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Role of Endovascular Imaging in Diagnosis, Management Planning and Treatment of Intracranial Aneurysms : A Case Series

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Abstract

Background: Intracranial aneurysms are localized dilatations of cerebral arteries that may remain clinically silent until rupture, leading to subarachnoid hemorrhage (SAH) or intraparenchymal hemorrhage (IPH), both of which are associated with significant morbidity and mortality. Prompt imaging evaluation is essential for early diagnosis and prevention of rebleeding. While non-contrast CT and MRI serve as initial diagnostic modalities, digital subtraction angiography (DSA) remains the definitive investigation for precise aneurysm characterization. Advances in endovascular therapy, including simple coiling and balloon-assisted techniques, have transformed the management approach to both ruptured and complex aneurysms. ***Case Series Description:*** This retrospective case series includes 30 patients presenting with acute neurological symptoms such as sudden severe headache, vomiting, visual disturbances, limb weakness, altered sensorium, or focal deficits. Initial neuroimaging with NCCT or MRI identified SAH or intraparenchymal hemorrhage, followed by CT angiography or MR angiography to detect vascular abnormalities. All patients underwent DSA for detailed evaluation of aneurysm size, neck morphology, dome-to-neck ratio, and parent vessel involvement. Aneurysms were identified in various locations including the anterior communicating artery (ACOM), middle cerebral artery (MCA) bifurcation, anterior cerebral artery (ACA), posterior communicating artery (PCOM), and supraclinoid internal carotid artery (ICA). Endovascular treatment was individualized and included simple coiling, balloon-assisted coiling for wide-neck aneurysms, and re-coiling in cases of recurrence or coil migration. Procedures were performed via transfemoral or transradial access under general anaesthesia. Post-procedure angiography confirmed complete exclusion of aneurysms from circulation with preserved parent vessel patency in the majority of cases. Follow-up CT imaging demonstrated expected coil artifacts and progressive resolution of hemorrhage. This case series highlights the critical role of DSA in accurate aneurysm characterization and demonstrates the effectiveness of endovascular techniques as a minimally invasive and reliable treatment strategy for intracranial aneurysms.

Keywords: Intracranial aneurysm; Subarachnoid hemorrhage; Digital subtraction angiography; Endovascular coiling; Balloon-assisted coiling.

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INTRODUCTION

Intracranial aneurysms are focal dilatations from weakened walls of arteries in the brain. They may remain silent but they become an important cause of morbidity and mortality when these aneurysms rupture and cause intraparenchymal bleed or subarachnoid hemorrhage.(1) They typically exhibit symptoms that start suddenly, such as a sharp headache, nausea, altered sensory perception, or a localized neurologic deficiency. In order to manage a bleeding injury and stop it from happening again, early identification is crucial. The initial imaging modality for patients who come with a range of symptoms is nearly invariably brain MRI or NCCT. This is used in conjunction with MR or CT angiography to assist identify cerebral aneurysms.(2) Digital subtraction angiography, which aids in accurately characterizing the aneurysm, is the gold standard for accurate information on cerebral aneurysms.(3) The use of endovascular procedures has resulted in an accurate diagnosis of the location and size of the aneurysm, which aids in determining the patient's best course of treatment. Surgical clipping was originally thought to be the best way to treat intracranial aneurysms, but with the development of endovascular treatment techniques, coiling and coiling-assisted devices like stents and balloons are now used to treat a large number of intracranial aneurysms.(4,5) Wide neck aneurysms were a drawback of the traditional coiling devices because of the higher chance of coil migration into the parent artery

and the challenge of characterizing the parent vessel-aneurysm interface in sucking situations. This was addressed by the introduction of balloon and stent aided coiling, which lowers the chance of coil prolapse.(6,7,8) Flow diverters, which have become increasingly popular in recent years, are another useful technique.

MATERIALS AND METHODS

Study Design: This study was a retrospective single-center case series conducted over a defined time period of two years. The study evaluated patients presenting with symptoms suggestive of intracranial hemorrhage secondary to aneurysmal rupture.

Study Setting: The study was conducted at a tertiary care center with facilities for advanced neuroimaging and interventional neuroradiology. All imaging and endovascular procedures were performed by experienced radiologists and neuro-interventionists.

Study Population: A total of 30 patients were included in the study. Patients presented with acute neurological symptoms such as severe headache, vomiting, limb weakness, altered sensorium, visual disturbances, or focal neurological deficits.

Inclusion Criteria

- Patients presenting with symptoms suggestive of intracranial hemorrhage
- Radiological evidence of subarachnoid hemorrhage (SAH) or intraparenchymal hemorrhage (IPH) on NCCT or MRI brain
- Imaging evidence of intracranial aneurysm on CT angiography (CTA) or MR angiography (MRA)
- Patients who subsequently underwent digital subtraction angiography (DSA)

Exclusion Criteria

- Patients with non-aneurysmal causes of intracranial hemorrhage
- Patients who did not undergo cerebral angiography
- Incomplete clinical or imaging records

Imaging Protocol

All patients initially underwent non-contrast CT (NCCT) brain or MRI brain as the primary imaging modality to detect intracranial hemorrhage. When SAH or IPH was identified, CT angiography (CTA) or MR angiography (MRA) was performed to evaluate for vascular abnormalities.

Patients with suspected aneurysms underwent digital subtraction angiography (DSA), which was considered the gold standard for aneurysm characterization. DSA provided detailed information regarding:

- Aneurysm size
- Neck morphology
- Dome-to-neck ratio
- Parent vessel involvement
- Branch vessel relationship
- Circulatory anatomy

Endovascular Procedure

Based on angiographic findings, treatment decisions were individualized. Management strategies included:

- Simple endovascular coiling
- Balloon-assisted coiling for wide-neck aneurysms
- Re-coiling in cases of recurrence or coil migration
- Conservative management when intervention was not indicated

Procedures were performed under general anaesthesia using transfemoral or transradial arterial access. Microcatheters and microcoils of appropriate size were used depending on aneurysm characteristics. In wide-neck aneurysms, balloon-assisted coiling was performed to prevent coil prolapse into the parent vessel.

