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Intracranial Aneurysm Surgery in Southeast Nigeria: Experience and Challenges in Neurosurgical Management

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ABSTRACT

Background: Intracranial aneurysms (IAs) remain underreported in sub-Saharan Africa, with limited data on neurosurgical management, challenges and outcomes. This study aimed to document the clinical experience and challenges of IA management at a tertiary neurosurgical centre in Southeast Nigeria. This study presents the first institutional experience of intracranial aneurysm surgery in Southeast Nigeria. **Methods:** We conducted a nine-year retrospective cohort review (2015–2023) of computed tomography angiography (CTA/MRA)-confirmed intracranial aneurysms managed at our centre. Data extracted included demographics, clinical presentation, aneurysm characteristics, surgical approaches, intra- and post-operative challenges, and outcomes. **Results:** Fifty-eight patients with intracranial aneurysms were managed (female-male ratio 2.5:1), of whom 35 underwent surgery. The mean age was 42.3 ±12.1 years. Of the 58 patients, 32.8% were <40 years, and 55.2% had admission systolic BP >160mmHg. All presented with subarachnoid hemorrhage, predominantly from posterior communicating artery aneurysms (53.4%). World Federation of Neurosurgical Societies (WFNS) grades were 0–2 in 48.3% and 3–5 in 51.7%. CTA-based aneurysm size was <11mm in 15 (42.9%) (four of these had bigger dimension at surgery) and > 25 mm 7 (20.0%). Delay from presentation to surgery was < 3 days in 9 (25.7%), 4-7 days in 14 (40.0%), > 7 days in 12 (34.3%). Successful surgical clipping was performed in 94.3% of cases and common carotid artery ligation in 1 case. Intraoperative challenges included brain oedema (25.7%), rupture (22.9%), and vasospasm (11.4%). Postoperative complications included delayed ischemic neurologic deficit (34.3%) and hydrocephalus (31.5%). Post-operative mortality was 17.1% (6/35) while overall in-hospital mortality occurred in six patients (10.3%). **Conclusion:** Our experience revealed that younger patients with hypertension predominated, with posterior communicating artery aneurysms being most common. Neurosurgeons should be conscious of the study's highlighted intra- and post-operative challenges during surgical planning. High complication rates underscore the need for improved preoperative planning and postoperative monitoring in resource-limited settings.

Keywords: Intracranial aneurysm, Subarachnoid hemorrhage, Aneurysm clipping, WFNS grade, surgical complications

INTRODUCTION

Aneurysmal subarachnoid haemorrhage is a major cause of mortality and long-term morbidity globally. It has an estimated global incidence of 6.7 per 100,000 persons with wide variations between 0.7 to as high as 21 per 100,000 persons across various regions of the world (1,2). Intracranial aneurysms (IAs) are considered uncommon in Nigeria when compared to other countries like Finland and Japan with much higher incidences (3). Even in Nigeria, the neurosurgical case-load in other specialties like spine, paediatric neurosurgery and oncology have appreciated over the years unlike vascular lesions (4). Hence most hospitals and young neurosurgeons have not

prioritized attention towards developing this specialty enough to report local institution's experience and challenges in neurosurgical decision making, management of varieties of cases of intracranial aneurysms and lessons learnt in the course of developing the specialty and skill practicing in Nigeria. The severity of subarachnoid haemorrhage at presentation was classified using the World Federation of Neurosurgical Societies (WFNS) grading system, which combines the Glasgow Coma Scale with the presence of focal neurological deficits. In this system: Grade I = GCS 15 without motor deficit; Grade II = GCS 13–14 without motor deficit; Grade III = GCS 13–14 with motor deficit; Grade IV = GCS 7–12 (with or without deficit); and Grade V = GCS 3–6 (with or without deficit). Patients in Grades I–III are considered good grade with generally favourable prognosis, while Grades IV–V represent poor grade with worse outcomes (5, 6). This study was conducted at a private tertiary neurosurgical centre in Enugu, Southeast Nigeria, which serves as a major referral hub for several states in the region. There are no dedicated neurovascular centres in Southeast Nigeria, and the limited number of such facilities nationally, coupled with a fragmented referral system, often contributes to delays in diagnosis and treatment. This paper proposes to report our observations and challenges encountered during management of IAs following experience at a tertiary neurosurgical centre in Southeast Nigeria. It aimed primarily to describe the patient profile, aneurysm characteristics, surgical approaches, and immediate outcomes of intracranial aneurysm surgery at our centre. Secondary objectives were to document intra- and post-operative challenges, delays to surgery, and health-system barriers encountered over a nine-year period (2015–2023).

