the cases of complete obliteration as follows: type 1, no visualization of the sac and neck of the aneurysm ; type 2, presence of a small residual neck; and type 3, visible dye in the sac of the aneurysm.

We assessed the clinical outcomes by evaluating the postoperative mRS and Glasgow Outcome Scale (GOS) scores. The outcomes were classified as good if the mRS score was either 1 or 2 and poor if it was 3. Similarly, the outcomes were categorized as good if the GOS score was 4 or 5 and poor if it was <4.

Statistical analyses of baseline characteristics were performed using chi-square tests, Fisher's exact tests for categorical variables, and standard t-tests for continuous variables. All factors affecting outcome were analyzed by univariate analysis, followed by logistic regression analysis. A p-value<0.05 was considered statistically significant. Statistical analysis was performed using SPSS software for Windows, version 22 (IBM Corp., Armonk, NY, USA).

RESULTS

There were 60 patients with wide-necked AcomA aneurysms out of the 130 patients treated at our center for AcomA aneurysms; of these, 26 patients were treated by EVT and 34 by MC. The average age of the patients treated by EVT and clipping was 52.47 ± 10.86 and 50.76 ± 8.85 years, respectively ($p<0.001$). The male:female ratio in the EVT and clipping groups was 13:13 and 13:21. The duration to treatment in the EVT and clipping groups was 7.63 ± 3.85 and 8.25 ± 4.57 days, respectively ($p=0.04$). There were more patients with intracerebral hematoma in the clipping group ($p=0.03$). The two groups did not differ in Hunt and Hess grade ($p=0.685$), mRS score ($p=0.290$), and Fischer grade ($p=0.806$) (Table I).

Angioarchitecture on Preoperative DSA

The average fundus diameter in the clipping and coiling groups was 8.33 ± 3.46 and 5.31 ± 1.26 mm, respectively ($p=0.03$). The average neck diameter in the EVT and clipping groups was 4.15 ± 1.11 and 6.66 ± 2.27 mm, respectively. The average aspect ratio was 1.20 ± 0.24and 1.27 ± 0.19 in the EVT and clipping groups, respectively ($p=0.239$). Bilobulated aneurysms were present in 11 out of 24 patients treated with EVT and 16 out of 36 patients treated with clipping (Figure 1).

Table I: Demography and Clinical Profile of Patients Who Underwent Microsurgical Clipping and Endovascular Therapy for Ruptured Wide-Necked Anterior Communicating Artery Aneurysm (AcomA)

	Microsurgical clipping (n=34)	Endovascular therapy (n=26)	p-value
No.of cases	34	26	
Sex Male	13	13	0.21
Female	21	13	
Age (yrs)-(mean)	50.76 ± 8.85	52.47 ± 10.86	**0.001**
Duration to treat after onset	8.25 ± 4.57	7.63 ± 3.85	**0.042**
Intracerebral haemorrhage	16	3	**0.03**
Intraventricular haemorrhage	15	9	
SAH	25	22	
Hunt & Hess Grade			0.685
1	7	5	
2	9	7	
3	12	11	
4	4	2	
5	2	1	
Fischer grade			0.806
1	3	4	
2	5	5	
3	12	9	
4	14	8	
MRS Score			0.290
1	8	4	
2	10	13	
3	14	8	
4	2	1	
Coronary artery disease	2	4	0.12
Hypertension	10	8	0.16
Diabetes Mellitus	5	7	0.21

