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Case Report

Treating a Challenging Giant Aneurysm of Middle Cerebral Artery (MCA) with a Staged Procedure of Endovascular Coiling and Flow Diverter (FD): Case Report

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Abstract

Background: *Giant intracranial aneurysms pose significant challenges in treatment due to a high risk of postoperative complications, including delayed rupture, cerebral edema, and aggravation of mass effect. Endovascular approaches, such as adjunctive coiling and flow diverter (FD) procedures, have become increasingly recommended for wide-necked, large, and giant aneurysms.*

Case Description: *In this report, we present a challenging case of a staged coiling and FD procedure in a giant unruptured middle cerebral artery (MCA) aneurysm. The patient, a 26-year-old adult female, was admitted to our hospital with a history of convulsions. Digital Subtraction Angiography (DSA) revealed a massive aneurysm measuring 40 mm × 27 mm in the M1 segment of the MCA. To mitigate the risk of mass effect aggravation, we performed a two-staged procedure with a seven-day interval between the interventions. The first step involved partial endovascular coiling to shrink the aneurysm, followed by successful flow diversion. The patient did not experience further convulsions or neurologic deficits, and the follow-up angiogram showed no residual flow to the aneurysm.*

Conclusion: *We report one of the very first cases of adjunctive coiling and FD in 'unruptured' giant aneurysms. Our neurovascular intervention provides valuable insights into the approach and treatment of unruptured giant aneurysms in cerebral arteries. By employing a staged procedure, effective flow diversion can be achieved even in giant unruptured aneurysms. Although further research is necessary to confirm its superiority and address critical issues, our findings may contribute to the future management of giant aneurysms and inspire avenues for research in the neurosurgical community.*

Keywords: *aneurysm, coil, flow diverter, unruptured, mca*

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Introduction:

Adjunctive coiling and FD are suggested nowadays for the treatment of wide-necked, large, and giant aneurysms.[3] It significantly improves aneurysm occlusion and reduces aneurysm recurrence and rupture rates.[1]

However, in our case, where the aneurysm size was 40 mm × 27 mm; it exerted a tremendous mass effect, as revealed by MRI. [Figure 1b] We suspected that treating the giant aneurysm in a single intervention of FD and coil may create a severe mass effect with midline shift and may trigger further complications

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associated with it, as reported in the literature[8], and that is why initial decompression was necessary through partial coil embolization. A previous study by Brinjikji *et al*. (2016) showed the efficacy of staged FD deployment after coiling in ruptured intracranial aneurysms with subarachnoid hemorrhage (SAH).[2] In SAH, staged treatments are used to avoid dual antiplatelet medication in the acute phase. It has been shown that staged treatment of ruptured complex and giant intracranial aneurysms with coiling in the acute phase and flow-diverter treatment following recovery from SAH is both safe and effective. However, we report a staged coil and FD deployment in an unruptured giant intracranial aneurysm. As the patient preferred intervention over invasive surgery, we had to treat the patient with neurointervention. Again, to avoid the mass effect, deploying FD alone has a risk of delayed rupture[1]. That is why we staged the whole intervention procedure and chosen adjunctive coiling and FD. We avoided both options of either FD alone or treating with both coil and FD in a single intervention. On the other hand, doing full coiling was not feasible in our case due to the aneurysm size and its anticipated mass effect owing to the large coil mass, that is why we had to choose partial coiling. Initially, we partially embolized only a few coils. Thus, we gave the aneurysm lumen a space to get reduced and initial decompression was done and digital subtraction angiography (DSA) revealed that the aneurysm had become significantly smaller in seven days, though a larger time window could confirm this. Then, we inserted an FD in the next stage, and an angiogram after three months revealed no residual flow covering the aneurysm. Thus, we were successful in intervening the aneurysm apparently.