Post-procedure angiography was performed in all cases to confirm:

- Complete exclusion of aneurysm from circulation
- Preservation of parent vessel patency
- Adequate distal flow

Outcome Assessment

Immediate procedural success was defined as complete angiographic exclusion of the aneurysm with maintained intracranial circulation.

Patients who underwent endovascular intervention were followed up with CT brain imaging to assess:

- Resolution of subarachnoid or intraparenchymal hemorrhage
- Presence and stability of metallic coil artifacts
- Evidence of re-bleeding or complications

Clinical and radiological data were reviewed retrospectively and analyzed descriptively.

CASE 1

A 67-year-old female presented with sudden onset progressively worsening headache for four days. CT brain with CT Angiography revealed subarachnoid hemorrhage in the right parietal lobe with suspicion of an ACA aneurysm. Digital subtraction angiography confirmed an anterior communicating artery aneurysm. Endovascular management was planned, and aneurysm coiling was performed under general anesthesia using 3D microcoils (4 mm × 8 cm and 3 mm × 6 cm). Post-procedure angiography demonstrated complete exclusion of the aneurysm with preserved parent vessel patency. The patient tolerated the procedure well without immediate complications.

Figure 1: SAH in right parietal

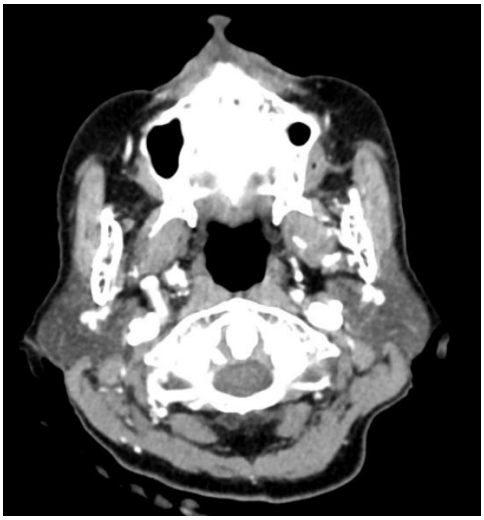


Figure 2: CT angio

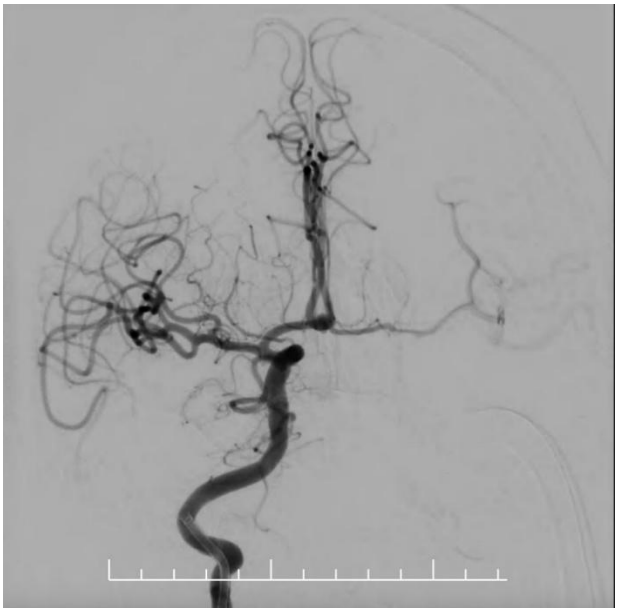


Figure 3: DSA

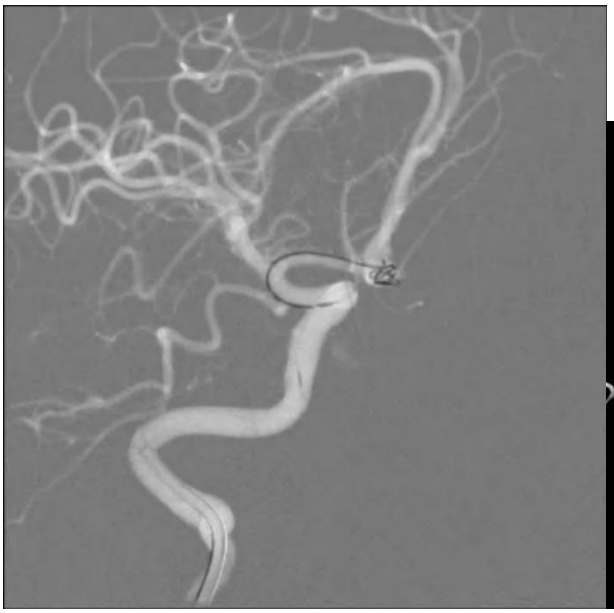


Figure 4: Coiling

Figure 5: Post coiling metallic artifact

CASE 2

A 55-year-old female, known hypertensive on regular medical treatment, presented with complaints of persistent, diffuse headache that had progressively worsened over the preceding two days. The headache was associated with multiple episodes of vomiting and difficulty in ambulation. She subsequently experienced a fall with head injury.

As part of the initial evaluation, a non-contrast computed tomography (CT) scan of the brain was performed, which demonstrated a large acute intraparenchymal hematoma in the left frontal lobe with extension into the ventricular system. Further assessment with CT angiography revealed a narrow-necked saccular (berry) aneurysm arising from the A2 segment of the bilateral anterior cerebral arteries (ACA). For definitive evaluation and treatment planning, digital subtraction angiography (DSA) was performed via right radial arterial access. The angiographic study confirmed the presence of a narrow-necked saccular aneurysm involving the A2 segment of the bilateral ACA. The patient was subsequently managed with endovascular coil embolization, during which three microcoils were successfully deployed to secure the aneurysm.