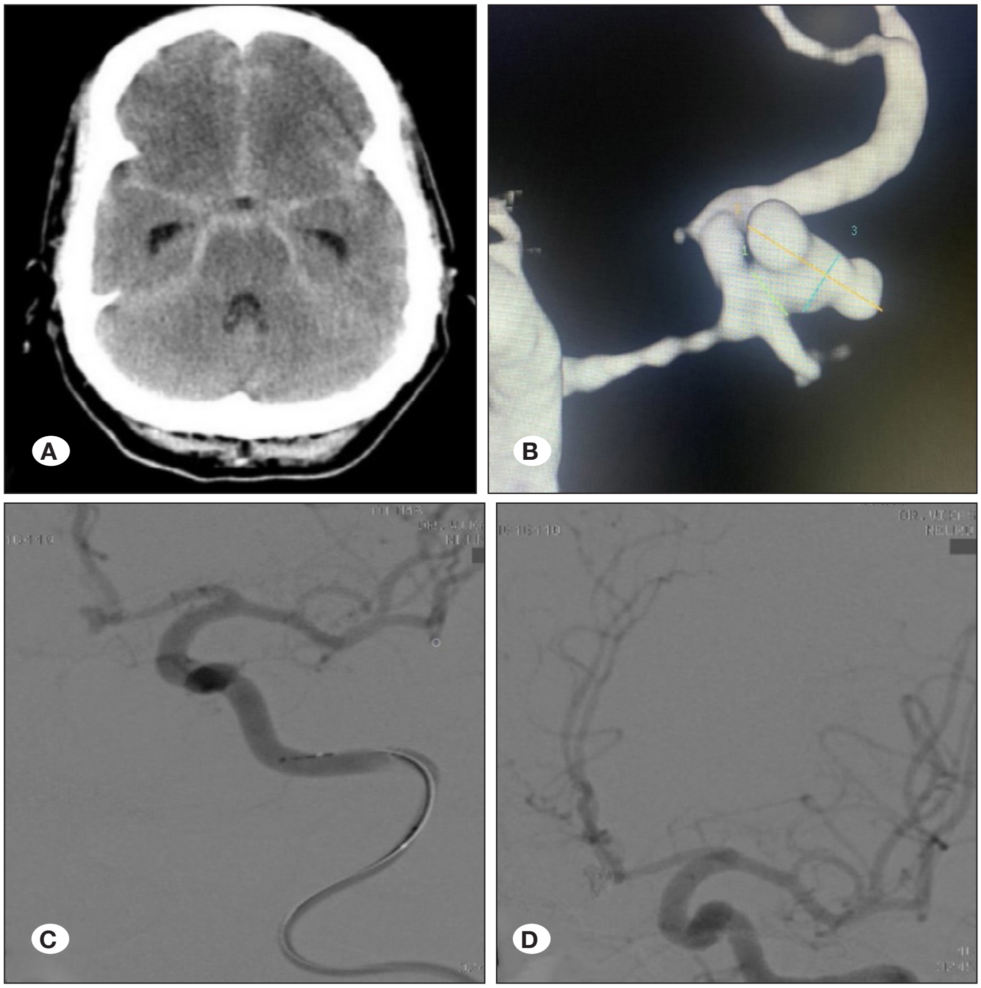

Figure 1: A) Non contrast computed tomography (NCCT) suggestive of diffuse subarachnoid haemorrhage (SAH). **B)** 3D -Digital subtraction angiography (DSA) reconstructed image suggesting wide necked aneurysm with fenestration and bilobed heart shaped configuration. **C)** DSA suggestive of coiling the bilobed aneurysm with double microcatheter in sac. **D)** DSA suggestive of complete obliteration of the aneurysm.

Hypoplastic A1 was present in 12 out of 24 patients treated with EVT and 16 out of 36 treated with clipping. Fenestration of the AcomA was present in two patients each in both groups. Multiple aneurysms were present in five patients treated with EVT and six patients treated with clipping.

We performed pterional craniotomy on the left side in 16 patients with dominant feeders from left A1 and 18 on the right side. We performed balloon-assisted coiling in seven patients and stent-assisted coiling in two patients. We minimized the need for using balloons and stents by utilizing the double microcatheter technique in seven patients and performed simple microcatheter coiling in the other 10 patients (Table II and Figure 2).

Perioperative Complications

We noticed intraoperative rupture in one patient in the EVT group. While performing the procedure in one patient, we noticed coil loops projecting outside the aneurysmal sac. We repositioned the microcatheter and redeployed the coils with balloon inflation. Intraoperative DSA did not reveal significant vasospasm but postoperative DSA performed 24 hours later suggested so. We had to perform repeat spasmolysis by placing a microcatheter in the distal ICA, which finally relieved the vasospasm. In another patient who was treated with EVT, he was transferred to the ICU after extubation; CT was performed due to postoperative lower GCS (Glasgow comma score) score of 9/15 compared to the preoperative score of 12/15, which suggested rebleeding; thus, the patient was again transferred to the operation theater. A coil loop was found protruding from the confines of the aneurysmal sac with a residual neck. As the patient could not afford EVT, pterional craniotomy and clipping of the residual neck of the aneurysm were performed. The patient recovered slowly with an mRS score of 2/4 (Figure 3). In the clipping group, there were four patients with intraoperative rupture while applying a permanent clip; bleeding was controlled by adjusting the position of the clip in three patients. One of these four patients have blister aneurysms in the ophthalmic segment on the contralateral ICA. We clipped the aneurysm from the right pterional approach and noticed a sudden increase in blood pressure. Intraoperative NCCT (Non contrast computed