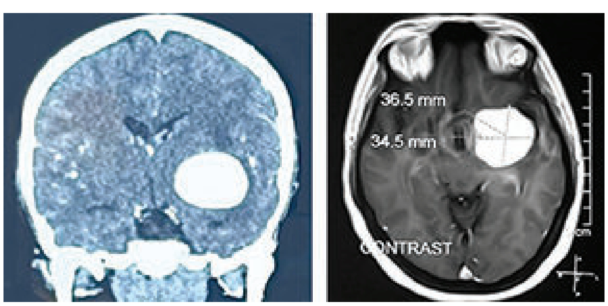

Fig.-1: *1a. CT imaging. A hyperdense space occupying lesion is seen in the left side of brain. 1b. MRI imaging. The images suggest a hyperintense lesion in left fronto-temporal region of the brain with mass effect suggestive of an aneurysm.*

Description of Case

An adult female (26 years) was admitted to our center with a history of frequent convulsions (tonic-clonic type) for last few months, no hypertension (HTN), and positive diabetes mellitus (DM). The patient had no neurologic deficits. The modified Rankin Scale (mRS) and NIH Stroke Scale (NIHSS) scores were both 0, as there was no weakness or disability. Her seizure was controlled with anti-epileptic medications (i.e., levetiracetam). CT [Figure 1a] and MRI [Figure 1b] imaging showed a space-occupying lesion on the left side of the brain. DSA study of the patient confirmed a left MCA bifurcation aneurysm of size 40.10 mm × 27.47 mm. [Figure 2]

We approached treating it with non-invasive neuro-intervention first and open microsurgery was preserved for failed neuro-intervention. To avoid the aggravation of mass effect and eventual neurologic deterioration

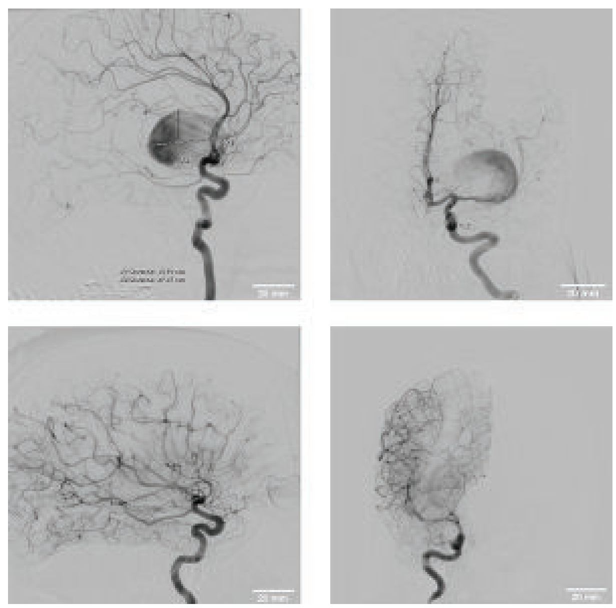

Fig.-2: *DSA image of the aneurysm. The image reveals a superiorly directed left MCA bifurcation giant aneurysm which is partially thrombosed. Aneurysm neck is narrow (6.10 mm). The horizontal diameter is 40.10 mm. Vertical diameter or neck dome length is 27.47 mm. No stenosis seen in pre or post aneurysm segment. Long axis of M1 is almost same as long axis of frontal segment of M2. Frontal segment of M2 is dominant and temporal segment of M2 is non-dominant. There is no cross flow contralateral carotid but gave good gross flow from the vertebral artery through P-com artery to left ACA only.*

following intervention, we decided to approach it in two stages, first reducing the aneurysm blood flow and then deploying an FD.

Once the patient was ready for the intervention, we partially embolized the aneurysm with only three coils. Thus, we gave the aneurysm room to decompress. The DSA image just after our first intervention is shown in Figure 3. Through right femoral artery, long sheath was navigated up to mid cervical region left Internal Carotid Artery (ICA). Through long sheath, intracranial catheter NAVIEN™ (Medtronic, Minnesota, USA) was navigated up to left cavernous carotid. Traxcess™ 14 wire guided microcatheter Marksman™ (Medtronic, Minnesota, USA) was introduced into aneurysm. Then, we inserted 3 coils of sizes- 22 mm × 63 cm (3d), 20 mm × 50 cm (3d) and 18 mm × 40 cm (3d). It was expected that the aneurysm will get decompressed.

Figure 4 illustrates the overall scheme of our interventional plan.