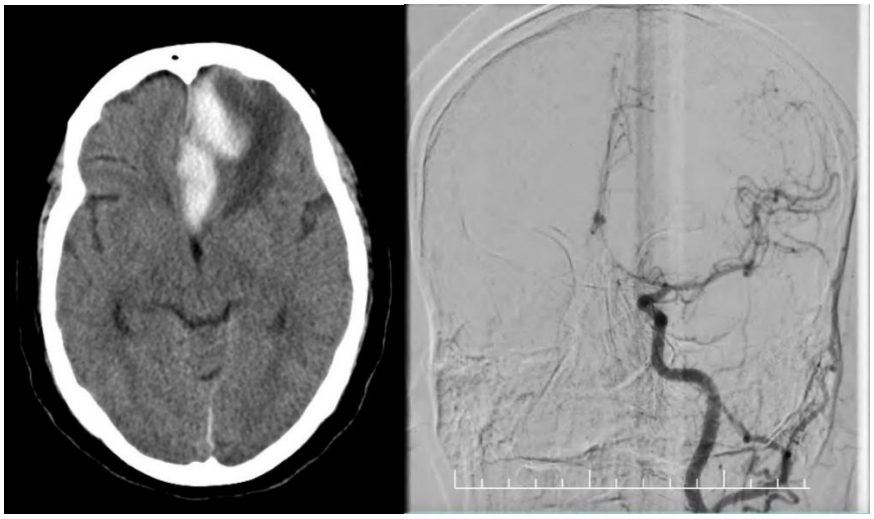


Figure 6

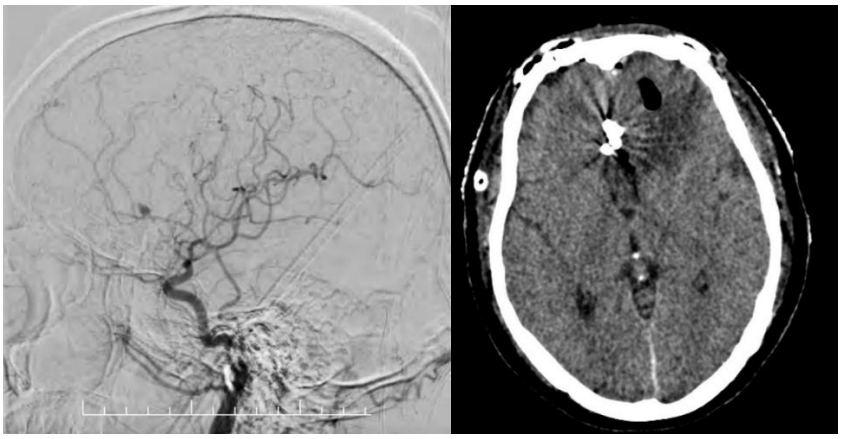


Figure 7

CASE 3

A 76-year-old female with a known history of diabetes mellitus and hypertension presented with sudden onset headache of three hours' duration. The headache was rapidly progressive and associated with blurring of vision.

An urgent non-contrast computed tomography (CT) scan of the brain revealed an acute intraparenchymal hemorrhage in the right gangliocapsular region with intraventricular extension and evidence of midline shift towards left side. In view of the radiological findings CT Angiography was performed in same sitting and a ruptured middle cerebral artery (MCA) aneurysm was suspected.

Subsequently, a cerebral angiogram was performed via right radial arterial access, which confirmed the presence of a right-sided MCA aneurysm. Emergency endovascular coil embolization was carried out in the same sitting, and the aneurysm was successfully secured using three microcoils.

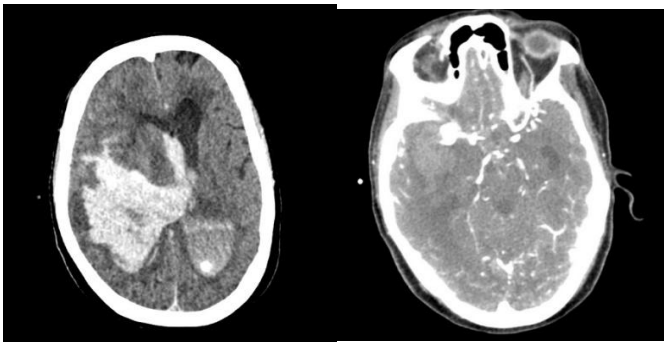


Figure 8 Intraparenchymal hemorrhage with intraventricular extension and right MCA bifurcation aneurysm