METHODS

This was a retrospective cohort study of all neurosurgically treated CTA/MRA-confirmed IAs within a tertiary neurosurgical centre in Southeast Nigeria. The study covered a nine-year period from January 2015 to December 2023, providing a comprehensive reflection of our institutional experience over nearly a decade. We included all patients with CTA/MRA-confirmed ruptured saccular intracranial aneurysms managed at our centre within the above period. Patients with fusiform or mycotic aneurysms, those with unruptured aneurysms who did not undergo surgery at our centre, and repeat operations were excluded. Data was obtained from patient folders, operation notes, radiology notes and other laboratory reports. The data analyzed included patient demographics, anatomical location of the aneurysm including variations in anatomy of the parent vessels, the clinical condition of the patient at time of admission, aneurysm size based on angiography and during surgery, type of surgery offered, intra-operative complications and challenges observed at surgery, common post-operative complications, and mortality. Analyses were conducted using descriptive statistics (means, proportions, and 95% confidence intervals). Comparisons were performed across WFNS grades and by time-to-surgery intervals (<7 days vs ≥7 days). Ethical approval for this study was obtained from the hospital's ethics committee. Primary outcomes were in-hospital mortality and delayed ischemic neurological deficit (DIND), while secondary outcomes included hydrocephalus, ICU and hospital stay, costs, and intraoperative challenges.

All the patients had diagnosis based on non-contrast enhanced Computed Tomography (NECT), CT angiography using the 64-slice Philips Brilliance Machine or Magnetic Resonance Angiography (MRA) using the I.5T GE Signa Explorer 16 channel MRI Machine. Radiologic scans were interpreted by both neurosurgeons and consultant radiologists. All patients presenting with the typical thunder-clap headache, focal neurological deficit, and neck stiffness were admitted as per the center's protocol into the ICU (if in coma), HDU or an exclusive private room with restricted access and noise. Patients that were restless were sedated to calmness and all the non-operative protocols were instituted including: analgesia, nimodipine, blood pressure control if there is associated hypertension, urethral catheterization, stool softeners, anti-seizure prophylaxis, antipyretic, gastritis prophylaxis and mechanical deep vein thrombosis prophylaxis. Unconscious patients were managed as per standard protocols. Electrolytes, renal function, clotting profile parameters and other laboratory parameters were assessed daily. System evaluations to exclude neurogenic pulmonary oedema and other chest concerns, cardiac evaluations including ECG, Echo and cardiac markers were assessed. Other potential co-morbidities were evaluated, and corrections were instituted where necessary. It is important to note that although components of triple-H therapy were occasionally applied in the earlier years of our practice, this approach is now avoided before definitive aneurysm securing due to the established risk of re-rupture. Current practice in our unit is limited to nimodipine and careful blood pressure control until clipping.

Our policy is to operate on the patient as soon as consent is obtained, and it is safe to operate following cardiology, anaesthesiology, and other relevant systemic clearances. All patients were offered clipping and coiling options. As there is no coiling facility in the study centre, all patients that opted for coiling were referred out. All the patients operated on general anaesthesia with arterial lines, central venous pressure lines and other invasive multi-parameter monitoring. Usually, patients are sedated before transfer to the theatre and periods of intubation are cautiously managed to avoid blood pressure surge. The unit's current protocol is to maintain normal mean arterial blood pressure during the craniotomy period but further drop it to SBP of 90mmHg around the time of clipping. Permissive hypotension is the goal prior to clipping.