After the first intervention, we started dual antiplatelet therapy (aspirin and ticagrelor) to prevent the risk of thromboembolism. After seven days, we deployed an FD in our neuro-cathlab and intra-procedural DSA showed a significantly reduced aneurysm lumen and blood flow. [Figure 5 & Video 1] As the aneurysm blood flow and luminal size were reduced to an amount that appeared to be desirable and sufficiently satisfactory for us as per DSA, we decided to deploy the FD without any further delay. However, it is important to mention that, though the images and video show a reduced lumenogram, seven days is not enough to comment on its actual anatomical aneurysm shrinkage because the inserted coils may be gradually embedded in the mural thrombus. We could not perform a post-coiling MRI to confirm its actual shrinkage due to the patient's economic condition. However, the case is worth sharing since it appears to be the first reported staged

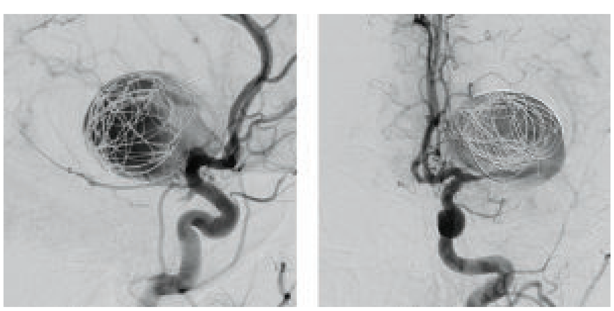

Fig.-3: *DSA Image after embolizing 3 coils to the aneurysm in our first intervention. 3 coils of sizes- 22 mm × 63 cm (3d), 20 mm × 50 cm (3d) and 18 mm × 40 cm (3d) were inserted.*

neurointervention procedure (partial coiling and then FD) in an unruptured giant aneurysm.

After that, we deployed an FD of 2.5 × 20 mm with the Pipeline embolization device (PED; Medtronic, Minnesota, USA) as now it became easy to operate on a smaller aneurysm. [Figure 6] Through long sheath followed by intermediate catheter NeuroBridge® (ACANDIS GmbH, Pforzheim, Germany) and finally micro catheter NeuroSlider® 0.021 (ACANDIS GmbH, Pforzheim, Germany), the FD was navigated and was deployed at the neck of aneurysm distal to bifurcation. [Figure 6 & Video 2] Normal blood flow was ensured after the procedure and the whole procedure was uneventful.

