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Discussion on Flow-Diversion of Acutely Ruptured Intracranial Aneurysms: A Single - Center Experience

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Abstract: ***Subarachnoid hemorrhage (SAH) represents a significant clinical challenge, often resulting in severe neurological complications and high mortality rates(1). Neurovascular interventions in SAH patients aim to isolate the ruptured cerebral aneurysm from the circulation, in order to avoid the devastating outcome of re-rupture(2). In the setting of SAH, physicians are limited to using intrasaccular devices such as coils, as the patient lacks the luxury of being on dual-antiplatelet therapy (DAPT) which allows for permanent intra-luminal devices to be used. Even so, flow-diversion has emerged as a promising approach to address the intricacies associated with SAH(3). Flow-diverting devices have gained traction in recent years(4), predominantly due to their ability to promote aneurysm thrombosis and subsequent vessel remodeling. By altering the hemodynamic environment within the aneurysm, these devices facilitate the redirection of blood flow away from the lesion, while preserving the patency of parent and perforating arteries. We will discuss the patient selection method we use in order to optimize its implementation. The objective is to provide a thorough understanding of flow-diversion in the context of SAH management and its potential role in improving patient outcomes.***

Keywords: aneurysm; flow diversion; stent; subarahnoid haemorrhage

1. Our clinical guidelines for flow-diversion in SAH setting:

From the period of 2021 to 2022, we have had 78 (n=78) patients that presented in our hospital with SAH of aneurysmal origin. Of those, 12 (n=12) presented with peri-mesencephalic hemorrhage with no obvious cause for the bleed and were treated conservatively. Two (n=2) had aneurysms that were deemed too risky to treat using endovascular means and were surgically clipped. In 6 (n=6) patients, we had no other way to treat the aneurysm, as endovascular coiling would lead to the disruption of blood-flow in the underlying vessel. In those cases, we undertook the strategy to place a flow-diverter in the acute setting of SAH.

Upon admission to the hospital, patients underwent a CT-angiography to evaluate the state of the ventricle system and the risk of hydrocephalus occurring. We judge the inherent anatomy and the aneurysm itself and devise a general strategy. The patient selection for flow-diversion in patients with SAH is extremely conservative as it carries great risk should the need for open surgery to treat complications occur. If it is a low-risk patient with an aneurysm, which is deemed impossible to coil even with adjunctive devices (i.e. balloon-assisted, stent-assisted coiling), but possible for flow-diversion placement, we give a loading dose of DAPT, consisting of 30mg of Prasugrel and 200mg acetylsalicylic acid prior to the intervention.

All six of our patients elected for flow-diversion had a modified Fisher scale 1-2 (5). No major post-procedural complications were observed.

In all cases a right femoral approach was selected and a 6F sheath was placed in the right femoral artery. Heparin was administered in order to achieve a desirable clotting time. In difficult anatomy, we place a distal access catheter along with the generally used guiding catheter, to achieve extra stability of the delivery system. The flow-diverter used in all patients is the p64 FD (Phenox, Germany), delivered vie a Phenom 27 microcatheter. Post-procedurally the DAPT was continued with a normal dosage of 10mg Prasugrel and 100mg acetylsalicylic acid daily p.o.

2. Illustrative Case

The patient is a 48-year-old male with previous history of SAH 10 years prior, which was treated using surgical clipping. He presented in our hospital with symptoms of headache, nausea and vomiting and a Glasgow coma scale score of 15. The conducted digitally subtracted angiography (DSA) showed no signs of recanalization of the previously ruptured and clipped aneurysm of the right internal carotid artery (ICA)(Figure 1. A, B). We observed a blister-like aneurysm of the front wall of the left ICA, which would be impossible to treat through either coiling or clipping (Figure 1. C, D). The decision to place a flow-diverter stent was made, and we follow our discussed protocol. The flow-diverter was placed along the M1 segment of the left middle cerebral artery, C7 and C6 segments of the left ICA, with adequate wall opposition achieved (Figure 1. E-H). No restriction of blood-flow at the site of the device or distal circulation was observed. The patient was discharged after two weeks of post-procedural conservative therapy for the SAH with no neurological impairment.