The scalp was infiltrated as well as the pin sites for the May-field head holder prior to its application. Craniotomy was achieved using the fronto-temporal craniotomy except one patient operated through the inter-hemispheric approach. All the clipping surgeries were performed using titanium clip (Brazil). All patients operated-on had microsurgery assisted by the Zeiss Pentero 900 operating microscope. Temporal clipping and topical verapamil were used routinely at the earlier years of the study (first five years) but were optional and rarely used in the later four years based on concerns of delayed ischaemic neurologic deficit (DIND). When indicated, hydrocephalus management is usually done during surgery or post-surgery by External Ventricular Drainage (EVD) or ventriculo-peritoneal shunt unless the team thinks that it is contributing to ICP in patients that are unstable.

Post-surgery, patients are managed in the ICU until when they are stable enough to be transferred to the HDU or ward using the standard protocols with active search and management of anticipated fluid, electrolyte, autonomic, DIND and other complications. Physiotherapy is commenced as soon as the patient is fully recovered from anaesthesia. Unless contraindicated, permissive hypertension is employed. Following discharge, patients are followed up in the out-patient department. Sutures are removed usually 14 days post-surgery. Nimodipine and other symptomatic drugs are gradually discontinued around this period. Patients on anti-seizure drugs are continued until when it is safe to tail off.

RESULTS

A total of 179 cases of intracranial aneurysms were radiologically diagnosed during the study period. We managed 58 (32.4%) IAs out of the diagnosed cases (figure 1). Female-male ratio was 2.5:1. Age distributions at time of rupture were 19 (32.8%) < 40 years, 28 (48.2%) 41-60 years and 11 (19.0%) > 60 years. The age range was from 18 to 72 years (table 1).

Anatomical locations were internal carotid artery (ICA) 31(53.4%) of which posterior communicating artery (PcomA) had 21 cases, anterior communicating artery (ACA) 19 (32.8%), middle cerebral artery (MCA) 4 (6.9%) and posterior circulation 4 (6.9%) – one vertebral artery-posterior inferior cerebellar artery (VA-PICA) and three Basilar. Some uncommon anatomical variations in intracranial vessels were observed including azygous A1 (one case), Fetal PcomA (3), congenital severe stenosis of right ICA circulation (1) and MCA (1) (table 1).

All presented following sub-arachnoid haemorrhage. Admission WFNS grade was 0-2 in 28 patients (48.3%) but 30 (51.7%) were grade 3-5 (table 2). Admission systolic BP was > 160 mmHg in 32 (55.2%) (table 2).

Among the 23 cases that could not have surgery, reasons for declining were: opting for coiling (2), unfavourable vascular anatomy (2), posterior circulation (4), died before surgery (6), opted to be discharged for alternative care from family pressure (9) (table 3). Out of the 35 (63%) patients that had surgery, CTA-based aneurysm size < 11 mm in 15 (42.9%); four of these had bigger dimension at surgery, 11-25 mm in 13 (37.1%) and > 25 mm 7 (20.0%) (figure 2).

Delay from presentation to surgery was < 3 days 9 (25.7%), 4-7 days in 14 (40.0%), > 7 days 12 (34.3%) (figure 3). Successful clipping was performed for 33 (94.3%), wrapping 1 (2.9%), CCA ligation 1 (2.9%), coiling nil (table 4).

Intra-operative challenges included brain oedema 9 (25.7%), associated ICH 10 (28.6%), rupture 8 (22.9%), blebs at neck 5 (14.3%), need for anterior clinoid drilling 5 (14.3%), vasospasm 4 (11.4%), parent vessel/aneurysm base calcification 4 (11.4%), giant aneurysms 7 (20.0%), thrombosed 3 (8.6%), multiple aneurysms 3 (8.6%), clip malfunction 1 and vessel kinking 1. One case co-existed with a frontal lobe cavernoma (table 5). Common post-operative challenges were DIND 12 (34.3%), hydrocephalus, electrolyte imbalance 11 (31.5%) each, and hormonal derangement 3 (8.6%) (table 5). Six operated patients died; one with WFNS 1 and five with WFNS > 3. Among the mortalities, two had intra-operative rupture, two had delayed onset malignant brain swelling, two had pituitary axis failure (table 5). Average duration of ICU stay was 5 days, mean hospital stay 10 days and the mean cost of ICU stay was

NGN 3,500,000 ($6,000), calculated using an exchange rate of NGN 583 to 1 USD, which was the prevailing rate during the study period. (table 5).