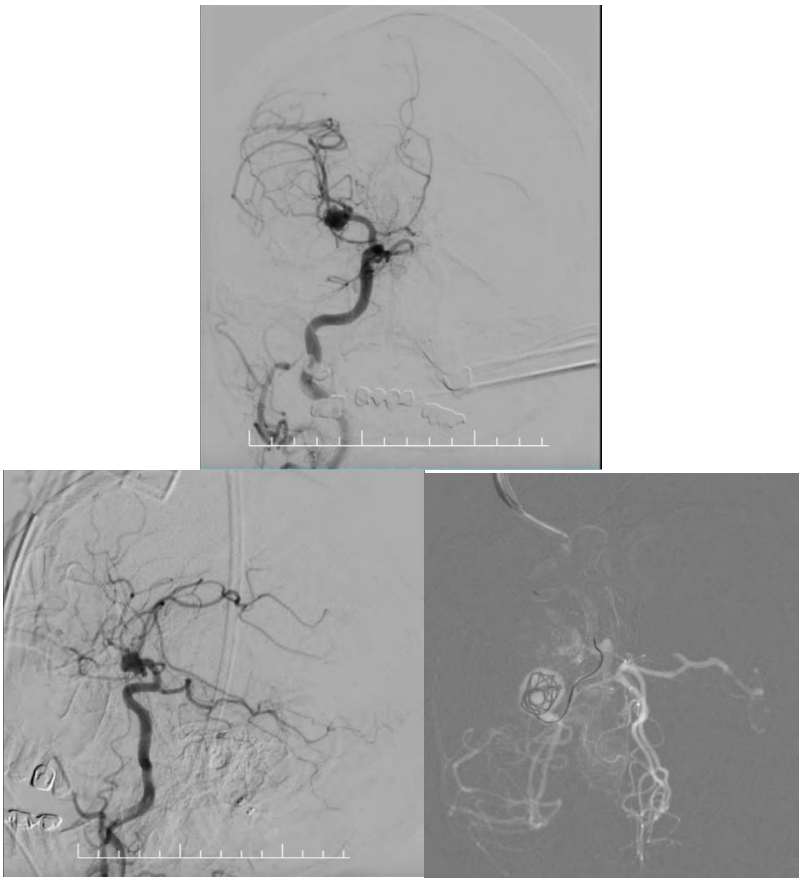


Figure 9-DSA showing right MCA bifurcation aneurysm with coiling

CASE 4

A 47 year old female presented to casualty with severe headache that had been increasing in intensity since 12 days and weakness in bilateral upper and lower limbs. She was not a known case of any comorbidity but on arrival she had a constantly raised blood pressure. Subarachnoid hemorrhage in both frontal lobes with intraventricular extension and a hyperdense hematoma in the right frontal lobe were seen on the CT scan. It was seen that the anterior side of the ACOM had a saccular aneurysm. A thin neck ACOM aneurysm was discovered during a selective right carotid artery angiography performed with DSA via the transfemoral route.
Multiple tiny coils (4mmx10cm, 2mmx4cm) were used for aneurysm coiling. Complete exclusion of the aneurysm from circulation was demonstrated by post-coiling check angiogram, while the parent arteries and their branches remained intact. A post-coil CT scan of the brain revealed a resolving intraparenchymal hemorrhage in the right frontal-basifrontal lobe's parasagittal area. In the ACOM area, metallic coil artifacts were seen in the frontal interhemispheric region.

Figure 10: CT brain showing right frontal lobe hematoma

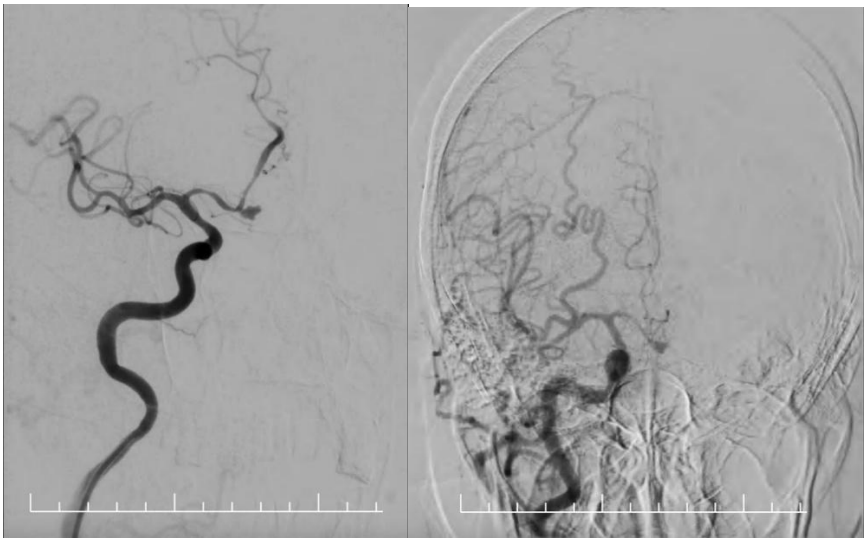


Figure 11: DSA IMAGES

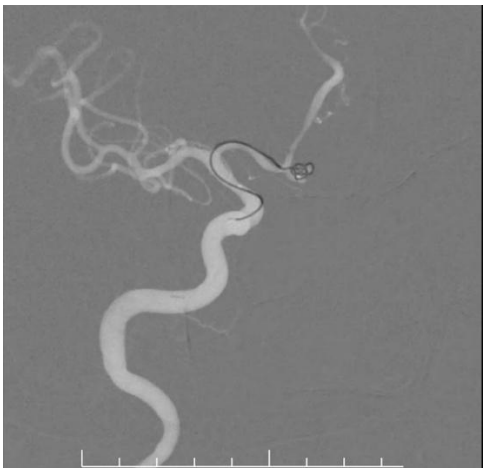


Figure 12: ANEURYSM COILING

Figure 13: FOLLOW UP CT BRAIN 6 MONTHS POST COILING- artifact with complete resolution

CASE 5

A 76-year-old female presented to the emergency department with complaints of headache, giddiness, and multiple episodes of vomiting for one day. She was a known case of hypertension and diabetes mellitus and was on regular medical therapy. Magnetic resonance imaging (MRI) of the brain revealed a large intraparenchymal hematoma involving the left fronto-temporo-parietal lobes, with extension into the ventricular system and associated midline shift toward the left side. Magnetic resonance angiography (MRA) raised suspicion of an aneurysm at the junction of the M1 and M2 segments of the left middle cerebral artery (MCA). For definitive evaluation, digital subtraction angiography (DSA) was performed via right radial arterial access. Cerebral angiography using a 5F H1 catheter demonstrated a saccular aneurysm at the left MCA bifurcation, measuring approximately 6–8 mm in size. Endovascular management was undertaken, and the aneurysm was successfully treated with coil embolization using three microcoils. A post-procedure CT scan of the brain demonstrated the expected metallic coil artifact, along with mild reduction in the size of the intraparenchymal hematoma.