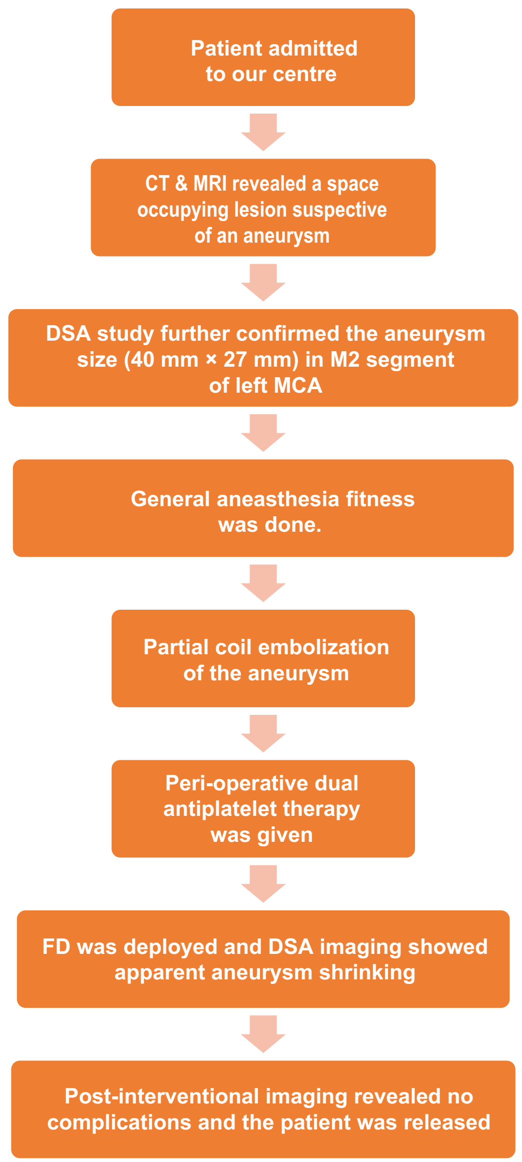

Fig.-4: *Flowchart of our interventional plan in this case.*

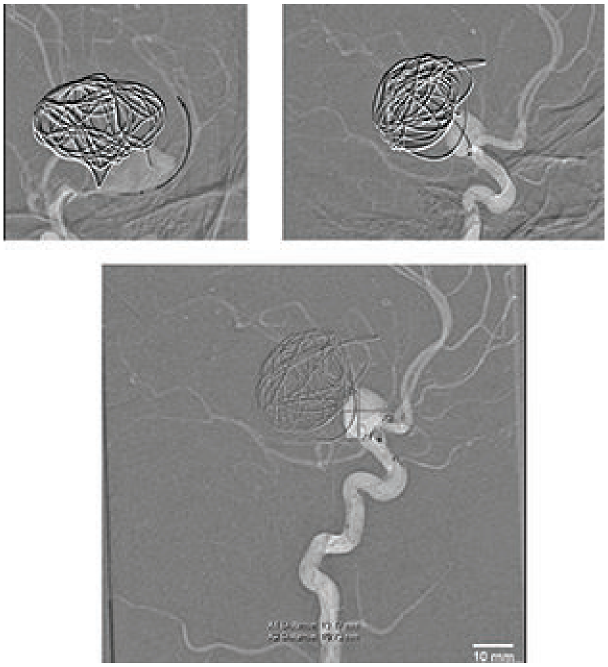

Fig.-5: *Follow up DSA image of the aneurysm after seven days of the first intervention of coil embolization. The aneurysm lumen size is apparently reduced in a short time window and became easier for flow diversion. The blood has been thrombosed and the new horizontal diameter is 12.17 mm and the new vertical diameter is 10.73 mm.*

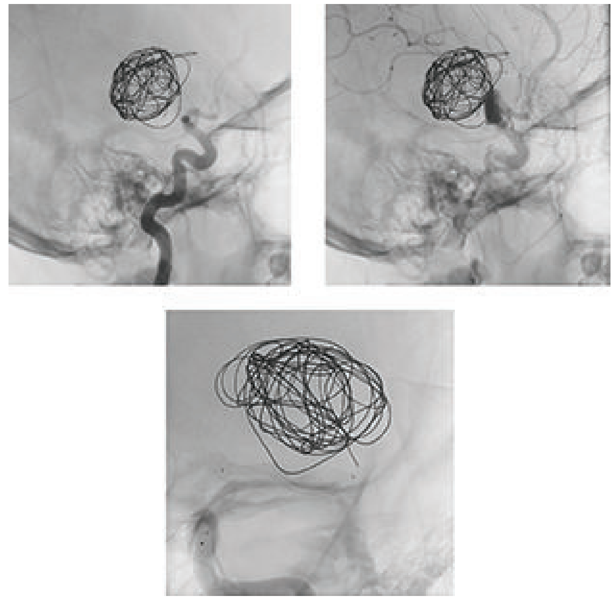

Fig.-6: *DSA Image after placing the FD. The image confirms that the FD was deployed correctly and full occlusion covering the aneurysm was achieved.*

The patient had no focal neurologic deficits after the procedure To quantify, both the mRS/NIHSS score was 0 as there was no weakness or disability. Follow-up CT scans revealed no further complications after the procedure and the patient was released. [Figure 7-9]

