

TREATMENT MODALITIES & OUTCOME TRENDS OF COMPLEX ANTERIOR CIRCULATION INTRACRANIAL ANEURYSMS: A CASE SERIES STUDY

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ABSTRACT:

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Background: Complex intracranial aneurysms (CIAs) are technically challenging neurosurgical pathologies, and despite extensive efforts to treat these intricate vascular lesions, no formal management guidelines exist in the literature. In this study, we evaluate contemporary clinical practice and recent trends and outcomes in managing anterior circulation CIAs.

Methods: This study is a prospective observational study that included 40 patients. All patients were evaluated by multidisciplinary team (MDT) consisting of neuro-endovascular radiologists, vascular neurosurgeons, and neurologists for assessment of the therapeutic options.

Results: Twenty cases were managed surgically, while 18 were treated by various endovascular techniques. Surgical and endovascular modalities were used as a hybrid approach to treat 2 cases. Recurrence or residual of treated aneurysms was seen only in the endovascular cohort (Four cases out of the 18 cases treated by endovascular techniques). Four documented intervention related mortalities occurred during the first 6 months.

Conclusion: CIAs managed surgically showed less recurrence rate than those treated by different endovascular techniques. CIAs treated by endovascular modalities showed much lower length of hospital stay and better modified Rankin scale after 6 months. Complications rate and mortality rate were similar in both groups and were usually related to the initial poor presentation with high World Federation of Neurosurgical Societies (WFNS) grades upon the initial ictus.

Keywords: bypass; clipping; complex aneurysms; endovascular; subarachnoid haemorrhage.

INTRODUCTION:

Treating complex intracranial aneurysms (CIAs) presents a significant technical challenge in the field of neurosurgery. Despite extensive discussion and research, there are currently no standardized guidelines for managing this complex pathology. The classification of an aneurysm as complex is primarily based on expert opinions, as there is no formal framework in place. The label of

complexity indicates a higher risk of unfavourable outcomes in terms of natural progression and/or therapeutic interventions. It also highlights the increased requirement for advanced therapeutic skills and expertise in dealing with such intricate pathologies⁽¹⁾.

Hanel and Spetzler have proposed specific criteria to define an aneurysm as complex. These criteria include: 1) Diameter equal to or larger than 2.5 cm,

- 2) Location of the aneurysm,
- 3) Shape of the aneurysm,
- 4) Aneurysm refractory to treatment,
- 5) Presence or absence of collateral circulation,
- 6) Intraluminal thrombus within the aneurysm,
- 7) Wall calcification of the aneurysm,
- 8) Branching aneurysm,
- 9) Feeding parent artery forming a part of the aneurysm,
- 10) Distinct wall structure of the aneurysm, such as blister-like or dissecting,
- 11) Embedding of the aneurysm on the surrounding brain, brainstem, and cranial nerves resulting in mass effect and neurological deficits. By considering these criteria, an aneurysm can be classified as complex based on its characteristics, aiding in treatment decision-making and management planning⁽²⁾.

New advances in skull base approaches, cerebral revascularization, improved surgical instruments together with advanced anaesthetic and post-operative care.⁽³⁾ Furthermore, the advancements in endovascular techniques have enabled us to expand the treatment options for lesions that were previously considered inoperable. These rapidly developing techniques have allowed us to push the boundaries of what was once deemed untreatable, providing new possibilities for patients with complex pathologies.⁽⁴⁾

AIM OF THE STUDY:

The objective of this prospective observational study was to evaluate the clinical outcomes of the different treatment modalities in management of complex anterior circulation intracranial aneurysms in terms of efficacy, morbidities, and complications.

PATIENTS AND METHODS:

A prospective observational study of **40** patients with complex anterior circulation intracranial aneurysms were included from

King's College Hospital, London, United Kingdom. All cases meeting the inclusion criteria from May 2016 till December 2021 were included to this study.

Inclusion and exclusion criteria:

We included : **1)** patients younger than 75 years old, **2)** complex anterior circulation aneurysm according to Hanel and Spetzler criteria⁽²⁾. Posterior circulation aneurysms, age above 70 and simple aneurysms were excluded.

Ethical consideration:

Following our institutional guidelines, the treating neuroendovascular and neurovascular surgeons informed all patients and their families about the potential risks and benefits associated with the planned procedure. In adherence to this protocol, a written consent form was obtained, signed by either the patient or their next of kin, at least 24 hours prior to the intervention.