Figure 14: Pre-procedure CT brain showing intraparenchymal hematoma

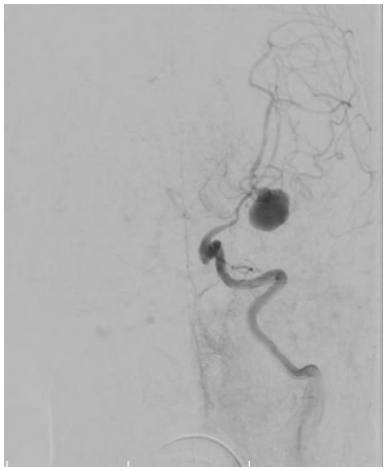
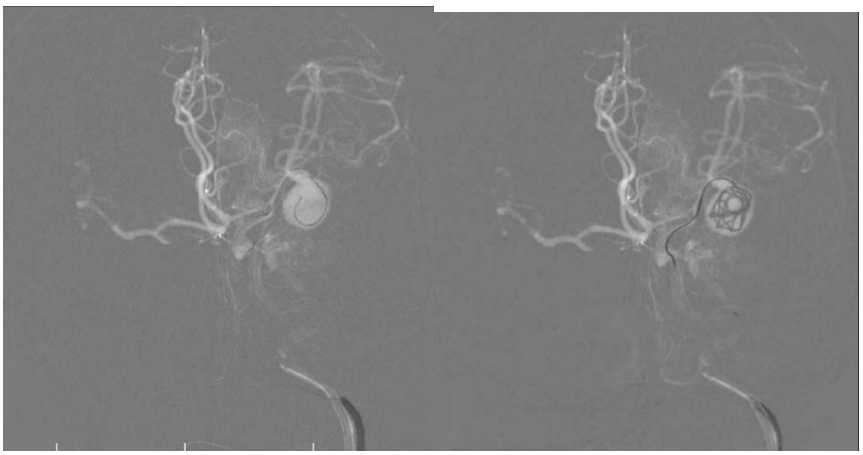


Figure 15: DSA



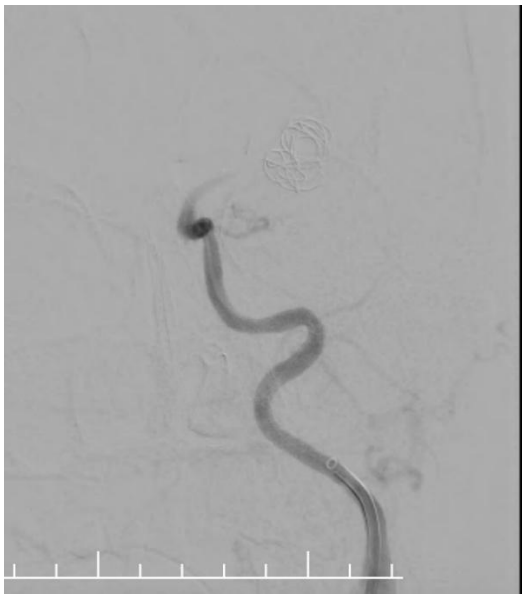


Figure 16: ANEURYSM COILING

Figure 17: POST COILING CT BRAIN

CASE 6

46 year old man came to OPD with complaints of drowsiness and gradual blurring and loss of vision since 14 days. K/c/o hypertension on treatment with h/o tobacco chewing since 15 years

MRI brain with MRA was s/o acute subarachnoid hemorrhage in cortical sulci of bilateral fronto-parietal lobes, left sylvian fissure with intraventricular extension. E/o saccular aneurysm of supraclinoid segment of left ICA.

DSA was performed the next day via right transfemoral route and selective left ICA angiogram was done which revealed wide neck saccular aneurysm at left supraclinoid ICA/ PCOM artery.

This was followed by balloon assisted coiling in which lesion was crossed with guidewire and ballon 4x20mm size and coiling was done using multiple coils (frame complex 3x10mm, 5x10mm, bare platinum extra soft 3x8mm). Balloon was inflated using last coil. Post coil check angiography showed complete exclusion of aneurysm from circulation and normal flow in ICA and its branches

