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# Single-session treatment of bilateral, tandem, internal carotid artery aneurysms with pipeline flex with shield technology

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## ABSTRACT

The treatment of intracranial aneurysms (IA) has been transformed by the development of flow-diversion (FD) devices. Initially, these revolutionary devices were conceived for giant and fusiform aneurysms located on the internal carotid artery (ICA). Technological improvements have expanded their indications. Distal middle cerebral, anterior cerebral artery aneurysms, or even posterior fossa aneurysms can now benefit from this technology. One other category of aneurysms that can be treated is multiple IA's.

Multiple IA's are encountered in approximately one-quarter of patients presenting with subarachnoid haemorrhage. Endovascular management of such cases is complex, requiring different devices and treatment strategies to secure all lesions. FD's can be successfully employed to reconstruct vessels, which harbour more than one aneurysm, especially multiple ICA lesions. Multiple aneurysms located on both ICA's are generically known as tandem aneurysms.

We present the case of a patient with tandem aneurysms located on both intracranial internal carotid arteries that we treated simultaneously with the Pipeline Flex with Shield Technology in one single session. To the best of our knowledge, this is the first case reported in the literature so far.

## INTRODUCTION

Multiple intracranial aneurysms (IA) are found in up to 30% of patients with subarachnoid haemorrhage.<sup>1</sup> Endovascular cure of multiple IA's by simple coiling with or without balloon or stent assistance, performed in one single session, has been assessed in previous studies, as having high procedural success rates and a low number of complications.<sup>2,3</sup> Alternatively, only small patient series have explored the safety and efficacy of flow-diverters for multiple IA, especially as a one-stage treatment.<sup>4</sup>

## Keywords

multiple intracranial aneurysms, flow-diversion, surface modification



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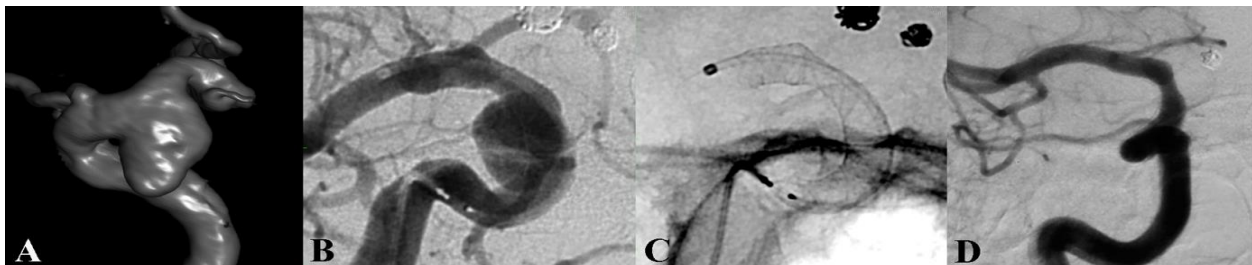
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Our case highlights the treatment of three intracranial aneurysms located on both internal carotid arteries (ICA), with two Pipeline Flex with Shield Technology devices implanted bilaterally in one single session. This is, to the best of our knowledge, the first case reported in the literature pertaining to the use of this device in bilateral, tandem intracranial aneurysms.

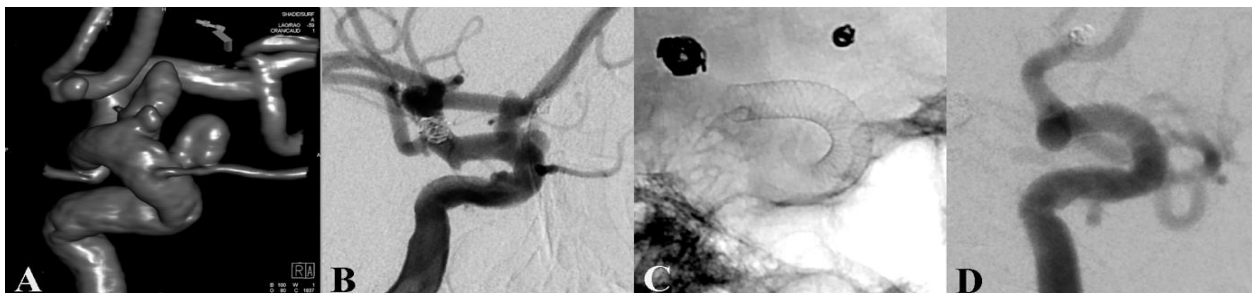
#### CASE REPORT

A 53-year-old female was brought in the emergency department with acute onset headache, dizziness, and nausea. Neurological examination revealed a conscious patient, GCS 15, with 1 point on the Hunt&Hess scale. CT showed mFisher 2 subarachnoid hemorrhage and multiple intracranial aneurysms (not shown). Catheter angiography was performed the next day demonstrating 5 aneurysms, one on the anterior communicating artery (ACA), one on the basilar tip, and 3 on both ICA's, in the ophthalmic segments. Based on the morphologic characteristics and the distribution of the blood on CT, a decision was made to coil the basilar tip and the ACA aneurysms, while the ICA lesions remained to be treated with flow-diversion in a further session. Simple coiling was performed under general anaesthesia for the two aneurysms mentioned above, without clinical complications and a good neurological outcome (Fig. 1 B, C).