The primary outcomes were technically successful treatment, the patient's performance status using the Modified Rankin Scale (mRS), complications, and recurrence rate with various treatment methods. Technical treatment success was confirmed by complete obliteration of the treated aneurysm as per Digital subtraction angiography (DSA) or non-invasive angiography without evidence of recanalization or recurrences.

Immediate post intervention neurological evaluation:

All patients were assessed neurologically post intervention using the formal GCS score and full neurological examination.

Post intervention radiological evaluation:

The primary radiological investigations done were plain CT head, CTA and MRA. In all the surgically treated cases, Indocyanine Green Video Angiography (ICGVA) confirmed complete occlusion of the aneurysms. In the endovascular group,

occlusion was also confirmed at the end of the procedure.

Data analysis:

The following parameters were documented in our study: patient's age, gender, WFNS grading scale, modified Fisher grading scales (if applicable), status of aneurysm rupture, complications during the operation, and clinical outcomes. We also recorded the presence or absence of certain symptoms during the follow-up period, including intracranial haemorrhage (subarachnoid/intraparenchymal), ischemic stroke, procedural thromboembolic events, and mortality. Any adverse events leading to neurological deficits were classified as neurological complications. The neurological status of the patients was assessed at baseline, discharge, and throughout a mean follow-up duration of 12 months using the modified Rankin Scale (mRS). Descriptive statistics were employed, presenting categorical parameters as numbers and percentages, and quantitative parameters as means and standard deviation (SD).

RESULTS:

Patients' demographics:

The youngest and the oldest patients were 17 and 75 years old, respectively. The mean age of the study population was 52.9, the median was 55.5, while the standard deviation (SD) was 13.66. The study included 16 males and 24 females of different ethnic groups. Seventy two percent were European, while 3 % only were Asian. Positive family history of cerebral aneurysms was reported in 2 cases only. Half of the study population were smokers.

Clinical presentation:

Among the 40 patients included in the study, 26 patients present with the typical

picture of SAH with sudden severe thunderclap headache and subarachnoid blood in the Computed Tomography (CT). The remaining 14 patients present with other clinical pictures including: coma, cranial nerve palsies, visual deficits, stroke, and incidental finding.

All the patients included in the study had CT head and high-quality thin cuts 3D CT Angiography (CTA) as an initial investigation upon hospital admission. DSA was done in 35 cases while Magnetic Resonance Angiography (MRA) was only done in 9 cases.

Aneurysms characteristics:

All 40 aneurysms included in the study were located in the anterior circulation. Internal carotid artery (ICA) aneurysms represent 30% of the cases **Figure 1**, while middle cerebral artery (MCA) and anterior cerebral artery (ACA) aneurysms represent 40% and 30% respectively. Around 23% of the aneurysms included in the study were giant (more than 25 mm in diameter). Blister small diameter aneurysms (1-5 mm) represent 37% of the study population. Aneurysms with diameter of 20-25 mm were reported in 20% of the cases, while the remaining 20% were found to have diameter ranging from 6 mm to 20 mm. These results demonstrate that for the aneurysm to be complex, it does not need to be only giant. Blister aneurysms with small diameter were most of the study population because of the complexity of their management. The mean, median and SD of the aneurysm's sizes are 15.4 mm, 15.5 mm and 11.5, respectively. The smallest aneurysm's diameter is 1.5 mm, while the largest aneurysm's diameter is 40 mm. Wide neck aneurysms represent 8% of the study population.

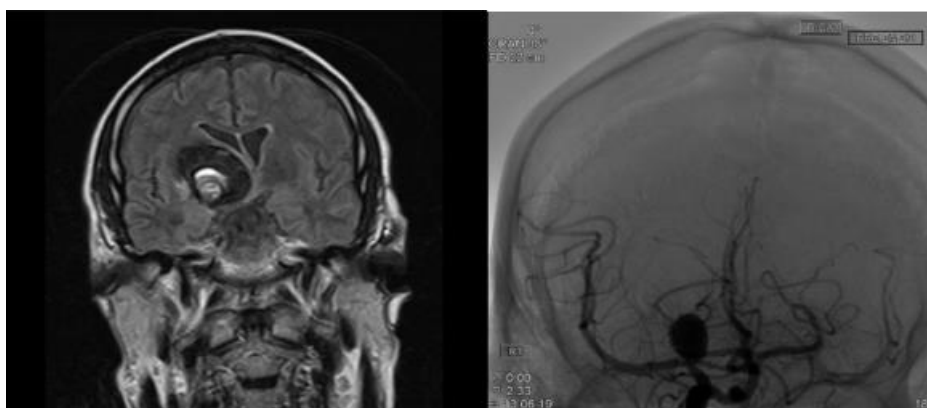


Figure 1: (A) Coronal MRI T1WI, (B) AP view DSA showing right terminal ICA giant, partially thrombosed aneurysm of a patient presented with decline in visual acuity.