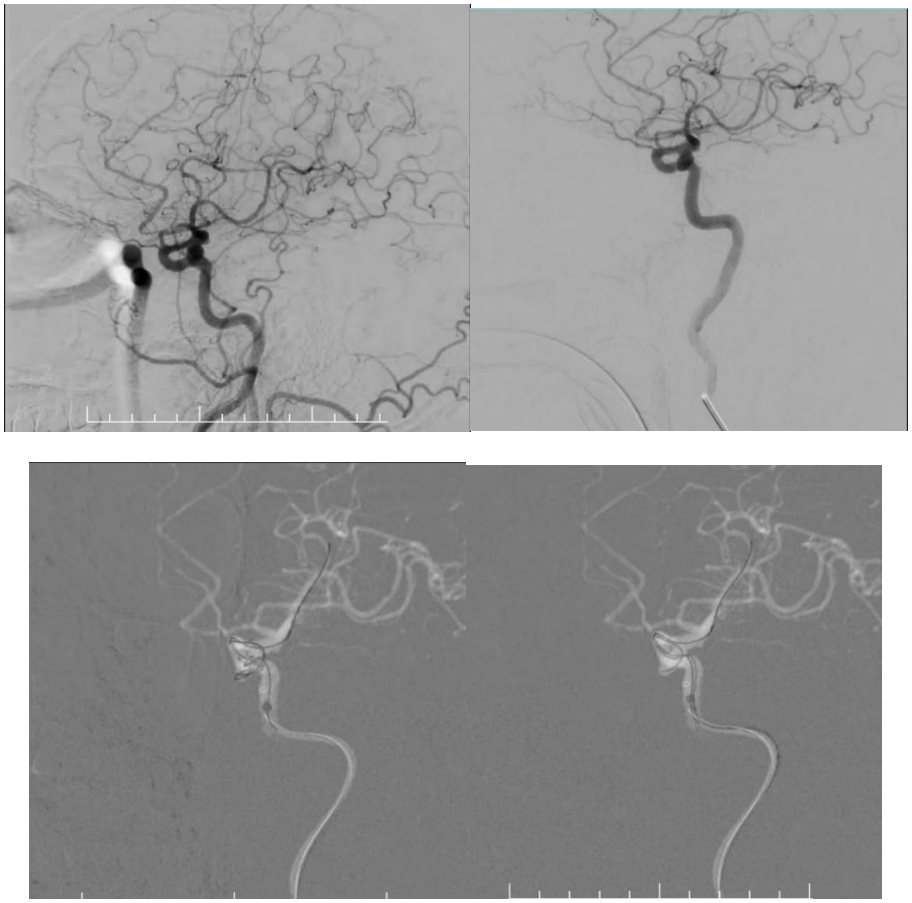


Figure 18: Balloon assisted coiling

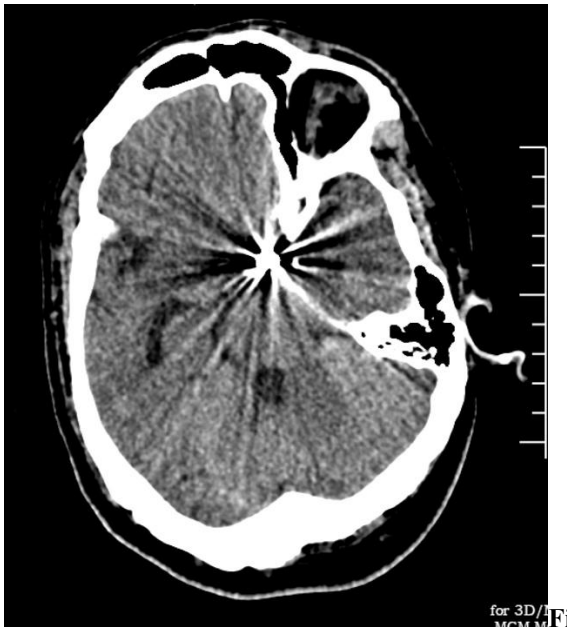


Figure 19: Post coiling

CASE 7

CASE OF RECCURENT INTRACRANIAL BLEED IN S/P MCA BIFURCATION ANEURYSM COILING

A 78-year-old female, a known case of hypertension, presented to the emergency department with sudden onset of severe, diffuse headache of two hours duration accompanied by blurring of vision. She had a significant past history of intracranial hemorrhage two years earlier, at which time she was diagnosed with a left middle cerebral artery (MCA) bifurcation aneurysm. She had undergone endovascular coil embolization for the same. Post-procedural cerebral angiography at that

time demonstrated complete exclusion of the aneurysm from the circulation with preserved patency of the parent vessels. Follow-up CT scans of the brain had shown complete resolution of the hemorrhage.

In view of her current symptoms, a non-contrast CT scan of the brain was performed, which revealed a large intraparenchymal hemorrhage involving the left fronto-temporo-parietal region with intraventricular extension and associated midline shift toward the left side. Under general anesthesia, a selective left internal carotid artery (ICA) angiogram was performed via the transfemoral approach. Angiographic evaluation revealed a recurrent left MCA bifurcation aneurysm along with evidence of coil migration. Selective cannulation of the aneurysmal sac was achieved using a neuro-microcatheter, and endovascular embolization was performed using three microcoils. Post-procedure angiography confirmed complete exclusion of the aneurysm from the circulation with maintained patency of the parent vessel and its distal branches.

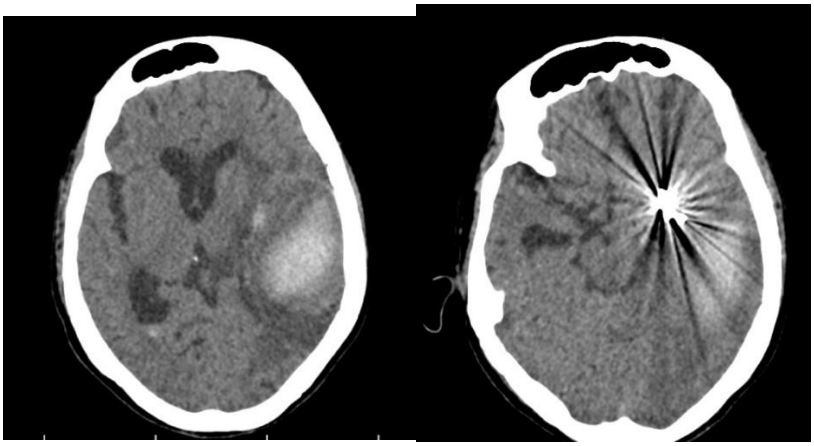


Figure 20: CT Brain with intraparenchymal hematoma with coil artifact from previous coil