Due to the lack of flow-diverter devices in our department at that time, the patient was scheduled nine months later for endovascular treatment of the remaining 3 ICA aneurysms in one single session. The patient received 75mg aspirin, and 75mg clopidogrel for 2 weeks before the intervention. No platelet function test was used before the intervention. Under general anaesthesia, a 7F Destination long sheath (Terumo, Tokyo, Japan) was placed consecutively in the left and right common carotid arteries, and a 6F Navien intracranial support catheter (Medtronic, California, USA) was navigated in the intracranial ICA. Phenom 27 microcatheters with 0,014" Avigo guidewires (Medtronic, California, USA) were used for distal navigation and flow-diverter implantation. Based on the vessel measurements, two Pipeline Flex with Shield technology devices (Medtronic, California, USA), 4x20mm on the left and 4x25 mm on the right, were successfully deployed in both ICA's without periprocedural complications (Fig. 1, 2 B, C). The patient was discharged two days later without neurological deficits, mRS 0. Dual antiplatelet therapy was continued for 6 months, and a control angiogram was performed. It showed complete obliteration of all aneurysms. (Figures 1, 2 D). Afterwards, clopidogrel was discontinued, while aspirin remained as a life-long treatment.



**Figure 1.** **A.** Volume rendered depiction of the right ICA shows the broad-neck aneurysm located in the ophthalmic segment. **B, C.** DSA and unsubtracted image in the “working” projection. Note the two coil masses at the top of the images, representing the previously coiled anterior communicating and basilar tip aneurysms. **D.** At 6-months the aneurysm is completely occluded. ICA=internal carotid artery; DSA=digital subtraction angiogram.



**Figure 2. A.** Virtual rendered angiogram of the left ICA denoting the two elongated aneurysms located in the ophthalmic segment. **B, C.** DSA and unsubtracted view in the “working” projection showing the position of the device. **D.** 6-months control angiogram highlighting the complete obliteration of the two aneurysms. ICA=internal carotid artery; DSA=digital subtraction angiogram

## DISCUSSIONS

Flow-diverter devices have revolutionised the treatment of intracranial aneurysms. Large, wide-necked, even fusiform, or dissecting, can benefit from the concept of flow-diversion, progressive intra-aneurysmal thrombosis, endothelialisation of the aneurysm neck and subsequent vessel reconstruction<sup>5,6</sup>. One of the first devices to implement these notions was the Pipeline Embolization Device (PED) (Medtronic, California, USA). Currently at its third generation, the Pipeline Flex with Shield Technology, incorporates a phosphorylcholine surface modification, that acts to reduce the risk of platelet aggregation and thrombosis<sup>7</sup>. The use of this device for the cure of ICA aneurysms is safe and efficacious, with low complication rates, as reported in a recent study<sup>8</sup>. However, its employment, as a solution for multiple IA, especially in both ICA's, in one single treatment session, has not been reported before.

We based our decision to implant two devices for all five aneurysms as a one-shot therapy, based on a number of arguments: one single procedure implies the use of general anaesthesia and femoral artery puncture once, consequently avoiding their inherent risks; furthermore, only one set of devices for access and flow-diverter deployment during the same hospital admission would be more cost-effective.

On the other hand, bilateral flow-diverter implantation can expose the patient to a higher risk of specific complications. In-stent thrombosis and distal thromboembolic events were encountered in 4.7% of cases in the IntrePED study,<sup>9</sup> although older generation PED's, without surface modification, were used. The phosphorylcholine surface theoretically ensures a smaller rate of thromboembolic complications, confirmed in a more recent prospective trial.<sup>8</sup> The more dreaded haemorrhagic complications of flow-diverter treatment, delayed aneurysm rupture and delayed intraparenchymal bleeding, can be a reason for concern if a single-session, bilateral implantation is contemplated. Spontaneous aneurysm rupture can occur in up to 1% of cases,<sup>9</sup> especially if large or giant aneurysms are treated, which was not the case in our patient, the largest aneurysm having a maximal diameter

less than 10 mm. Intraparenchymal haemorrhage and its pathophysiological mechanisms are still a matter of debate. If haemorrhagic transformation of small infarcts generated by microemboli are the main cause, the surface modification of the device, can potentially, reduce the likelihood of such events. Otherwise, the “windkessel” effect is another mechanism incriminated. It relates mainly to the aneurysm size and its capacitance role, which in our case would not be a matter of concern due to their small to medium size.<sup>10</sup>

## CONCLUSION

Flow-diversion can be a safe and effective therapeutic alternative for multiple intracranial aneurysms, with low periprocedural complication rates. Bilateral, multiple internal carotid artery aneurysms can benefit from this technique, even in one single treatment session.

In this regard, the Pipeline Flex with Shield Technology offers a potential advantage due to its phosphorylcholine surface modification. Nonetheless, further studies are mandatory to confirm the safety and efficacy of bilateral, single-session internal carotid artery flow-diverter vessel reconstruction.

## ETHICAL REQUIREMENTS

No personal data of the patient is available for identification.

## CONFLICTS OF INTEREST

**Szikora I.** offered professional guidance on behalf of Medtronic for this case.

## ACKNOWLEDGEMENTS

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