The mean, median and SD of the different neck sizes are 4.01, 3.7 and 2.14, respectively. The smallest neck size is 1 mm, while the largest is 9 mm. This ratio usually influences the decision to treat the aneurysm either by surgical or endovascular techniques. The mean, median and SD of the dome to neck ratio in this study are 3.65, 3.15 and 2.34, respectively. The lowest ratio is 0.75, while the highest is 10.

Among the 40 aneurysms included, 17 aneurysms presented with SAH. The remaining 23 aneurysms are presented with different clinical pictures including accidental discovery, mass effect and compressive neuropathy. Additional characteristics of ruptured and unruptured aneurysms are shown in Table 1.

Table (1): Characteristics of Rupture and Unruptured Aneurysms

	Ruptured group N=17	Unruptured group N=23
Age (years) (mean ± SD)	50.82 ± 14.2	54.52 ± 13.41
Female sex	8/17 (47%)	16/23 (69.5%)
Hypertension	2/17 (11.7%)	4/23 (17.39%)
Smoking	7/17 (41%)	13/23 (56.5%)
Family history	1/17 (5.88%)	1/23 (4.34%)
Size, mm (mean ± SD)	13.04 ± 10.6	17.27 ± 12.05
Size, Median with IQR in parentheses*	6 (5-25)	20 (4.5-25)
Irregular shape	4/17 (23.5%)	5/23 (21.7%)
Treatment		
Surgically	12	8
Endovascular	5	13
Hybrid	0	2
Location		
ICA	5	8
ACA	4	7
MCA	8	8
Modified Ranking Score (mean ± SD)	1.88 ± 2.14	0.95 ± 1.79
Length of Hospital Stay (mean ± SD)	30.88 ± 20.00	14.39 ± 11.99
Mortality	2/17 (11.7%)	2/23 (8.6%)
Note, -Unless otherwise specified, data are numbers with percentages in parentheses. ACA = anterior cerebral artery, ICA = internal carotid artery, MCA = middle cerebral artery		
* Data are medians, with interquartile range in parentheses		

Treatment modalities:

All patients were evaluated by the MDT. Twenty cases were managed surgically, while 18 were treated by different endovascular techniques. Surgical and endovascular modalities were used as a hybrid approach to treat 2 cases.

The surgical modalities used included clipping, clipping with wrapping technique, bypass and surgical parent vessel occlusion. Among the patients who were managed surgically, half of them were treated by clipping only. Eight patients were managed by the clip/wrap technique. Revascularization techniques were used twice, while parent vessel sacrifice was reported once in this study.

On the other hand, the different endovascular modalities included were as follows: 7 cases treated by stent-assisted coiling, 5 were managed by flow diverters, 3 with balloon-assisted coiling, 3 with simple coiling and only one was managed by endovascular parent vessel occlusion.

Immediate post intervention neurological evaluation:

Nine patients were kept asleep post interventions either due to the initial poor grade SAH or due to the complexity of the procedure and the need for maximum brain protection. Clinical assessment of patients after interventions is a cornerstone in the management of patients with aneurysmal SAH. Early detection of any new neurological deficits was addressed promptly with subsequent quick management.

Around 22 patients had no focal neurological deficits, 9 were intubated sedated and the rest had either hemiparesis, confusion, or dysphasia.

Post intervention radiological evaluation:

The primary radiological investigations done were plain CT head and CTA. MRA was done in only one case of partially thrombosed giant aneurysm **Figure 2**. In all the surgically treated cases, Indocyanine Green Video Angiography (ICGVA) confirmed complete occlusion of the aneurysms. In the endovascular group, occlusion was also confirmed at the end of the procedure.