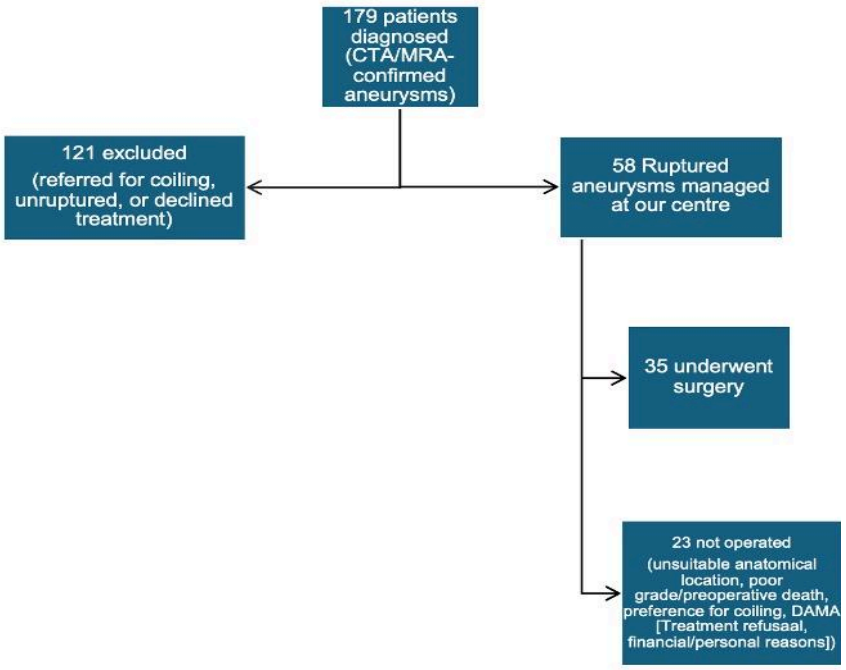

Figure 1. Flow chart of cases managed.

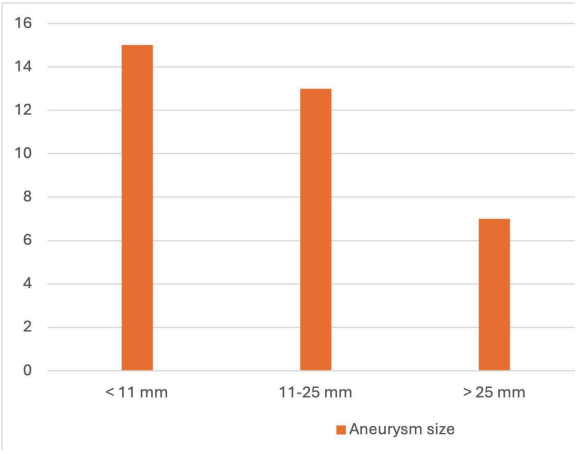

*Figure 2: Aneurysm size radiologically. * Four of the radiologically small aneurysms (< 11 mm) had larger sizes intraoperatively.*