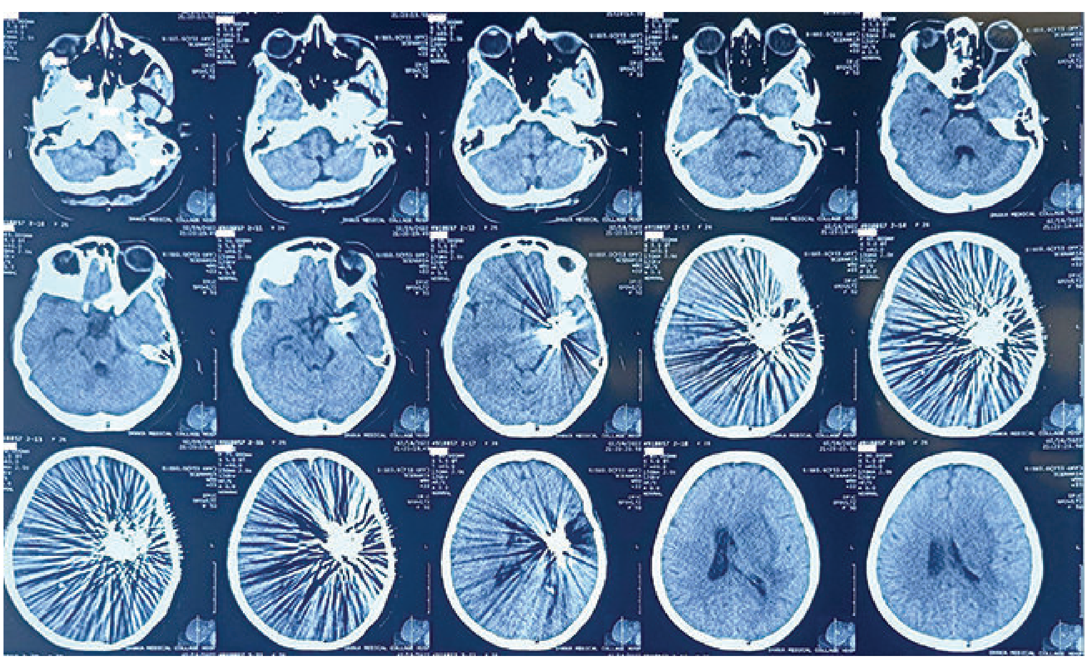

Fig.-7: *CT Imaging of the same day after the interventional procedure of FD. No cerebral edema was seen in the CT image.*