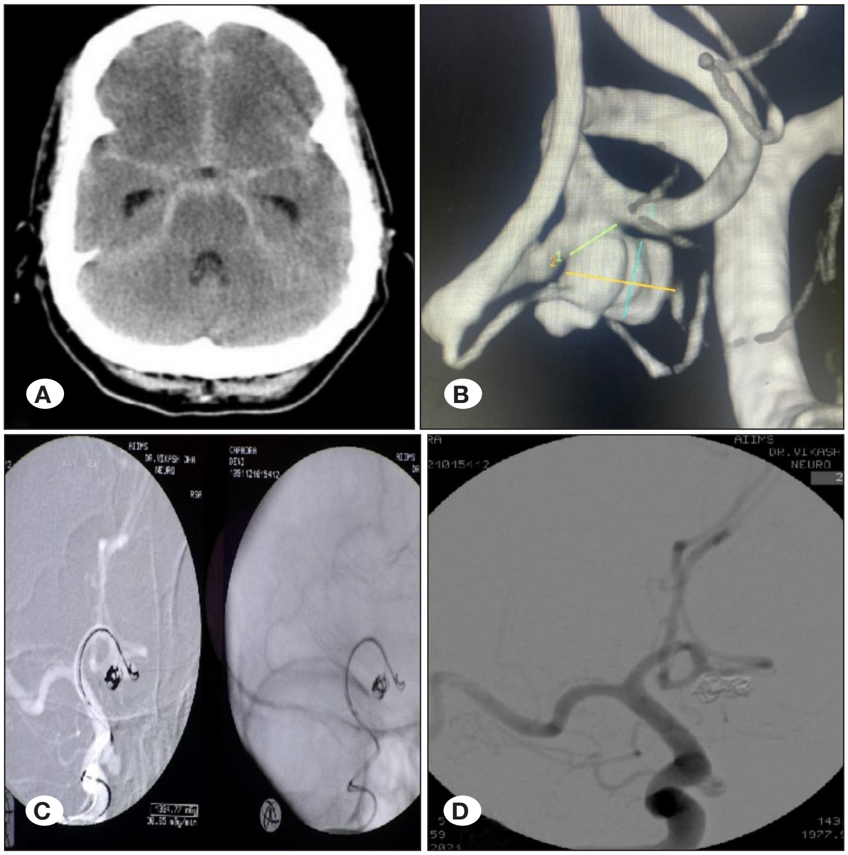

Figure 2: A) Non contrast computed tomography (NCCT) head suggestive of diffuse subarachnoid haemorrhage (SAH). **B)** Digital subtraction angiography with 3-D reconstruction suggests wide necked aneurysm with two daughter pseudo sacs with central aneurysm sac in T shaped fashion. **C)** DSA revealed wide necked T- shaped aneurysm projecting from anterior communicating artery (AcomA). **D)** DSA suggesting complete obliteration of aneurysm with its pseudo sacs.

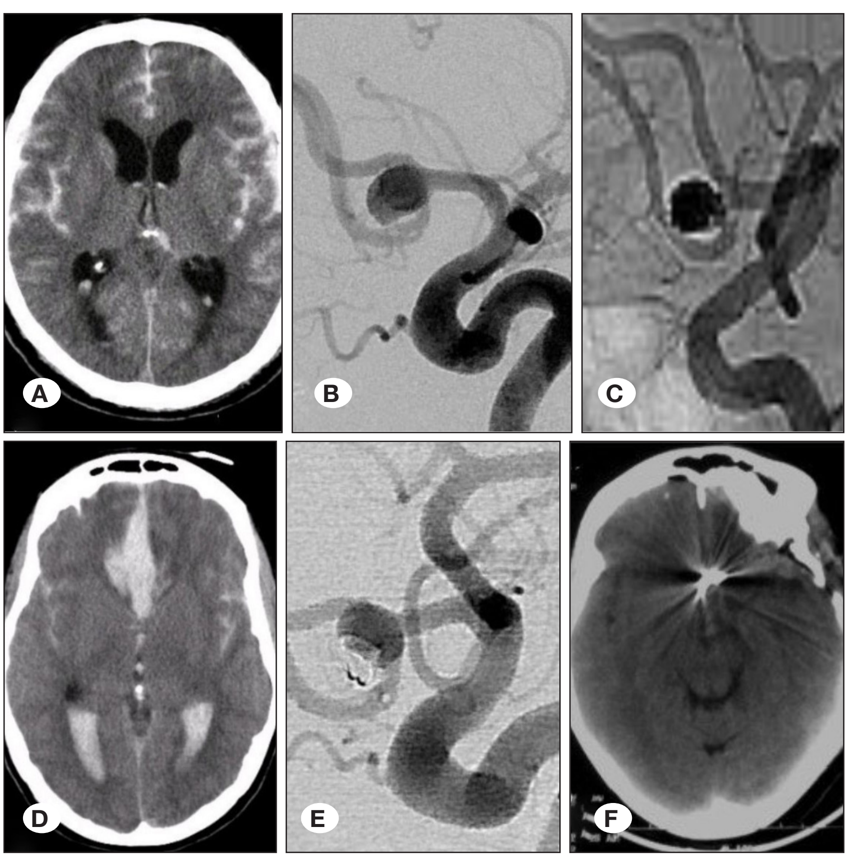

Figure 3: A) NCCT head of 55 years old female suggesting diffuse subarachnoid haemorrhage. **B)** DSA with left common carotid injection suggested wide necked AcomA aneurysm. **C)** DSA on left CCA suggested coil obliteration of the AcomA aneurysm. **D)** Immediate postoperative NCCT head suggested diffuse subarachnoid haemorrhage with thick bleed in interhemispheric fissure. **E)** Repeat DSA suggested ruptured aneurysm with residual neck. **F)** Follow up CT suggested secured aneurysm with coiled mass and clip in situ.