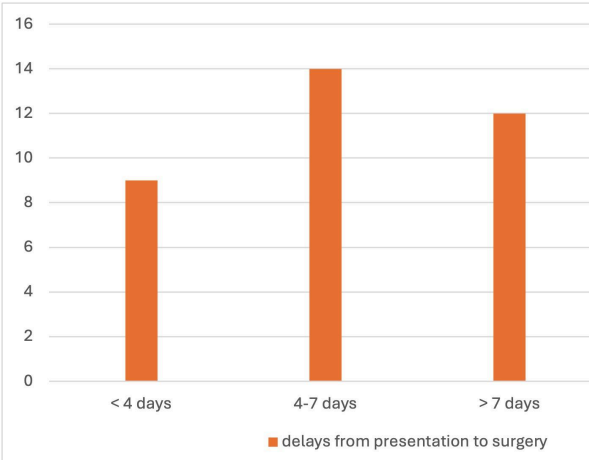

Figure 3: delays from presentation to definitive surgery

Table 1: Demographics of total cohort

	n (%)
Sex	
Male	17 (29.3%)
Female	41 (70.7%)
Age at time of rupture	
< 40 years	19 (32.8%)
40-60 years	28 (48.2%)
> 60 years	11 (19%)
Anatomic locations	
ICA	31 (53.5%
*Pcom	21
ACA	19 (32.8%)
*AcomA	16
*Pericallosal	1
MCA	4 (6.9%)
Posterior circulation	4 (6.9%)
VA-PICA	1
Basilar	3
Uncommon anatomy	
Azygous A1	1
Fetal Pcom	3
Congenital severe stenosis	
Right ICA	1
Right MCA	1

Table 2: Clinical presentation

	n (%)
Ruptured	58 (100%)
WFNS grade	
1	20
2	8
3	19
4	10
5	1
Moderate to severe BP	32 (55.2%)

Table 3: Non-operated cases (n = 23)

Reason	**Number**
Opted for coiling	2
Non-operable by clippin	6
Died before surgery	6
DAMA*	9

**DAMA- discharge against medical advice*

Table 4: Mode of surgery

Mode of surgery	**Frequency**
Clipping	33
Wrapping	1
CCA ligation	1
Coiling	0
Total (n)	35

Table 5: Intraoperative and postoperative challenges of operated cohorts (n = 35)

	Total
Intra-operative challenges	
Brain oedema	9
ICH*	10
Rupture	8
Blebs at neck	5
Need for anterior clinoid process drilling	5
Vasospasm	4
Parent vessel/aneurysm base calcification	4
Giant aneurysm	7
Thrombosed aneurysm	3
Multiple aneurysms	3
Clip malfunction	1
Vessel kinking	1
Co-existing frontal lobe cavernoma	1
Post-operative challenges	
DIND**	12
Hydrocephalus	11
Electrolyte imbalance	11
Hormonal derangement	3
	6
Mortality	
Intraoperative rupture	2
Delayed onset malignant brain swelling	2
Pituitary axis failure	2

**ICH – intracerebral hemorrhage; **DIND-delayed ischemic neurologic deficit*

DISCUSSION

The findings from this study revealed that only 32% of cases clinically identified and diagnosed radiologically could receive neurosurgical care in our facility. This is a serious challenge because most hospitals from which these patients were sent for diagnostic angiography investigation do not have the manpower and equipment capacity to manage or operate on these cases of intracranial aneurysms. In a significant proportion of the cases, patients were only sent for a non-contrast brain CT scan as investigation for stroke, migraine headache or meningitis, not minding that all the cases already had features of SAH at presentation. In many cases, angiography was performed for these referred cases only after further discussion with the referring physician. It is a common knowledge that cases of SAH are generally managed as 'stroke' in many non-specialized centers in the country and even among non-neurosurgical units in the teaching hospitals. This tends to allocate the same treatment protocol of stroke patients to aneurysm cases. It is difficult to say how much of these cases survived eventually. The index of suspicion to triage SAH cases and recognize its peculiar management challenges is low among general practitioners partly from financial interest and tendency to admit and manage cases or pure knowledge gap in the society. Emphasis should be placed on curriculum revision for the medical students as well as streamlining of the patient referral chain. Also, the

apparently non coordinated case identification and referral system may be partly accounting for the poor data management giving the impression of a very low incidence of aneurysmal SAH. Considering the high rate of unexplained sudden deaths in Nigeria on a background of poor autopsy service utilization, we recommend the commissioning of a community-based study for our population to unravel the true epidemiology of the unruptured intracranial aneurysms.