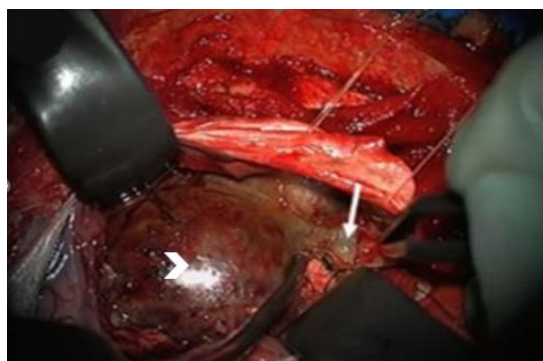


Figure 2: Intraoperative picture of large, thrombosed ACA aneurysm (arrowhead), with thrombosed parent artery (white arrow)

Delayed Ischemic Neurological Deficits (DIND):

DIND occurred in 7 cases only of the study population. This represents approximately 17% of the cases. It was also

noted that the 5 DIND cases in the surgical group were seen in clipping (2 cases) and clip/wrap (3 cases) sub-groups. On the other hand, the 2 reported cases in the endovascular group were seen in balloon assisted coiling sub-group. It is worth mentioning that no

DIND cases were seen with the hybrid modality.

Early complications after intervention (occurring within 30 days post ictus):

25 cases had **no** complications after intervention, 13 of which were from the endovascular group and 12 were from the surgical group.

From the 20 cases treated surgically, 9 complications were seen including hydrocephalus requiring permanent CSF diversion, stroke, intra-operative rupture and intra-cranial haemorrhage. On the other hand, 5 cases from the 18 cases managed by endovascular modalities reported complications varying from hydrocephalus, stroke and carotid cavernous fistula. major procedural complications incidence is shown in **Table 2**.

Table (2): Major Procedural Complications Incidence per Treatment Modalities and chniques

	Surgical Modalities	Endovascular Modalities	Hybrid
Stroke	3 (1 Clipping, 2 Clipping/wrap)	3 (Balloon Assisted Coiling)	0
Intra-cerebral haemorrhage	1 (Clipping/wrap)	1 (Flow diverter)	0
Carotid Cavernous Fistula	0	1 (Parent vessel occlusion)	0
Cranial Nerve Palsy	0	1 (Balloon Assisted Coiling)	0
Hydrocephalus	4 (2 Clipping, 2 Clipping/wrap)	1 (Coiling)	0

Length of stay in hospital (LOS):

Among the 40 cases, 17 cases (ruptured group) were presented by SAH while 23 (unruptured group) were presented either accidentally or due to mass effect symptoms. In the surgical group, the mean, median and SD of the LOS are 29.05, 29 and 18.66, respectively. The shortest hospital stay is 4 days and the longest is 83 days. In the endovascular group, the mean, median and SD of the LOS are 13.77, 9.5 and 12.2, respectively. The shortest hospital stay is 3 days, while the longest is 46 days. In the hybrid group, the 2 patients who underwent combined surgical and endovascular management stayed as inpatient for 4 and 15 days.

6 months follow up:

Thirty-six patients were followed up after 6 months with detailed neurological and radiological evaluation.

Recurrence after 6 months:

Among the 40 cases included in the study, 4 cases only had radiologically proven recurrence on interval scans after 6 months. The 4 cases were initially managed by endovascular

techniques. Two cases were initially treated by flow diverter device, 1 was treated by coiling and the last one was treated by balloon assisted coiling. Among the surgically treated aneurysms, no proven recurrence was reported after 6 months of follow up.

Intervention related mortalities after 6 months:

Unfortunately, 4 documented intervention related mortalities occurred during the first 6 months. Two cases out of the 4 were in the endovascular group: one was a case of ruptured Right para ophthalmic giant aneurysm treated by balloon assisted coiling died post ictal on 12th day of procedure. The second case was an unruptured Right cavernous carotid giant aneurysm treated by parent vessel occlusion died on day 15th post procedure secondary to Supra Ventricular arrythmia. Third case was surgically treated for Right Proximal M1 MCA ruptured aneurysm by clip/wrap technique and end of life was chosen by next of keen on day 15th post procedure. and the last mortality was seen in a case treated for recurrent unruptured Acom aneurysm by the hybrid approach (Clipping+ flow diverter) died due to

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spontaneous Acute SDH (was on dual antiplatelet). All the 4 mortalities occurred within 28 days from initial hospital admission for aneurysms management.

Based on rupture status of aneurysm; the LOS, mRS of 6-months follow up and

mortality (related to studied pathology or the procedure) are compared between different treatment groups in table 3. Neurological status after six months from interventions is illustrated in table 4.