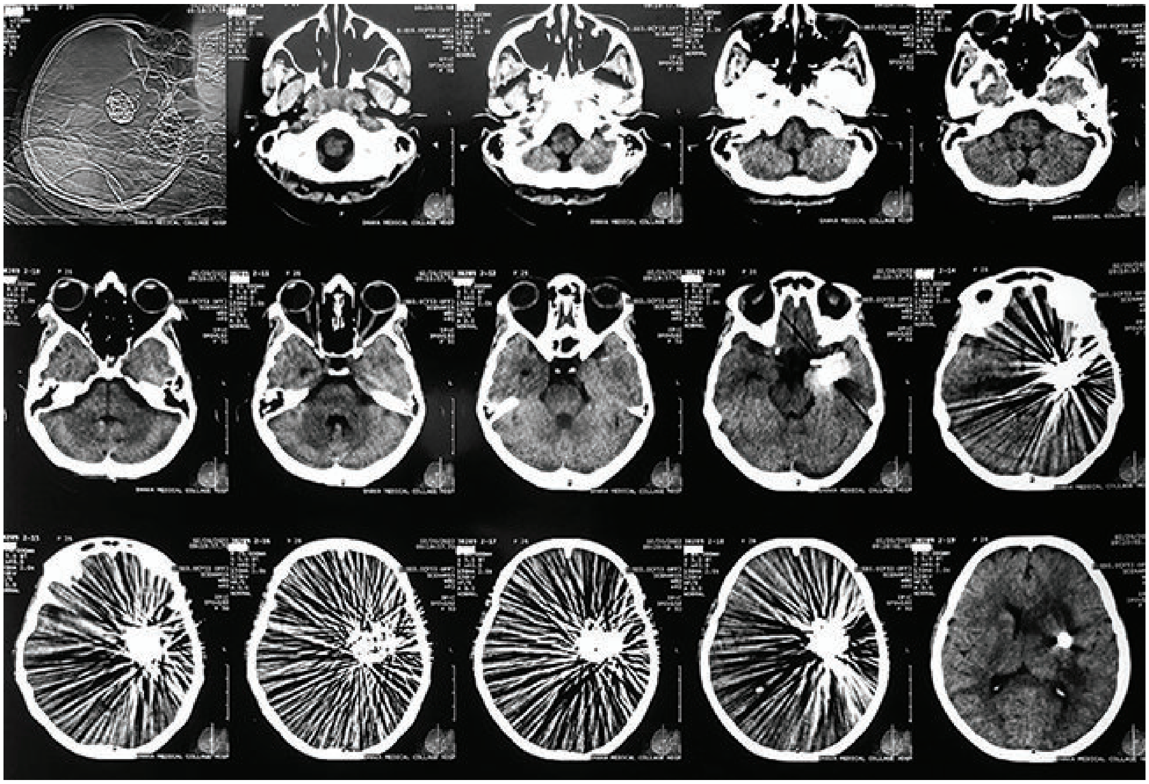

Fig.-8: *CT Imaging of 1 day after the interventional procedure of FD. No cerebral edema was seen in this CT image too.*

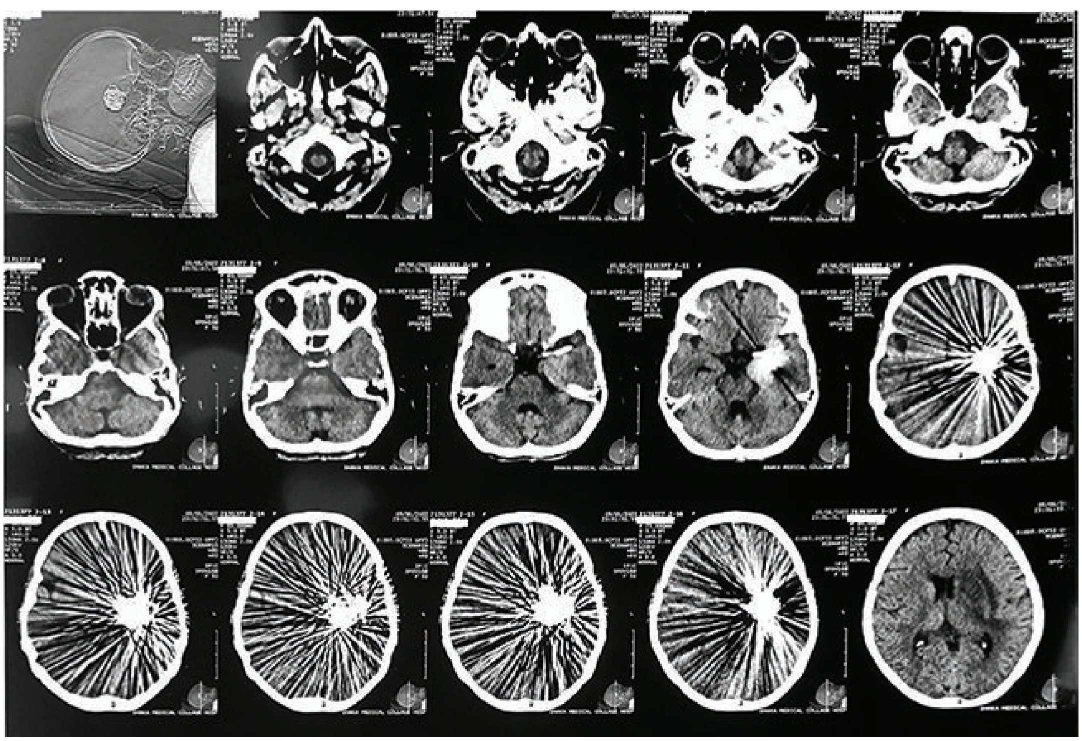

Fig.-9: *CT Imaging of 10 days after the interventional procedure of FD. No cerebral edema was seen in this CT image too.*

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On a three-month follow-up visit, the patient had no recurrence of symptoms. A follow-up CT angiogram was performed, and it showed no residual flow to the aneurysm. [Figure 10]

The patient was completely fine in a six-month follow-up with no recurrence of convulsions, and there was no neurologic deficit. We advised the patient to continue dual anti-platelet (i.e., ticalgrelor, aspirin) and anti-epileptic (i.e, levetiracetam) drugs for the next one year until we advise to stop those. Finally. the patient is now under our follow-up.