Furthermore, in low- and middle-income countries (LMICs), intracranial aneurysms often go undetected or are underreported due to such challenges of limited access to neuroimaging and specialized care (7). For example, Ohaegbulam et al. highlighted that improved access to neuroradiology in sub-Saharan Africa would likely reveal a higher incidence of aneurysms than currently recognized (4). Comparatively unlike high-income countries (HICs) where routine screening for aneurysms is more feasible, detection in LMICs often occurs after rupture, as seen in our series where all 58 aneurysms presented post-rupture. The reliance on referral for imaging from general hospitals without neurosurgical capacity exacerbates the detection challenge.

Another common challenge in the society is the gap experienced between ictus and presentation for neurosurgical care and majority of the cases eventually present with very high WFNS grade as shown in this study. The extent of delay is very variable, and some had reported two different episodes of thunderclap headache before they presented for definitive care. In some cases, more than one year had passed between diagnosis and presentation for surgery. Even among cases admitted for surgery, 34% could not be operated on earlier than one week post admission. Common reasons for the delay in presentation and surgery include family indecision on issues of safety of surgery on background of comorbidity and poor clinical grade, cost constraint and religious influence. Sometimes this waiting is costly as we lost six patients before consent and optimization for surgery could be achieved. In comparison, in HICs, the "time to surgery" for ruptured aneurysms is typically shorter due to established protocols for emergency neurovascular surgery. In LMICs, in addition to financial constraints and a lack of neurosurgical capacity delaying surgery, other common barriers include delays in obtaining consent, and logistical challenges with hospital resource availability (8). A study on the timing of aneurysm treatment in subarachnoid hemorrhage found that the average time from clinical manifestation to surgical intervention was 7.1 days, possibly due to limited access to specialized care (9).

From the result of our study, IAs in this environment predominantly affected the relatively younger age group and these are the productive workforce of the society. Unlike the study environment with a life expectancy of around 53 years, IAs frequency are known to increase with aging especially in most advanced countries where longevity is guaranteed (10-12). What is also worrisome is the high frequency of systemic hypertension observed among our cases of IAs. Studies have already established the higher predisposition of the Nigerian population to systemic hypertension when compared with the Caucasians, Japanese and the Finnish population where IA incidences are higher (13-17). Early onset high blood pressure is a known risk for IA rupture (18-23). It is possible that the high association with systemic hypertension explains the high rupture incidence at a relatively younger age in our population. There is a need to institute awareness campaigns for routine screening and other secondary prevention strategies for systemic hypertension and IAs.

Unfortunately, all the cases managed were diagnosed following a prior bleed with all presenting as ruptured aneurysm unlike the trend in some other parts of the world where predominantly, most cases are identified unruptured and asymptomatic through routine screening. This early identification and follow-up increase the probability of better management, reduced risk of morbidity and mortality associated with ruptured aneurysms and gives a good window for elective surgery planning when the indications are met. In this regard, routine screening using CT or MR angiography is recommended for our population starting from the age of 40 years as part of periodic medical health assessment. Our findings raise important implications for prevention. The relatively young mean age at presentation, combined with a strong association with hypertension, suggests that aneurysms in our population are occurring in a group that should be in their most productive years. This supports the case for early identification of aneurysms in high-risk groups. While we recognize that universal population screening is currently beyond the reach of most sub-Saharan African health systems, we argue that CTA/MRA screening of selected groups — particularly young hypertensives — could be a feasible starting point. Such an approach has the potential to reduce the catastrophic burden of rupture, especially in contexts where surgical or endovascular rescue options are limited. Larger population-based studies will be required to refine these recommendations, but our data provide an initial basis for this policy consideration.

In the team's experience, posterior communicating artery aneurysm was the most common case managed with varying degrees of complexity. It

accounted for 36% of all cases managed and 68% of all the ICA segment aneurysms and three of the seven giant aneurysms operated on. Previous studies have demonstrated that aneurysms with high-risk features are more prone to rupture at a younger age while increasing age is also associated with lower risk of rupture of PcomA aneurysms (24, 25). On the contrary, many studies in other regions of the world tend to report the anterior communicating artery (AcomA) aneurysm as the most common IAs accounting for up to 23-40% of IAs (26-28). The reason for PcomA dominant frequency in this study is not clear although studies from Finland also had a pattern of MCA aneurysm predominance (29, 30). However, different chromosomal studies carried out in Finnish and Japanese populations with IAs demonstrated association of IAs with different genetic locus abnormalities in the two populations. These studies have revealed strong genetic predispositions based on race (31, 32). Hence, the PcomA frequency in our population needs to be further evaluated in lines of genetic predisposition. A striking angiography consideration among the PcomA cases was the presence of fetal type PcomA circulation. This should be strongly evaluated before any plan for clipping procedure since any injury to this artery may be catastrophic as seen in one of outpatients.