On the control DSA 6 months after treatment, we observed excellent results and no late complications associated with the device (Figure 2.).

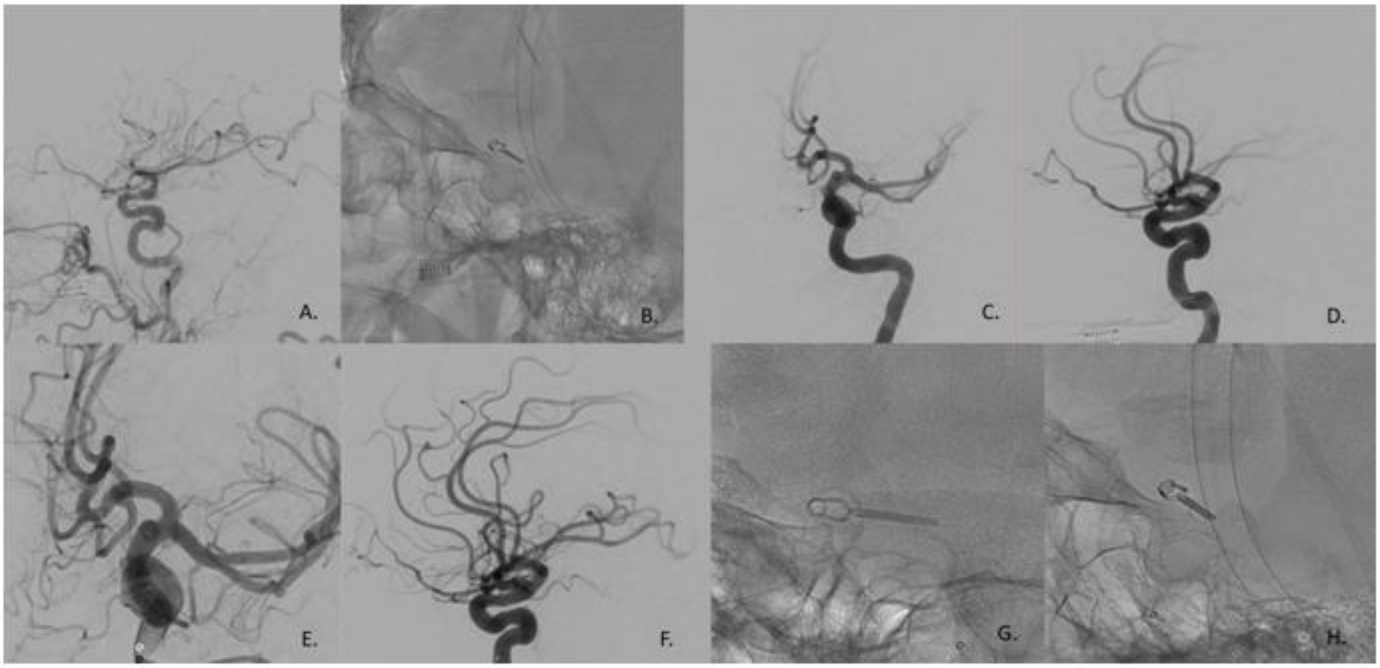

Figure 1: A (DSA), B (Single-shot image of the clip): We observed no filling of the previously clipped aneurysm on the right ICA.

C, D: On the DSA conducted on the left ICA, we found a blister-like aneurysm that we deemed the culprit, responsible for the bleeding. Coiling and surgical clipping were excluded as treatment modalities, due to the nature of the pathology. We decided on flow-diversion as the only viable option.

E, F (Post-deployment DSA): No hindrance of distal blood-flow was observed.

G, H (Single-shot image of the FD stent): We achieved adequate wall apposition and had perfect coverage of the aneurysm. We put the patient under observation in the intensive-care unit and continued with Triple-H therapy to combat the early and late complications associated with a SAH.