Table II: Angioarchitecture of the Ruptured-Wide Necked AcomA Aneurysms

	Endovascular therapy group, n=26	Microsurgical Clipping group, n=34	p-value
Fundus Size			
4-10 mm	17	26	**0.03**
> 10 mm	9	8	0.32
Average(mm)	8.33 ± 3.46	5.31 ± 1.26	**0.03**
Neck to fundus ratio			
< 0.5	6	4	0.21
0.5-1	10	20	**0.02**
>1	10	10	0.11
Average	1.20 ± 0.24	1.27 ± 0.19	0.23
Aspect ratio	1.28 ± 0.32	1.22 ± 0.24	0.23
Lobulations			
Unilobular	8	13	0.23
Bi-lobular	11	16	0.43
Multilobulated	5	5	0.32
Projection of aneurysms			
Inferior	4	5	0.23
Posterior	9	3	**0.02**
Superior	7	12	0.23
Anterior	6	16	0.34
Hypoplasia of A1	12	16	0.11
Multiple aneurysm	5	6	0.31
Fenestration	2	2	

tomography) head suggested rebleeding. DSA performed, thereafter, suggested a secured AcomA aneurysm but with a ruptured blister aneurysm, requiring the installation of a pipeline device; the patient recovered with a postoperative GCS score of 15/15 (Figure 4A–H). We noticed postoperative vasospasm on repeat DSA after the neurological condition deteriorated in 6 out of 26 patients treated by EVT and 14 out of 34 patients treated by clipping (p=0.03). Postoperative infarct was noted in three patients in the EVT group and nine patients in the clipping group (p=0.03). The incidence of infarct in our patient who developed symptomatic vasospasm was reduced due to repeated intraarterial microcatheter spasmolysis by injection of nimodipine (Figure 5). Four patients in the coiling group who developed acute hydrocephalus was managed initially with an external ventricular drainage (EVD) system and, subsequently, a ventriculoperitoneal (VP) shunting was required in one patient. In the clipping group, seven patients developed acute hydrocephalus and two patients required VP shunting for neurological stabilization. All these patients who developed acute hydrocephalus was initially stabilized using the EVD system. Postoperative rebleeding was found in one patient in the coiling group and two patients in the clipping group; these patients have to undergo repeat procedure and developed vasospasm with infarct postoperatively (Table III).

Angiographic Outcome

Following the procedure, 20, 5, and 1 patient in the EVT group had grades 1, 2, and 3 Raymond–Roy occlusion, respectively. In the clipping group, these were 24, 8, and 2 patients, respectively (p=0.483). (Figures 1 and 2; Table IV).

Clinical Outcome

GOS score at discharge and at the 6-month follow-up was better in the EVT group (84%) than in the clipping group (79%) (p=0.02). The length of ICU (p=0.001) and hospital (p=0.001) stay was shorter in the EVT group. One patient in the coiling group and two patients in the clipping group who developed a diffuse infarct, following rebleeding and retreatment and