Following comparison of aneurysm dimension pre-surgery and intra-operatively, another observation from our series was that CTA derived measurement may vary from the actual size of the aneurysm. This was observed among the complicated IAs where factors like aneurysm thrombus/clot, severe vasospasm, tamponading effect of surrounding haematoma and calcification of the wall influence the extent of contrast filling of the aneurysm cavity. Radiological features that may give a pointer to a bigger aneurysm in such case are very wide vascular bifurcation angle, dense ICH haematoma clot abutting the aneurysm, severe filling defect of major vessels supplying the aneurysm and evidence of calcification of the walls on CT scan. Neurosurgeons need to bear this in mind during planning of procedures and in clip size selection especially where resources are limited.

All the cases we managed had clipping done through a transcranial approach. Although the trend in the current treatment paradigm is competing between clipping and coiling options, the study environment is constrained in equipment and manpower capacity for coiling procedure. With all the arguments of superiority of clipping over coiling in ruptured IAs as well as other benefits of craniotomy in cerebral oedema management, sub-arachnoid space washout and haematoma evacuation, one may argue against the benefit of investment into the armamentarium for coiling procedure against the low case load of IAs in our environment. However, there is still need to develop the skill and efforts in this minimally invasive coiling option to enable patients make choice as two of our patients opted to travel abroad for coiling procedure, bridge the delay in decision making associated with phobia for craniotomy, and support services for other minimally invasive procedures including stroke management.

Surgery related challenges observed are worth highlighting. Intra-operative brain oedema, risk of rupture and vessel manipulation induced vasospasm were the most predominant concerns. Anaesthesia management expertise is important in preventing intra-operative brain oedema and aneurysm rupture. Special precaution is taken at time of intubation and application of the head-holder device. Initial protocol was to allow permissive hypotension from the start of surgery, but this was associated with metabolic acidosis. Currently, we maintain normal blood pressure until around the time of clipping before we lower the BP to reduce rupture risk; and following a successful clip application, we target a high BP as precaution to avoid vasospasm.

We observed that indiscriminate use of temporal clips may be associated with delayed worsening of vasospasm in ruptured aneurysms. This may be a heightened response to an already ‘sick’ vessel following application of these temporal clips or impact of the closing force of the clip. We currently recommend avoidance of temporal clips unless strongly indicated in cases where rupture risk is high as seen in aneurysms with blebs at the neck or following pre-mature rupture of the aneurysm. Rather, on a background permissive hypotension, we target neck dissection and permanent clip application. This approach has helped to reduce the frequency of vasospasm post-operatively in our experience.

Also, we encountered ruptured aneurysms of varying characteristics including thrombosed aneurysms, calcification of the aneurysm neck and parent vessel wall and giant aneurysms. Careful pre-operative planning and deliberate search for these peculiar characteristics help to reduce intra-operative risks. We experienced a case of avulsion of the aneurysm at the neck in the process of clipping the aneurysm with wall calcification. There was also a report of clip malfunction with an attempt to clip a thrombosed aneurysm due to wrong choice of clip size and strength. Intraluminal thrombosis of IAs was also one of the reasons for discrepancy between the CTA based pre-operative measurement and the intra-operative assessment of aneurysm size.

