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Pentaxial access platform for ultra-distal intracranial delivery of a large-bore hyperflexible DIC (distal intracranial catheter): A technical note

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ABSTRACT

Background: Intracranial access techniques in modern neurointervention are shifting towards more robust access platforms. We present in this report a novel method of navigating a 5 French distal intracranial catheter (DIC) deep within the intracranial circulation in an atraumatic fashion via a pentaxial access system.
Methods: We retrospectively reviewed all neurointerventions performed at two author institutions identifying all aneurysm treatments where the pentaxial system was used to build the catheter support for intracranial positioning of a 5 French DIC.
Procedural data collected include parent artery tortuosity, use of vasodilator, intra-procedural DIC position, and peri-procedural complications.
Results: The pentaxial access platform provided ultra-distal intracranial navigation of the 5 French DIC in the following 11 neurointerventions for treatment of anterior circulation aneurysms: Pipeline embolization device (PED) for anterior communicating artery (ACom) aneurysm, n = 2; surpass for large internal carotid artery (ICA) aneurysm, n = 4; Woven EndoBridge (WEB) device for ACom aneurysm, n = 5. Mean patient age was 55 ± 11 years (range 40–75 years). Mean aneurysm size was 6.7 mm ± 3.8 mm (range 2–16 mm). Mean fluoroscopy time was 29 ± 16.7 min. Intra-procedural DIC positions achieved included supraclinoid ICA (n = 6), M1 (n = 4), and A1 (n = 1). No significant catheter-related complications occurred.
Conclusion: Distal intracranial catheters can achieve ultra-distal intracranial positions safely with the pentaxial access platform. This technique is a near no step-off, atraumatic method of navigating a DIC in a stepwise fashion over de-escalating smaller diameter catheters via a microwire. Familiarity with catheter specifications including diameters and length is essential for the success of this system.

1. Introduction

The flow diversion revolution has not only changed the management of intracranial aneurysms from an approach of endosaccular occlusion to endoluminal reconstruction, it has also transformed the access techniques of neurointerventional procedures towards more robust access platforms. Catheter support systems have shifted from a classic biaxial set-up to a more sturdy triaxial system. This is secondary to the comparatively larger size of delivery systems required for modern neuroendovascular devices, first with the Pipeline embolization device (PED; Medtronic Neurovascular, Irvine, CA), and more recently with the Woven Endobridge Device (WEB; Sequent Medical, Aliso Viejo, CA) and the Surpass flow diverter (Stryker Neurovascular, Freemont, CA).

Distal intracranial catheters (DICs), such as the Navien DIC (Medtronic Neurovascular, Irvine, CA) and DAC (Distal Access Catheter; Stryker Neurovascular, Freemont, CA), serve as the cornerstones of triaxial systems. This newer class of hybrid distal access catheters has flexible soft tips allowing for trackability into intracranial locations. Several neurointerventional centers have described their experiences with delivering these catheters in various intracranial positions [1–6]. In cases of tortuous anatomy, a few strategies have also been described using a balloon or the Merci device as anchors to navigate the DICs into

Abbreviations: ACA, anterior cerebral artery; DAC, outreach distal access catheter; DIC, distal intracranial catheter; DSA, digital subtraction angiography; ICA, internal carotid artery; ID, inner diameter; MCA, middle cerebral artery; PED, Pipeline embolization device; SEM, standard error of the mean; WEB, Woven EndoBridge.

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the desired intracranial position [7,8]. We present in this report a novel technique of navigating a 5 French DIC deep within the intracranial circulation in a near no step-off fashion via a pentaxial access system during neurointervention.

2. Patients and methods

2.1. Patient selection

We retrospectively reviewed all neurointerventions performed at two author institutions, identifying all aneurysm treatments where the pentaxial system was used to build the catheter access for the intracranial positioning of a 5 French DIC.

2.2. Data collection

Data on patient demographics, aneurysm characteristics, proximal tortuosity, use of vasodilator, procedural equipment, and technical details including final intra-procedural 5 French DIC position, and periprocedural complications related to the catheter position were collected. Factors assessed for proximal tortuosity included aortic arch type, cervical ICA tortuosity (defined as a 90° turn, hairpin turn, or corkscrew loop), and cavernous ICA grade [9]. Data were presented as counts.

2.3. Pentaxial access technique

All patients were treated preoperatively with a dual antiplatelet regimen consisting of aspirin 325 mg daily and clopidogrel 75 mg daily for at least 7 days prior to the intervention. All procedures were performed with systemic anticoagulation using heparin with a 5000-unit bolus at the start of each case followed by an intra-procedure rebolus of 1000 units at each additional hour.