Table (3): Based on rupture status of aneurysm; the LOS, mRS of 6-months follow up and mortality compared between different treatment groups

	Surgical n=20		Endovascular n=18		Hybrid n=2	
	Ruptured	Unruptured	Ruptured	Unruptured	Ruptured	Unruptured
	12	8	5	13	0	2
LOS* (mean ± SD)	35.5 ± 20.46	2.37 ± 13.64	19.8 ± 15.20	11.46 ± 10.63	n/a	9.5 ± 7.77
Mortality n=4	1	0	1	1	0	1
mRS (mean ± SD)	2.08 ± 2.02	1 ± 1.19	1.4 ± 2.60	0.61 ± 1.66	n/a	3 ± 4.24

LOS= length of stay in hospital, SD= standard deviation, mRS= Modified Rankin Scale

Table (4): Neurological Status after 6 months from Intervention

	Surgical	Endovascular	Hybrid
Death	1	2	1
No FND	10	13	1
Visual Deficits	1	1	0
Motor Weakness	5	1	0
Cranial Nerves Deficits	1	1	0
Cognitive Decline	2	0	0

FND= focal neurological deficits

DISCUSSION:

Complex intracranial aneurysm (CIA) is a vast entity that includes not only giant aneurysms with a diameter > 2.5 cm, but also aneurysms with common partial thrombosis, mass effect, and/or aneurysm sac incorporating branching vessels. These aneurysms are considered complex and difficult to treat⁽⁵⁾.

Little knowledge exists regarding the natural history of CIAs, with the controversy around the best clinical management⁽⁶⁾. A recently published prospective multi-center study in 2019 by Dengler J et al. showed that conservative treatment alone is associated with higher rates of rupture, unlike microsurgery or endovascular treatment modalities for unruptured CIAs⁽⁷⁾.

In order to determine the most appropriate treatment protocol for CIAs patients, a risk factor analysis of its natural course and treatment options is needed. As a result, the overall aim of the study was to evaluate contemporary clinical practice, as well as recent trends and outcomes in the management of anterior circulation CIAs. Initially, our main aim was to do a large multi-center prospective observational study involving cases from Egypt, the United Kingdom, and the United States of America. This was mainly because institutional guidelines and different expertise strongly impact patient selection, surgical procedures, and perioperative patient management. Unfortunately, due to the COVID-19 pandemic, we managed to include cases from the UK only.

This single-center study highlighted our interdisciplinary treatment approach for challenging CAIs. We demonstrated that CIAs treated with endovascular techniques exhibited higher recurrence rates than surgically treated aneurysms. On the other hand, surgically treated aneurysms had a higher complication rate (45%) than aneurysms treated by the endovascular modalities (27.7%).

The LOS was also significantly longer in the surgical group compared to the endovascular group. The mean LOS for the surgical group was 29 days, while it was 13 days for the endovascular group. The mortality rate during the first 6 months was 11% in the endovascular group, while it was 5% in the surgical group.

Norberto Andaluz et al. 2011 conducted a retrospective study on their management of CIAs from 1997 to 2009. They found that 192 patients were admitted with CIAs, 128 of whom presented with SAH, while 64 had unruptured, symptomatic CIAs. Treatment included direct clipping (65.6%), endovascular management (coiling/stenting) (28.1%), bypass (3.1%), and no intervention (3.1%)⁽¹⁾. Their study concluded that a multidisciplinary approach strongly enhances the treatment and handling of possible postoperative sequela of complex aneurysms, an entity initially considered untreatable⁽¹⁾.

Unfortunately, the literature is deficient in clearly defining complex aneurysms. With the exception of recent trial of Hanel and Spetzler focusing on defining the entity, all recent studies focus on treating individual aneurysm subtypes rather than the broad-spectrum complex aneurysm entity.

The famous **International Subarachnoid Aneurysm Trial (ISAT)** in 2002 included only ruptured aneurysms. It compared the endovascular and the surgical treatment in the term of 1-year survival free disability as a primary outcome, while the secondary outcome was the rebleeding rate⁽⁸⁾.

The comparison between our study to ISAT is difficult because of the difference in inclusion criteria between both studies. Also, the concept of complex aneurysms was not yet proposed in a wider aspect. Yet, the recurrence risk in both studies seems to be higher in the endovascular group.