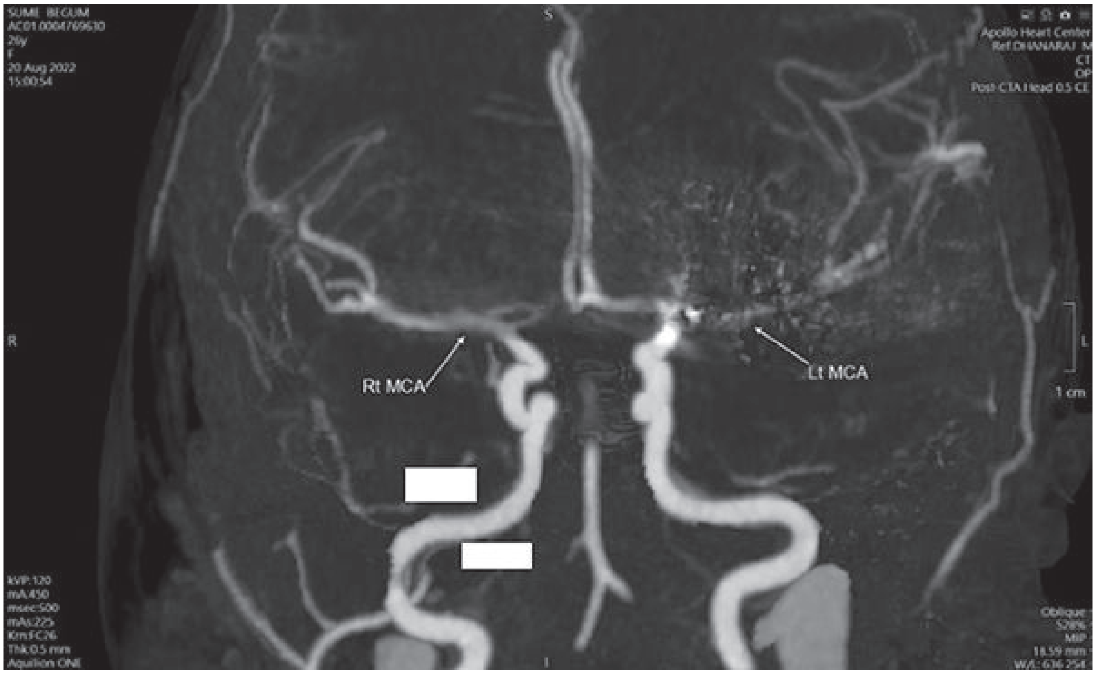

Figure 10: *Follow up CT angiogram after 3 months. No residual contrast filling noted to the coiled aneurysm sac. No definite recurrent/residual aneurysm within the limits of the subtracted CT angiographic images. Distal left MCA is well visualized.*

Efficacy of the Staged Neurointervention in Unruptured Aneurysms

- Does staging the procedure reduce the mass effect compared to the single intervention?
- Does the staging of the intervention reduce the risk of delayed rupture in larger patient groups compared to FD alone?
- What is the likelihood of cerebral edema or other complications in staged interventions?

Determining the Ideal Time Interval between Interventions

- What is the ideal time window to be chosen as an interval between two procedures?

Patient Follow-up

- Does the follow-up radiological images reveal alleviation or aggravation of post-procedure cerebral edema? (excluding beam scattering)
- Does the patient show any aggravation or recurrence of any symptoms or neurologic deficits clinically in follow-up?
- Does staged intervention shows any superiority in aneurysm occlusion rate in follow-up imagings compared to the single one?