Re-orientation of vessel anatomy may occur following clip application especially in severely

narrowed vessels. Neurosurgeons need to bear this in mind for potential risk of impairment of distal blood flow. In this regard, it is encouraged that vessel caliber patency should always be assessed following clipping to avoid post-clipping neurological deficit. In low resource settings, following application of permanent clips, distal vessel patency can be assessed using a graded, resource-adapted protocol. Primary intraoperative evaluation consists of high-magnification visual inspection for vessel colour, distal pulsation and capillary refill, and a brief temporary-clip test when feasible to confirm tolerance of occlusion. A handheld micro-Doppler probe (where available) can be used to confirm flow signals in the parent and major distal branches. In cases where intraoperative indocyanine green (ICG) angiography or intraoperative DSA are available, these can be used to confirm patency. If advanced intraoperative imaging is not available, early postoperative CTA (generally within 24–72 hours) can be performed to document clip position and vessel calibre. Patients should be monitored closely in ICU with serial neurological examinations and, when available, transcranial Doppler (TCD) to detect early flow compromise.

In some of the PcomA aneurysms, drilling of the anterior clinoid bone was required to allow access to the proximal side of the aneurysm neck. This need for clinoid drilling can be predicted from pre-operative brain CTA. In our experience, intracranial proximal control in these cases is very difficult and every effort must be made to achieve precise drilling under high magnification microscope with irrigation. The authors also recommend the need for surgeons to acquire proficiency in by-pass anastomosis surgery in this sort of cases with unfavourable anatomy including giant aneurysms.

Another common challenge encountered in the course of managing these aneurysms is how to manage raised intracranial pressure from SAH associated ICH and hydrocephalus against the risk of rupture, especially among patients with good WFNS grade. The authors prefer to delay invasive measures including endotracheal intubation in the first week when the risk of re-rupture is very high unless strongly indicated. All such invasive interventions are preferred to be carried out at the time of clipping surgery or whenever indicated as a stand-alone procedure post-clipping.

Among the few cases diagnosed with multiple aneurysms, the team usually plan clipping for the IA that caused the ictal SAH. However, the case with co-existing cavernoma was managed in the same surgery because access was favourable.

In our experience, the most serious post-operative challenge is delayed ischaemic neurological deficit. Two cases had associated delayed malignant cerebral oedema and died. Most of the patients that suffered DIND had initially uneventful immediate post-operative period and satisfactory neurological function but later had delayed drop in neurological function. We recommend close monitoring of patients in the first 10 days of surgery including haemodynamic, fluid and electrolyte management. It is also important to watch out for pituitary axis failure especially in anterior communicating artery aneurysms using periodic hormone profile assays, especially cortisol and thyroid hormones. These post-operative concerns have made the team to err more on the side of caution towards avoiding a rushed transfer of patients out of ICU even if they are stable post-surgery, recommending up to five days stay in ICU post-surgery. Our experience underscores the critical link between pre-operative planning and post-operative outcomes. Anticipation of thrombus, calcification, and aneurysm wall changes on imaging allows better clip selection and reduces intra-operative rupture risk, while structured ICU monitoring for vasospasm, pituitary dysfunction, and delayed ischemic neurologic deficit is essential to improve outcomes. Strengthening referral protocols, developing endovascular capacity, and advanced training in bypass techniques are practical steps toward resolving these challenges in our setting.

CONCLUSION

Experience revealed that younger age groups were more affected by background hypertension. Posterior communicating artery aneurysm is the most common site of aneurysm in our population. Neurosurgeons should be conscious of the study's highlighted intra- and post-operative challenges during surgical planning. Based on these findings, priority areas for quality improvement include reducing time-to-surgery for patients presenting in good WFNS grades (0–3), standardizing clip selection in complex aneurysms with calcified or thrombosed necks and implementing structured monitoring protocols for DIND during the first 10 days after surgery. Addressing these factors, alongside broader capacity-building, will be essential to improving aneurysm outcomes in resource-limited environments.

Limitations

This study has several limitations. It is a single-centre, retrospective analysis, which may limit generalizability. Follow-up data beyond three months were incomplete, reducing our ability to assess long-term outcomes. The small number of primary events limited statistical power and precluded reliable multivariable modelling, so our findings are descriptive and exploratory. Finally, the

lack of an endovascular service at our centre may have influenced treatment selection and outcome.

Conflict of Interest

None.

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