In August 2020, *Jai Ho Choi et al.* published a retrospective review of 112 patients (141 total procedures) with what they defined as large (15–25 mm) and giant (> 25 mm) intracranial aneurysms (IAs), subjected to different treatments over nine years⁽⁹⁾. Forty-seven cases had coil embolization, 39 had a flow diverter (FD), 13 received clipping, and 13 had parent artery occlusion (PAO). Their results showed that 46.8% of cases suffered a recurrence, and retreatment was needed in 31.9% of the total sample, with the rates being significantly higher amongst the coil embolization group ($p < 0.001$); however, complete occlusion rates were significantly lower ($p = 0.027$) in this same group. They concluded that PAO techniques offered 91% occlusion with few complications⁽⁹⁾

In September 2016, *Seung Pil Ban et al.* retrospectively reviewed the medical records of 62 complex aneurysms treated by bypass techniques from 2000 to 2015. Except for one case having intracranial-intracranial bypass, all remaining cases underwent extracranial–intracranial bypass. With angiographic investigations, 93.5% of total aneurysms were completely obliterated, with graft patency of 90.3%. Morbidity and mortality rates were 8.1 % and zero %, respectively. Karnofsky Performance Scale ≥ 70 and mRS score ≤ 2 were achieved in fifty-seven cases⁽¹⁰⁾. The authors finally proposed that whenever conventional modalities of endovascular intervention and direct clipping options are not available, bypass strategies can be a viable alternative for patients with CIAs⁽¹⁰⁾.

In the USA, the FDA approves only two FD devices: the Pipeline Embolization Device

PED*; and the Surpass FD**. *Bender et al.* conducted a single-center study, including 445 PED FD procedures on anterior circulation aneurysms (19% large and 1 % giant) to evaluate occlusion and aneurysm persistence predictors. Complete occlusion was achieved in 87% of cases at 24 months of follow-up. Morbidity and mortality rates for this study were 3.5 and 1.1%, respectively⁽¹¹⁾.

On the other hand, the Surpass FD was studied by a multicentre, prospective study done by *SCENT Trial* on 180 cases. They included refractory or uncoilable ICAs with wide necks, large/giant, extending from the petrous segment to the carotid terminus.⁽¹²⁾ The mean aneurysm size was 12.0 mm, with 13 (7.4%) giant aneurysms. Over 12 months, 63 % exhibited primary effectiveness and 8.3 % morbidity and mortality rate, demonstrating the effectiveness and safety of Surpass® FD in the above-mentioned ICAs⁽¹²⁾.

In 2019, *Nussbaum et al.* conducted a retrospective study on 126 complex, refractory, and atheromatous aneurysm subjects that were treated with surgical revascularization from 1997 to 2015 at the National Brain Aneurysm Center, North Carolina, USA. Demographics included the site, size, rupture, and bypass status of every CIAs case. The authors also evaluated the neurological deficit using the mRS. 80 % of their sample were classified as giant aneurysms, with the rest being large and small, among which 78.6% were in the anterior circulation. Morbidity and mortality rates were 11.5 % and 8.5%, respectively, and > 90% bypass patency were observed at the 12-month follow-up in both high and low flow groups⁽¹³⁾.

Finally, in November 2020, *Junlin Lu et al.* described a retrospective review of unruptured giant ICA patients treated in Beijing Tiantan Hospital in China from 2011 to 2018. They compared conservative treatment, surgical or endovascular treatment prognosis. This study showed that conservative treatment of giant ICAs resulted

in high rupture and mortality rates amongst these patients emphasizing the superiority of surgical or endovascular treatments⁽¹⁴⁾.

Conclusion:

Ruptured CIAs pose a worse prognosis when compared to overall SAH cases. Multi-disciplinary neurovascular discussion for each individual case is crucial for deciding the best management strategy of these complex lesions.

The concept of complex intracranial aneurysms with the criteria described by Hanel and Spetzler in 2008 must be emphasized and regularly reviewed for any modifications in order to set up a clear and concrete treatment algorithm for the management dilemma.

CIAs managed surgically showed less recurrence rate than those treated by different endovascular techniques. On the other hand, CIAs treated by endovascular modalities showed much lower LOS and better modified Rankin scale after 6 months.

Complications rate and mortality rate were nearly similar in both groups and were usually related to the initial poor presentation with high WFNS grade upon the initial ictus.

Limitations and Recommendations

The findings of this study have to be seen in light of some limitations, these might include single center experience, small number of patients, multiple comparisons without corrections and no randomization.