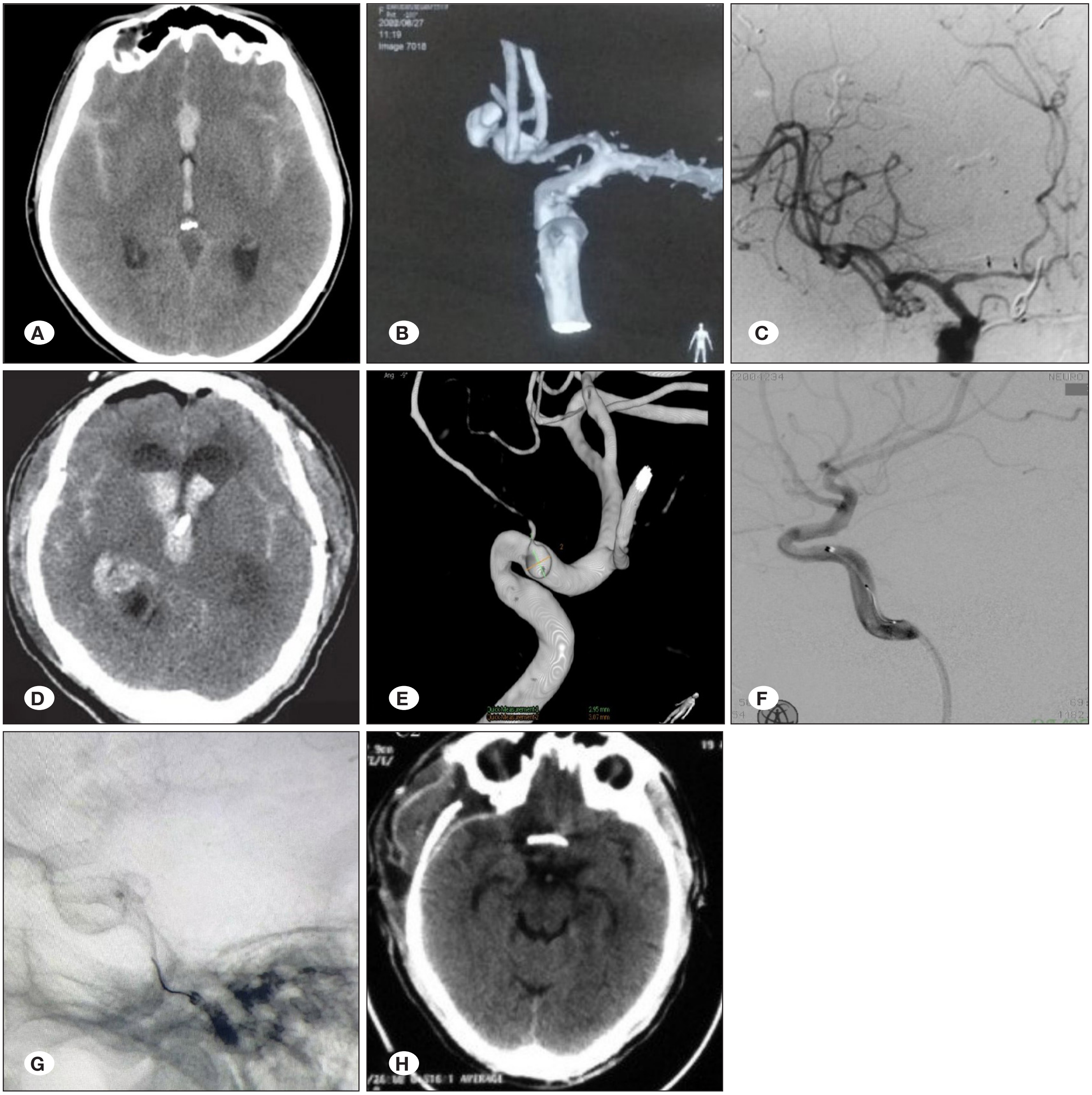

Figure 4: A) NCCT head of 58 years old female suggestive of diffuse subarachnoid haemorrhage. **B)** DSA with 3D reconstruction revealed wide necked dumb-bell shaped aneurysm with incorporation of bilateral A2 origin. **C)** Right common carotid injection suggested complete occlusion of AcomA aneurysm on DSA with no cross flow. **D)** While performing the procedure patient had sudden rise of blood pressure and bradycardia for which intraoperative CT was performed which revealed diffuse SAH with intraventricular bleed suggesting haemorrhage. **E)** There was no extravasation of dye from Rt ICA injection through AcomA aneurysm but left ICA injection suggested rupture ophthalmic segment blister aneurysm. **F)** Intraoperative DSA with left common carotid injection suggested no visualisation of ophthalmic aneurysm with no extravasation of dye. **G)** Fuoroscopic visualisation of skull with lateral view suggested pipeline device in situ. **H)** Follow up NCCT head suggested no fresh bleeding or infarct.