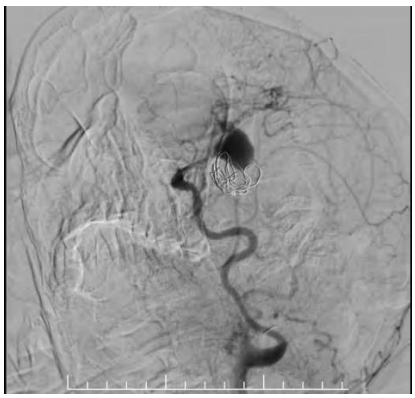


Figure 21: Migrated coil with large MCA bifurcation aneurysm

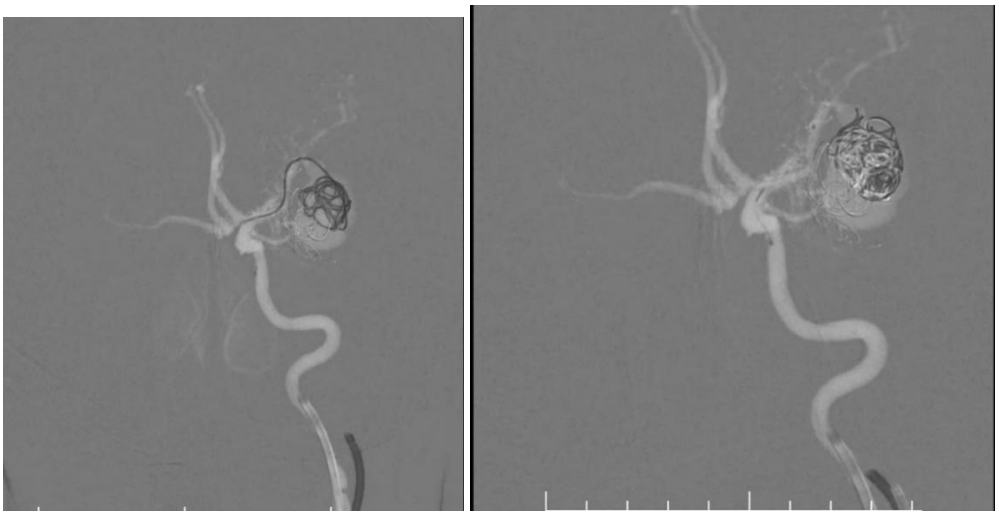


Figure 22: Recoiling

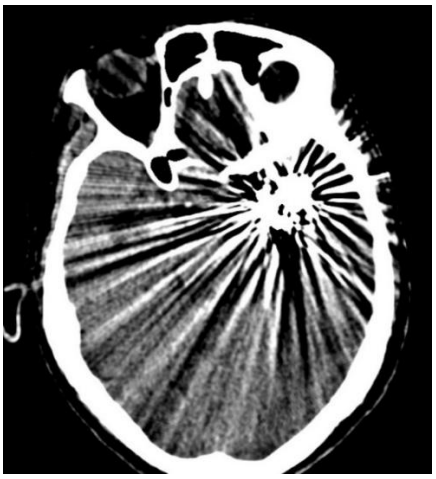


Figure 23: Post procedure CT brain showing metallic artifacts from the two coils

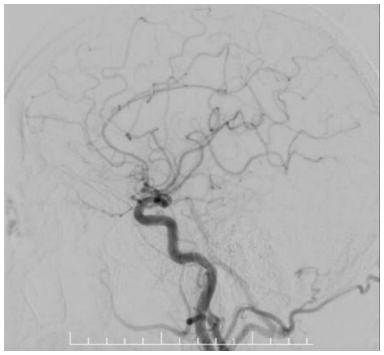
CASE 8

A 73-year-old female presented with complaints of headache and giddiness for two days. She had been recently diagnosed with hypertension one month prior and was on regular antihypertensive medication.

A non-contrast CT scan of the brain revealed features suggestive of acute subarachnoid hemorrhage involving the bilateral sylvian fissures and cortical sulci of both cerebral hemispheres. Subsequent CT angiography demonstrated an outpouching arising from the anterior communicating artery (ACOM), raising suspicion of an aneurysm.

For definitive evaluation, cerebral angiography was performed, which confirmed the presence of an anterior communicating artery aneurysm.

Figure 24: SAH in parietal lobes



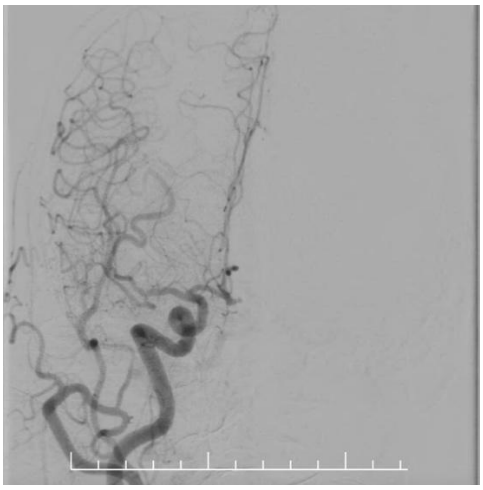


Figure 25: DSA

Figure 26: Coiling

Figure 27: Post coil

CASE 9

A 46-year-old male presented to the emergency department following a road traffic accident precipitated by a sudden loss of consciousness. He reported a history of sudden onset severe headache one day prior to the incident.

Urgent neuroimaging, including non-contrast CT and MRI of the brain, was performed. Imaging demonstrated subarachnoid hemorrhage involving the cortical sulci of the bilateral temporoparietal lobes and the left sylvian fissure.

Magnetic resonance angiography (MRA) was subsequently conducted; however, the study was suboptimal and suggested the possibility of aneurysmal rupture as the underlying cause of the subarachnoid hemorrhage.

To establish a definitive diagnosis, cerebral angiography was performed via the right transfemoral approach. A selective right internal carotid artery (ICA) angiogram revealed an anterior communicating artery (ACOM) aneurysm.

The aneurysmal sac was carefully accessed using a neuroguidewire and microcatheter system. Endovascular coil embolization was successfully performed using three microcoils. Post-procedural angiography confirmed complete exclusion of the aneurysm from the circulation, with preservation of the parent vessels and their distal branches.