There is a growing necessity towards studies with longer term of follow up especially for endovascular techniques involving flow diversion devices. This will increase the accuracy of the assessment of the obliteration and recurrence rates. Also, there is evident gap of knowledge due to the lack of well-designed randomized controlled trials of the various treatments used for management of CIAs. Many of the treatment modalities have significant potential

complications, as well as major resource implications.

Proper training programmes for neurosurgeons to acquire all the surgical techniques to deal with “simple aneurysms” to be able to deal with more complex ones.

Endovascular techniques are rapidly evolving and needs continuous training and up to date knowledge about all the proposed strategies for the management of these complex pathology.

Declarations:

Consent for publication:

We confirm that the manuscript has been read and approved for publication by all named authors and that there are no other people who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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Authors' contributions:

M.L, E.M and C.T conceived the original idea. This was also discussed with H.M and M.A.H. Eventually all authors discussed and agreed with the focus and ideas of this paper.

The main text of the paper was written by E.M, and subsequently improved by O.A and M.M.A. C.T and M.A.H helped edit the manuscript. H.M also helped in writing parts of the paper.

Data collection and formal analysis were done by E.M and O.A. The review and editing of the final edition of manuscript was done by C.T and M.M.A. M.L Led the project

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List of abbreviations

ACA	Anterior cerebral artery
CIA	Complex intracranial aneurysm
CT	Conservative treatment
CTA	CT Angiography
DIND	Delayed Ischemic Neurological Deficits
DSA	Digital subtraction angiography
ET	Endovascular treatment
FD	Flow diverter
GIAs	Giant intracranial aneurysms
ICA	Internal carotid artery
ICGVA	Indocyanine Green Video Angiography
ISAT	International Subarachnoid Aneurysm Trial
LOS	Length of Stay in Hospital
MCA	Middle cerebral artery
MDT	Multidisciplinary team
MRA	Magnetic Resonance Angiography
mRS	Modified Rankin Scale
PAO	Parent artery occlusion
PED	Pipeline Embolization Device
SD	standard deviation
ST	Surgical treatment
WFNS	World Federation of Neurosurgical Societies

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يمثل مرض التمدد المعقد للأوعية الدموية داخل الجمجمة تحديًا تقنيًا ضمن أمراض جراحة المخ والأعصاب. وعلى الرغم من الجهود المكثفة لعلاج هذه الظواهر الوعائية المعقدة، إلا أنه، رسمياً، لا توجد إرشادات بحثية موحدة للتعامل الأمثل معها ضمن التخصص.

في هذه الدراسة، نقوم بتقييم الممارسة السريرية المعاصرة والاتجاهات والنتائج الحديثة في إدارة التمدد المعقد للأوعية الدموية الأمامية للمخ.

هذه الدراسة هي دراسة استطلاعية شملت ٤٠ مريضاً. تم تقييمهم من قبل فريق متعدد التخصصات يضم أخصائيي الأشعة العصبية والأوعية الدموية وجراحي الأعصاب الوعائية وجراحي المخ والأعصاب لتقييم الخيارات العلاجية المتاحة. تمت معالجة عشرين حالة جراحياً، بينما تم علاج ١٨ حالة من خلال تقنيات الأوعية الدموية المختلفة. تم تعزيز تقنيات الأوعية الدموية بتدخل جراحي كنهج هجين لعلاج حالتين. لوحظ معاودة المرض أو وجود بقايا للأوعية الدموية الممددة بعد علاجها فقط في المجموعة التقنية (أربع حالات من أصل ١٨ حالة عولجت بتقنيات الأوعية الدموية التداخلية). تم توثيق أربع حالات وفاة متعلقة بالتدخل خلال الأشهر الستة الأولى.

أظهرت الأوعية الدموية الممددة المعالجة جراحياً معدل تكرار أقل من تلك التي عولجت بتقنيات الأوعية الدموية التداخلية المختلفة. بينما أظهرت المجموعة المعالجة بتقنيات الأوعية الدموية التداخلية قصر مدة الإقامة في المستشفى وتحسن مقياس رانكين بعد ٦ أشهر. تشابهت معدلات المضاعفات والوفيات في كلا المجموعتين وعادة ما كانا مرتبطتين بتصنيف متقدم طبقاً لمعايير الاتحاد العالمي لجمعية جراحة الأعصاب (WFNS) بالعرض الأولي المتأخر للحالات.