Figure 11: *Important questions to address in future reports on staged intervention in unruptured giant aneurysms. We recommend that to assess the superiority of staged neurointervention for unruptured giant aneurysms in elective settings, these crucial issues are to be addressed.*

Discussion:

Though staged treatment of coils and FD has been discussed in ruptured aneurysms by earlier authors [2], to our knowledge, we are report a case of staged treatment in giant unruptured aneurysms. In our case of a 40 mm × 27 mm MCA giant aneurysm, we felt that a single intervention of FD and coil could aggravate the mass effect and cause neurologic deterioration. However, in our scenario, deploying FD alone and observing it for a long time until the aneurysm was completely obliterated was not practical, because it could increase the risk of a delayed rupture. [1] In a low-resource country where CT scan facilities are scarce and mainly aggregated in city areas, neurointervention facilities are even rarer and mostly available in a few tertiary or super-specialized centers. So, it is likely that we could not spare the patient from delayed rupture by deploying FD alone, knowing that he/she will not get adequate emergency intervention if needed in her rural area. That is why reducing the aneurysm lumen first with a few coils and then deploying FD was the preferred option.

In the post-coiling DSA, we found significantly reduced aneurysm blood flow with smaller lumen, which seemed apparently sufficient for us to deploy the FD. Though a seven-day interval was not enough to evidently comment on the aneurysm shrinkage itself, future approaches to staged neurointervention should confirm its efficacy by MRI imaging or by calibrating the time window. Though we could not do any post-coiling and post-FD MRI due to the patient's financial issues, a three-month follow-up angiogram [Figure 10] demonstrated no residual blood flow to the aneurysm and the apparent success of the whole procedure. We also observed, clinically, no neurologic deficits. Future studies should therefore find out the ideal time interval between the procedures and assess anatomical shrinkage of aneurysm in between two procedures to confirm its superiority over the conventional approaches.

Another important hypothesis we would like to mention, but could not confirm is that we suspected that a single intervention could aggravate the cerebral edema because a large thrombus would be formed owing to the giant aneurysm size. Cerebral edema is reported to be a known complication in treating giant aneurysms in the literature. [4,5] The current understanding of vascular pathology is not only do inflammation cause thrombosis but also thrombosis can in turn directly trigger inflammation. [7] Thrombin cleaves fibrinogen (coagulation) and activates the cytokine IL-1á (inflammation), providing a direct link between coagulation and inflammation in vessel walls. As a result, the larger the thrombus, the greater the risk of acute inflammation, which may result in more severe cerebral edema, which could be a fatal complication in our case. [6,7] In our follow-up CT scans [Figures 7-9] due to excessive scatter and beam-hardening as a consequence of the endo-saccular coils we used, we could not comment on it. Rather, our CT images show some peri-focal cerebral edema but we could not make any such comparison that the cerebral edema would have been larger if operated on in a single intervention. Future approaches should therefore investigate whether staged interventions reduce cerebral edema in MRI imaging, even though this supports our theoretical understanding of the vascular pathology.

Nevertheless, we found our treated case worth reporting and sharing in the neuro-vascular community as it was one of the very first reported staged neurointervention procedures (partial coiling and then FD) in unruptured giant aneurysm in an elective setting. Future studies should explore the superiority of staged intervention over the traditional single procedure one and should answer the following vital questions. [Figure 11] Furthermore, we believe that it may invite future research in this field.

Conclusion:

This case report gives novel insight on approaching giant unruptured aneurysms where flow diversion is still challenging due to risk of aggravation of mass effect if treated in a single intervention with adjuvant coiling. Decreasing the aneurysm size initially makes it easily approachable. Though staging the neuro-interventional procedure in ruptured aneurysm was reported before, but we report here of the very first cases of staged neuro-intervention in unruptured aneurysm by partial coiling and then deploying FD. However, the superiority of staged neuro-intervention in giant unruptured aneurysms requires further study on larger patient groups, and some critical questions are yet needed to be addressed. Finally, we believe that our case may guide in the treatment and management plan of giant complex aneurysms (greater than 25 mm) in the future if proven by further research.

Declaration of Interest

The author(s) has no conflict of interest.

Abbreviations:

ACA = Anterior Communicating Artery

CT = Computed Tomography

DSA = Digital Subtraction Angiography

FD= Flow Diverter MCA = Middle Cerebral Artery

MRI= Magnetic Resonance Imaging

P-com = Posterior Communicating Artery

Data Availability Statement

The patient data will be available on request in order to ensure privacy/ethical restrictions.

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