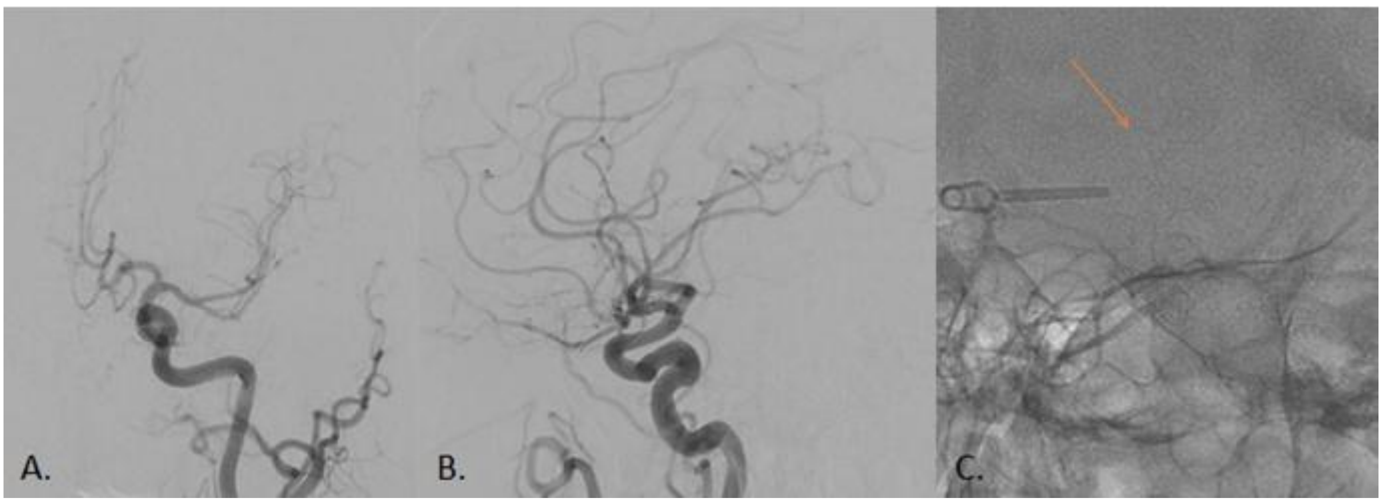

Figure 2: A, B: 6-month follow-up DSA of the previously treated left ICA aneurysm. C: Single shot image of the flow-diverter stent (orange arrow). The control DSA showed a total obliteration of the intracranial aneurysm, with complete patency of the blood vessels. The single-shot image of the stent didn't reveal any late deformities of the stent. We discontinued the DAPT by removing the morning Prasugrel tablet intake and left the patient on a single anti-platelet therapy (SAPT) for another year, when his next imaging control will be performed.

3. Discussion

In this paper, we have explored the potential of flow-diversion as a treatment modality in subarachnoid hemorrhage settings. The analysis of available literature has illuminated the advantages of flow-diversion over traditional endovascular and surgical interventions(6). However, it is essential to recognize the challenges and limitations associated with this emerging technique, and to acknowledge the need for further research to optimize its implementation in clinical practice.

The primary benefit of flow-diverting devices lies in their ability to promote aneurysm thrombosis and vessel remodeling while preserving the patency of parent and perforating arteries(7). This is crucial in minimizing the risk of complications and improving patient outcomes. The literature suggests that flow-diversion is a promising approach, but its efficacy and safety in SAH patients remain to be established conclusively(8,9). One challenge that has been identified in the application of flow-diversion in SAH settings is the selection of appropriate patients(10). Given the heterogeneity of SAH cases and the variations in aneurysm morphology, determining which patients would benefit most from flow-diversion is a complex task. This highlights the need for the development of standardized guidelines and patient selection criteria(11). Moreover, the optimal timing of flow-diversion in the context of SAH remains a subject of debate. Further research is necessary to determine the ideal time window for flow-diversion treatment in SAH patients. Finally, flow-diverting devices are not without their limitations. Device-related complications, such as in-stent thrombosis or delayed aneurysm rupture, can occur, and long-term follow-up is necessary to evaluate the durability of the treatment(12,13). Additionally, the learning curve for the deployment of flow-diverting devices may pose a challenge for practitioners inexperienced with the technique.

4. Conclusion

With the given experience in our clinic, and based on the literature on the matter, we can conclude that flow-diversion is a viable method for treatment of ruptured intracranial aneurysms, that have no other alternative of treatment. Patient selection and risk evaluation are of critical importance, as it carries great inherent risks.

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