The pentaxial system was used through femoral access. The system consisted of a 10 cm 8 French Pinnacle Sheath (Terumo Medical Corporation, Somerset, NJ), 6 French 0.088″ inner diameter (ID) Neuron MAX guide sheath catheter (Penumbra, Alameda, CA), a 5 French 0.058″ ID Navien DIC, a 0.038″ ID DAC, and 0.021″ ID Prowler Select Plus 45° catheter (Codman Neurovascular, Raynham, MA) with a Fathom 16 microwire (Boston Scientific, Marlborough, MA). In the last 2 cases performed for WEB embolization, the 0.021″ ID VIA catheter (Sequent Medical, Aliso Viejo, CA) was used instead of the Prowler Select Plus. Table 1 presents the complete specifications of the equipment used for this pentaxial access system.

After placement of the 10 cm 8 F femoral sheath, the 6 F 0.088″ Neuron Max guide sheath was coaxially introduced with a 6.5 F Shuttle Select Slip-Cath Selective Catheter (Cook Medical, Bloomington, IN) and positioned within the common carotid or proximal internal carotid artery over a 0.035″ glidewire (Terumo Medical Corporation, Somerset, NJ). The slip-cath and glidewire were then removed. Thereafter, small doses of intra-arterial verapamil (typically 5 mg) were infused through the Neuron Max sheath prophylactically to prevent catheter-induced vasospasm in some cases. Once the Neuron Max was in position, the Navien DIC, DAC and 0.021″ catheter (Prowler Select Plus or Via) were introduced as a unit with the Fathom 16 microwire. The Navien DIC was then advanced to the desired distal intracranial position by first navigating the Fathom 16 microwire, followed by the 0.021″ catheter over the microwire, then tracking the DAC over the 0.021″ catheter, and finally tracking the Navien DIC over the DAC. This sequence was repeated in a stepwise fashion until the Navien reached its final intracranial position. After achieving the desired Navien DIC position, the DAC, 0.021″ catheter and Fathom microwire were removed as a unit. A contrast injection was then performed to verify preserved antegrade flow and to assess for parent artery injury or catheter-induced vasospasm. Aneurysm embolization then proceeded with the respective devices. After completion of the aneurysm embolization, final control cerebral angiography with visualization of the catheterized parent artery was performed.

3. Results

The pentaxial access system was used for the ultra-distal intracranial positioning of the 5 F Navien DIC in 11 neuroendovascular treatments of anterior circulation aneurysms. Table 2 summarizes the details of the cases. Three men and 8 women were treated (aged 40 to 75 years, mean 55 ± 11 years). Mean aneurysm size was 6.7 mm ± 3.8 mm (range 2 to 16 mm). Five patients, each with anterior communicating artery (ACom) aneurysms, underwent WEB embolization. Four patients with large internal carotid artery (ICA) aneurysms were treated with the Surpass flow diverter and 2 patients with ACom aneurysms were treated with the PED (one with classic, the other with Flex). Arch types were type I (n = 5), type II (n = 2), type III (n = 0), undocumented (n = 4). Two patients had cervical ICA tortuosity, defined as a 90° turn, hairpin turn, or corkscrew loop. There was a spectrum of cavernous ICA tortuosity: type IA (n = 2), type IB (n = 3), type II (n = 5), type III (n = 0), type IV (n = 1). In 9 of the 11 cases, prophylactic vasodilator was administered prior to positioning of the DIC for catheter-induced vasospasm prophylaxis.

The pentaxial access technique for distal intracranial positioning of the DIC was successful in all cases on the initial attempt. Final intracranial DIC positions included supraclinoid ICA (n = 6), M1 segment of the middle cerebral artery (MCA, n = 4) and A1 segment of the anterior cerebral artery (ACA, n = 1). Mean fluoroscopy time was 29 ± 16.7 min and mean systemic heparin dose was 5100 ± 1900 units. No parent artery dissections or significant catheter induced vasospasm was observed in any of the cases. Additionally, none of the cases required retraction of the DIC as a result of poor distal anterograde flow related to catheter-induced arterial spasm. All aneurysm embolizations were completed successfully except for one WEB embolization secondary to aneurysm morphology.

Table 1
Pentaxial access platform – catheter specifications.

	Catheter	OD	ID	Length (cm)	Manufacturer
1	8 F Pinnacle Sheath	–	8 F	10	Terumo
2	Neuron Max	8 F	0.088 in. (2.24 mm)	90	Penumbra
3	5 F Navien DIC	5 F (0.070 in.)	0.058 in. (1.5 mm)	115	Medtronic Neurovascular
4	3.9 F DAC	3.9 F – (1.3 mm)	2.9 F 0.038 in. (1.0 mm)	136	Stryker Neurovascular
5[a]	Prowler Select Plus 45°	2.8 Fr (0.037 in., 0.95 mm)/2.3 Fr (0.030 in., 0.75 mm)	1.6 F 0.021 in. (0.53 mm)	150	Codman Neurovascular
	VIA 21[a]	2.8 Fr (0.037 in., 0.9 mm)/2.5 Fr (0.033 in., 0.8 mm)	1.6 F 0.021 in. (0.5 mm)	161	Sequent Medical

Abbreviations: DAC = distal access catheter; DIC = distal intracranial catheter; F = French; ID = inner diameter; OD = outer diameter.
[a] 0.021″ VIA catheter used in 2 cases.