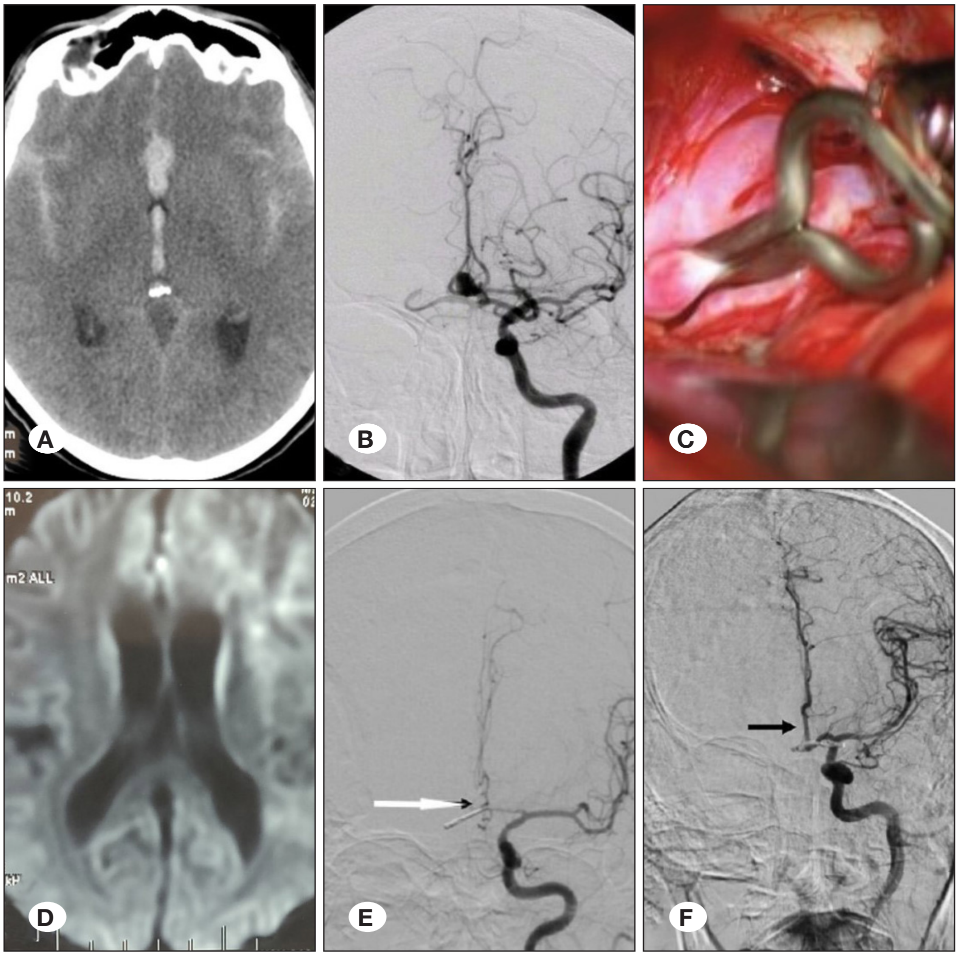

Figure 5: A) NCCT head of 22 years old patient suggesting SAH with thick interhemispheric bleed. **B)** DSA with left common carotid injection suggested wide necked AcomA aneurysm. **C)** Intraoperative image of clipped AcomA aneurysm. **D)** Postoperatively patient has neurological deterioration for which MRI brain was done suggesting infarct in distal ACA. On diffusion weighted image. **E)** DSA performed thereafter suggested vasospasm in bilateral Anterior cerebral artery territory. **F)** Repeat spasmolysis was done for 3 consecutive days following which there was sign of improvement both neurologically and on DSA image as distal vessels and collateral vessels were filling well.

Table III: Perioperative Complications of Patients Who Underwent Microsurgical Clipping and Endovascular Therapy (EVT) for Ruptured Wide-Necked Anterior Communicating Artery Aneurysm (AcomA)

	Endovascular therapy (n=26), n(%)	Microsurgical clipping (n=34), n(%)	p-value
Intraoperative rupture	1 (4.1)	4 (11.11)	0.11
Vasospasm	6 (24.6)	14 (38.88)	**0.03**
Postoperative Re-bleeding	1 (4.1)	1 (2.77)	0.13
Postoperative Infarct	3 (11.5)	9 (26.4)	**0.03**
Hydrocephalus	4 (16.4)	7 (19.44)	0.39
Shunt dependent hydrocephalus	1 (4.1)	2 (5.54)	
Aneurysm retreatment	1 (4.1)	2 (5.54)	0.21
Mortality due to stroke 30 days	1 (4.1)	2 (5.54)	

requiring ventilatory support for a prolonged period, died due to nosocomial infections and multiorgan dysfunction syndrome (Table V).

Follow-up

On the 6-month follow-up, mild improvement in angiographic complete occlusion grade 1 was observed in 84% and 91% of the patients in the coiling and clipping groups, respectively; mild improvement in grade 2 was also noted in 16% and 9% of the patients in the coiling and clipping groups, respectively (p=0.48). Good outcome score at 6 months after discharge showed a similar trend in both the coiling (84%) and clipping groups (79%), with the former showing better outcomes. The average follow-up duration was 16 ± 7.68 and 14 ± 6.46

Table IV: Raymond Roy Occlusion Grade on DSA on Immediate Postoperative Imaging and 6 Month Follow up of Patients Who Underwent Microsurgical Clipping and Endovascular Terapy for Ruptured Wide-Necked Anterior Communicating Artery Aneurysm (AcomA)

	Endovascular- therapy		**Microsurgical clipping**			
Raymond-Roy occlusion grade	**At discharge**	**At 6 month and last follow up Reported pt, n-25**	**At Discharge**	**At 6 month and last follow up, n=34**	**Chi-squared**	**1.650**
Complete occlusion (Grade-1)	20 (76.66%) 47.8% RT 84.6% CT 36.7% GT	21 (84%)	28 (82.35%) 52.2% RT 70.6% CT 40.0% GT	29 (90.6%)	DF	2
Residual neck (Grade-2)	5 (19.23%) 30.0% RT 11.5% CT 5.0% GT	4 (16%)	4 (11.76%) 70.0% RT 20.6% CT 11.7% GT	5 (9.34%)	Significance level	p=0.4383
Partial recanalisation of fundus (Grade-3)	1 (4.1%) 25.0% RT 3.8% CT 1.7% GT	-	2 (5.88%) 75.0% RT 8.8% CT 5.0% GT		Contingency coefficient	0.164
Total (N=60)	26 (43.3%)		34 (56.7%)			

***DF:** Degree of freedom.*

Table V: Outcome Based on Initial Hunt and Hess Grade and Length of Stay in Hospital at Discharge of Patients Who Underwent Microsurgical Clipping and Endovascular Therapy for Ruptured Wide-Necked Anterior Communicating Artery Aneurysm (AcomA)

	Clipping group			**EVT group**	
Hunt & Hess Grade	**Clipping group, n=34**	**Good outcome at discharge (GOS≥4)**	**At 6 month follow up (GOS≥4)**	**Coiling group n=26, Good outcome at discharge (GOS≥4)**	**Good outcome (GOS≥4)**
1	7	7	7	5	5
2	9	9	9	7	7
3	12	12	6	8	8
4	6	8	4	2	2
5	2	-		1	-
Length of stay in ICU	23.60 ± 6.29	-		9.27 ± 2.6	
Length of stay in hospital	33.6 ± 7.9	-		18.72 ± 2.19	
mortality	2	-		1	
Follow up in months	16 ± 7.68			14 ± 6.46	**p=0.028**

months in the clipping and EVT groups, respectively. Patients had angiographic occlusion and clinical features similar to those observed at the subsequent 6-month follow-up.