Figure 28: Initial CT brain revealing SAH

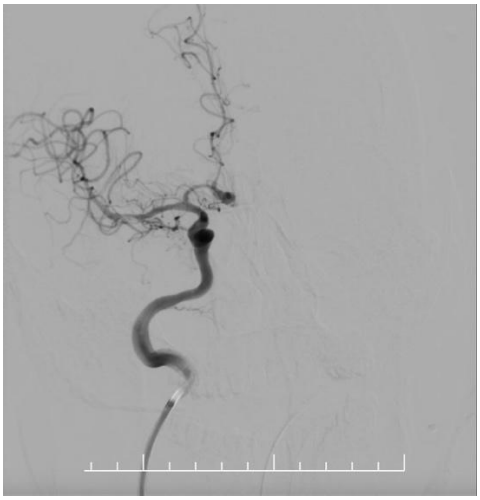


Figure 29: DSA

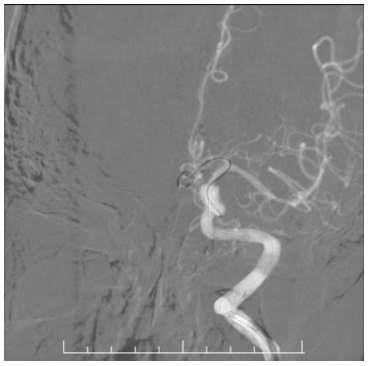


Figure 30: Aneurysm coiling

Figure 31: Post procedure ct brain showing metallic artifact of coil

CASE 10

A 40-year-old female presented to the emergency department with acute onset severe, diffuse headache accompanied by nausea.

A non-contrast CT scan of the brain demonstrated mild subarachnoid hemorrhage involving the left sylvian fissure and the left fronto-temporo-parietal region.

For further evaluation, cerebral angiography was performed via right transfemoral arterial access using a 5F H1 catheter. Angiographic assessment revealed a small saccular aneurysm measuring approximately 3 mm arising from the left posterior communicating artery (PCOM).

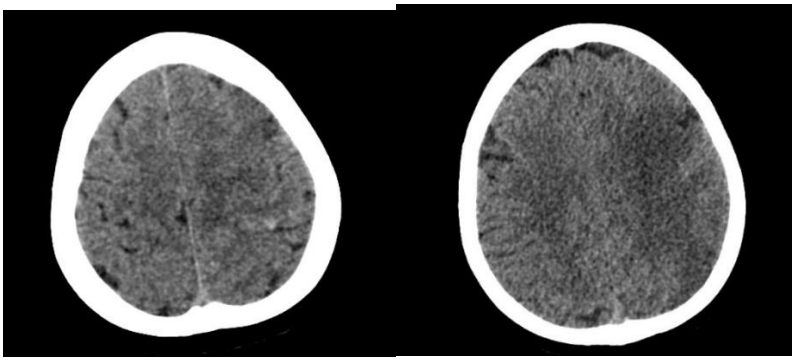


Figure 32: CT brain showing SAH in left fronto-parietal lobes

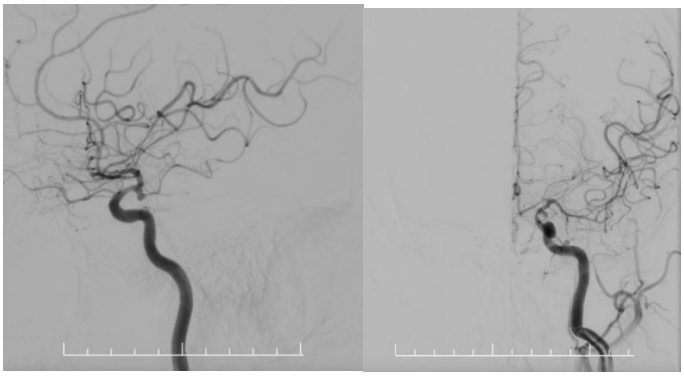


Figure 33:

DISCUSSION

Intracranial aneurysms are a notorious cause of mortality. A ruptured aneurysm that manifests as intracranial bleed or subarachnoid hemorrhage can be fatal, even though many aneurysms remain quiet for extended periods of time.(1) The most precise characterization of these aneurysms is a crucial part of their treatment. Usually, NCCT or MRI brain imaging is the initial imaging modality used in nearly all patients with intracranial aneurysm.(2) When a subarachnoid hemorrhage or intraparenchymal bleed appears, suspicion is aroused, and an intracranial aneurysm is diagnosed when an angiography scan and a plain scan are performed.(2,3)

Digital subtraction angiography is still the gold standard for intracranial aneurysms, even if these modalities are useful for reaching an initial diagnosis. Its benefit is the ability to precisely and accurately characterize the aneurysm in terms of its size, parent vessel connection, branch vessel involvement, neck shape, and dome to neck ratio. These factors are ultimately critical in determining whether to proceed with endovascular, surgical, or conservative patient care.(3,4,5)

With the development of methods like aneurysm coiling, balloon or stent aided coiling, and flow diverters, endovascular therapy of cerebral aneurysms has become the preferred approach in recent years. It has an excellent success rate and is somewhat less invasive than the traditional surgical clipping, which was formerly the most common procedure. Not all aneurysms, such as those with complicated arterial architecture or broad neck aneurysms, meet the requirements for endovascular treatment. (6,7,8,9) As the cornerstone of care planning for intracranial aneurysms, our case series aims to emphasize the significance of endovascular radiology as an accurate diagnostic tool as well as a management tool for intracranial aneurysms(12,13).

CONCLUSION

In order to diagnose and treat cerebral aneurysms, endovascular radiology is essential. It has evolved into a vital, minimally invasive technique for the precise diagnosis and management of cerebral aneurysms. The gold standard for evaluating aneurysms is still digital subtraction angiography, which is also crucial in identifying the best course of therapy. By directing interdisciplinary decision-making, endovascular imaging has a substantial impact on clinical outcomes even when coiling is not used.

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