DISCUSSION

The earlier criteria of the neck diameter of >4 mm and dome-to-neck ratio of >2 were used by neurointerventionists to define a wide neck, but, subsequently, dome-to-neck ratio <1.5 had been proposed to define a wide neck due to the advent of complex coils (2). Brinjikji et al. emphasized that it is the requirement of adjunctive therapy, such as the use of stents and balloons that would suggest a wide-necked aneurysm; they further suggested that aneurysm with dome-to-neck ratio > 1.2 can be treated without adjunctive therapy in 80% of such cases (2). Gonzalez et al. suggested a neck diameter of >4 mm as wide-necked. In present study, considering these facts, the inclusion criteria of AcomA aneurysm cases was a neck diameter of >4 mm (1,2,6).

The number of wide-necked AcomA aneurysms in the present study accounts for 40% of the ruptured AcomA aneurysms and 20% of all cases of ruptured aneurysms with subarachnoid hemorrhage treated at our center. In the study by Cherian et al., the incidence of patients treated for wide-necked AcomA aneurysms was 23% (3). The incidence in the present study appears to be higher due to the fact that the referral pattern at our center is different from that of Cherian et al.'s study (3). Endovascular treatment of wide-necked aneurysms is challenging and requires the use of intraluminal assist devices, such as balloons and stents, to support coil embolization. Earlier reported study by an international trial for subarachnoid hemorrhage due to a ruptured aneurysm (ISAT), barrow ruptured aneurysm trial, and meta-analysis did not mention the treatment outcomes of wide-necked aneurysms separately (5,10,11). Performing clipping and coiling are challenging in ruptured wide-necked AcomA aneurysms.

The clipping group was younger than the EVT group, which is similar to the trend observed in other studies comparing the outcome of treatment in these patients (5,7,10). EVT was preferred by relatives of elderly patients with associated comorbidities after we explained the benefits of this procedure. We treated patients with hematoma with mass effects by clipping, rather than by coiling, similar to the trend in other reported studies (7).

An aneurysmal sac with irregular margins, multilobulations, and presence of a daughter sac are factors that increasee the risk of rupture, with descending order of frequency of perioperative rupture (11). Morphologically, one to two daughter cyst may help anchor coils for the formation of the loop to cover the neck without prolapse in the arterial lumen, as observed in nearly 50% of our patients with one to two lobulations, in which we performed successful coiling without using a balloon or stent. Altogether, 40% of patients with wide-necked aneurysms in the present study also have shoulders, which help in placing coil with stable configuration covering neck and supported by shoulders and similar findings were reported in the study by Declaring et al. (4). This may help achieve stable coil configuration in wide-necked AcomA aneurysms while performing simple coiling without using assistive devices as in the present study. The average fundus-to-neck ratio and aspect ratio for patients requiring adjuvant therapy, such as the use of stent and balloon, in the present study are similar to the observations made by Brinjiki et al., suggesting that the fundus-to-neck ratio and aspect ratio, not the neck size, is more suggestive of the need for adjuvant therapy during EVT (2). Wide-necked aneurysms treated by Brinjikji et al. with adjunctive endovascular support have an average neck size of 4 ± 2 mm, fundus-to-neck ratio of 1.59 ± 0.42, and aspect ratio of 1.48 ± 0.59; the frequency of adjunctive device used in the aneurysm with an aspect ratio between 1.2 and 1.6 was almost similar to our study (2). The values of all these parameters, other than the neck size, were lower in our study, suggesting more unfavorable configurations of the ruptured wide-necked AcomA aneurysms for EVT. However, we could coil the aneurysm, with results similar to those reported in the above mentioned study. These facts imply that other anatomical factors may play a role, which may be favorable for successful coiling without adjunctive treatment, such as anchoring of coils in the daughter cyst and shoulders present in the aneurysms near its origin at the neck.

The incidence of hypoplasia of contralateral A1 was similar to those reported by Yang et al. and Jabbar et al., which were approximately 49%; patients with ruptured Acom aneurysm had an increased risk of developing anterior cerebral territory infarct and poor outcome (8,16). Sungkaro et al. reported that the incidence of A1 hypoplasia in the same geographical territory as the cases in the present study was approximately 55%, consistent with our study results (13). We chose the side with a dominant supply for craniotomy or EVT to avoid the formation of more infarcts, as suggested by studies that performed the procedure in the side with hypoplasia of the A1 segment of the anterior cerebral artery (8,16).

Different studies have reported the intraprocedural rupture rate of approximately 4% among Acom aneurysms during endovascular management; and this rate was similar in patients with ruptured or unruptured aneurysms. The perioperative rupture rate in the present study is similar to that reported in a previous study involving cases treated by EVT (5). The intraprocedural rupture rate reported by Sungkaro et al. was approximately 10% while clipping in Acom aneurysms, and in our study, it was around 11% (13). This higher incidence of intraprocedural rupture of AcomA aneurysms in our study may be due to the fact that our study had a higher number of patients with multilobulated aneurysms than the other reported studies (12). The rebleeding rates of the coiling and clipping groups were approximately 2% 3%, respectively, similar to outcomes in the present study, suggesting comparable efficacies of both procedures (5,12). The cases of postoperative symptomatic vasospasm was more common in the clipping group than in the coiling group, which may be due to the fact that the adjacent vessels were more manipulated when applying the clips. Multiple clipping readjustments were required in cases of multilobulated aneurysms, which caused both intraprocedural rupture and perforator injuries leading to infarct formation. Postoperative infarcts were also more common in the clipping group than in the EVT group. Hypoplasia of contralateral A1 and vascular manipulation were more common in the clipping group in the present study, and previous studies suggest that they are associated with an increased incidence of infarct (8,13,16). Performing frequent spasmolysis by using a microcatheter placed in the distal ICA after detecting symptomatic vasospasm may have caused a reduction in the incidence of postprocedural infarct in our patients, as compared to the patients in other studies (8,13,16).

Patients with intraventricular bleeding following aneurysmal rupture developed acute hydrocephalus, and, upon arrival at our hospital, an EVD tube was placed. Timely intervention and regular flushing of the tube facilitated continuous drainage of the cerebrospinal fluid and blood degradation product and helped reduce the shunt-dependent hydrocephalus in both groups, regardless of being treated with either clipping or coiling. The patients who developed hydrocephalus following intraventricular bleeding with higher Fischer grade on NCCT head are more likely to develop shunt-dependent hydrocephalus; in the present study, timely interventions with EVD helped decrease the risk of shunt-dependent hydrocephalus (15).

The rate of Raymond–Roy occlusion grade 1 cases in our coiling group was 77% and that of grade 2 cases was 19%, whereas in the clipping group, the grade 1 and 2 angiographic occlusion rates were 82.3%, and 11.76%, respectively, and the significant recanalization rate was 7% at the time of procedure completion (9). Major recanalization was due to the multilobulated aneurysm and perforators arising from the fundus leading to either inadequate placement of clips or inadequate filling of the aneurysmal sac by coils. A similar study conducted by Moon et al. reported grade 1 and 2 occlusion rates in the coiling group of 78.4% and 21.6%, respectively, whereas, in the clipping group, the grade 1 occlusion and significant recanalization rates were 90% and 10%, respectively (12). This suggests that the occlusion of ruptured wide-necked Acom aneurysm can be achieved by both treatment modalities performed by a dual trained vascular surgeon, similar to the unruptured group.

A previous study on the outcome of MC among ruptured Acom aneurysms reported a good outcome rate of 72%, whereas EVT performed by another neurointerventionist had a good outcome rate of 82% (3,13). In the present study, the rate of good outcome was similar to the rates reported by studies who analyzed patients treated by EVT and MC, but in the present study, EVT and clipping were performed by same neurosurgeon trained in endovascular and microsurgical procedures (3,13). Similar results were reported by Veken who had dual training in clipping and EVT (14).

The clinical and angiographic outcomes at 6 months and the subsequent follow-up in the clipping and EVT groups in the present study were similar, suggesting that clinical and angiographical stability may persist in long term.

In a systemic review conducted by Zhang et al., there was a significant reduction in the length of ICU and hospital stay in the coiling group as compared to clipping group; however, the treatment costs were similar in both groups. We did not perform quantitative cost reduction analysis, unlike a previous (18), but the reduction in length of ICU and hospital stay suggests so.

Study Limitations

First, we explained to the relatives the treatment options available for wide-necked AcomA aneurysms. Patients with more unfavorable angiographic morphology, such as multilobulations or branches arising from the fundus, may have opted for clipping. It may have affected the perioperative complication rate in the clipping group than the EVT group. Randomization may have avoided treatment bias in such a scenario. Second, long term follow-up was lacking in the present study, but the clinical and angiographic outcomes at 6 months and subsequent follow-up suggest clinical and angiographical stability and less chances of subsequent variability in these outcome parameters in our patient population.

CONCLUSION

The clinical outcomes of wide-necked ruptured AcomA aneurysms may depend more on the fundus-to-neck and aspect ratios, rather than on the neck size alone. Such patients may have better results when treated by EVT, rather than by clipping. Moreover, the outcomes of these aneurysms treated by a dual trained neurosurgeon may be similar to those of surgeons experienced in either one of them only, as it helps in judicious decision making while treating perioperative complications like vasospasm, infarct, hydrocephalus, and rebleed. In resource-starved patient populations, similar to our study population, such training helps in achieving cost-effective patient management, as it reduces length of stay in the ICU and hospital. Our study emphasized the growing role of dual trained neurovascular surgeons for treating patients with wide-necked ruptured AcomA aneurysms. Future prospective randomized study is warranted to confirm that the treatment outcome of wide necked ruptured aneurysm by endovascular treatment are better as compared to microsurgical clipping.

AUTHORSHIP CONTRIBUTION

Study conception and design: VCJ
Data collection: VCJ, MSA, VSS
Analysis and interpretation of results: VCJ, SA, VSS
Draft manuscript preparation: VCJ, MSA, VSS
Critical revision of the article: VCJ, MSA, VSS
All authors (VCJ, VSS, MSA) reviewed the results and approved the final version of the manuscript.

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