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## Case report

## Acute distal migration of a flow diverting stent

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## ABSTRACT

The introduction of flow diverting stents, particularly for treatment of petrous to supraclinoid internal carotid artery aneurysms, has greatly impacted endovascular treatment of intracranial aneurysms. Despite their high efficacy, complications, such as ischemic events, distal hemorrhage, or problems with stent deployment, remain a significant concern. We present the first reported case of acute distal migration of a Pipeline Embolization Device (PED). A 24-year old female underwent elective placement of a PED for treatment of a left paraclinoid internal carotid artery aneurysm. Despite an uneventful intra-operative course, adequate stent placement and a normal neurologic examination immediately after placement, she demonstrated right hemiparesis shortly thereafter. Repeat angiography revealed acute distal migration of the PED and an occlusive thrombus. Thought to be secondary to chronic in-stent thrombosis, distal migration has been previously described in a delayed fashion over weeks to months. However, to our knowledge, this is the first reported case of distal flow diverter migration in an acute setting immediately following the procedure.

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## 1. Introduction

Flow diversion has emerged as a promising endovascular alternative for the treatment of intracranial aneurysms. The Pipeline Embolization Device (PED; Covidien/eV3, Irvine, CA, USA) is a flexible low-porosity stent, initially designed for aneurysms of the internal carotid artery between the petrous and supraclinoid segments [1]. In addition to altering flow hemodynamics to promote aneurysm stasis and thrombosis, the PED also provides a scaffold for neointimal formation and endothelialization. Studies evaluating the efficacy of the PED have found a complete aneurysm occlusion rate of 86% with only 2.8% of treated patients requiring further retreatment [2]. While morbidity with the use of PEDs remains low, ischemic, hemorrhagic and device-related complications have been described previously.

Ischemic and thrombotic events are the most frequently described complication of PED use with reported rates of neurologic decline in 6.8%, although diffusion-weighted imaging changes may be seen in up to 50.9% [3]. Although seen less frequently, hemorrhagic complications occur in approximately 2.5% of cases; however, the underlying etiology remains largely unknown [4]. The risk of distal stent migration is observed substantially less frequently

and has only been previously described in a chronic, delayed fashion.

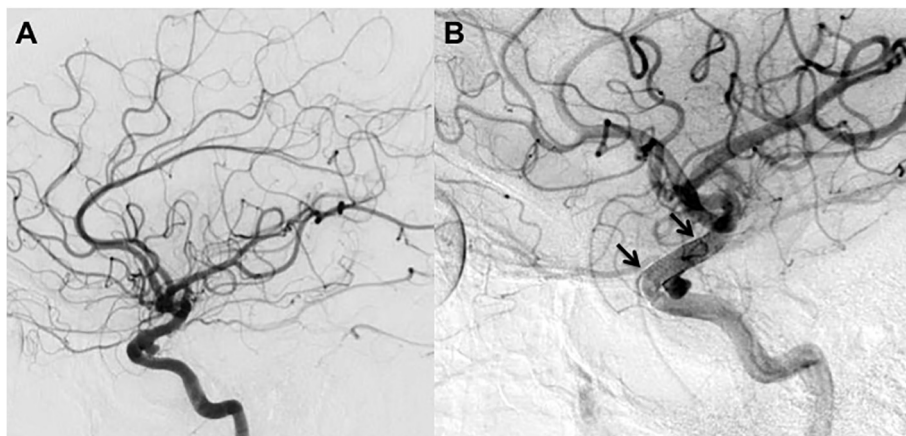
Proximal stent migration, typically due to intra-procedural PED foreshortening during stent deployment, is a frequent intra-operative complication observed in up to 12% of cases [5]. Often seen during the initial deployment, proximal migration of PEDs has also been described as a late complication, presenting with aneurysm recurrence [5,6]. Distal migration following deployment of a flow diverting stent has been reported in a delayed fashion in up to 5.9% of cases, presumably secondary to chronic in-stent stenosis [7]. We report the first case of distal flow diverter migration in an acute setting, immediately following the procedure.

## 2. Case report

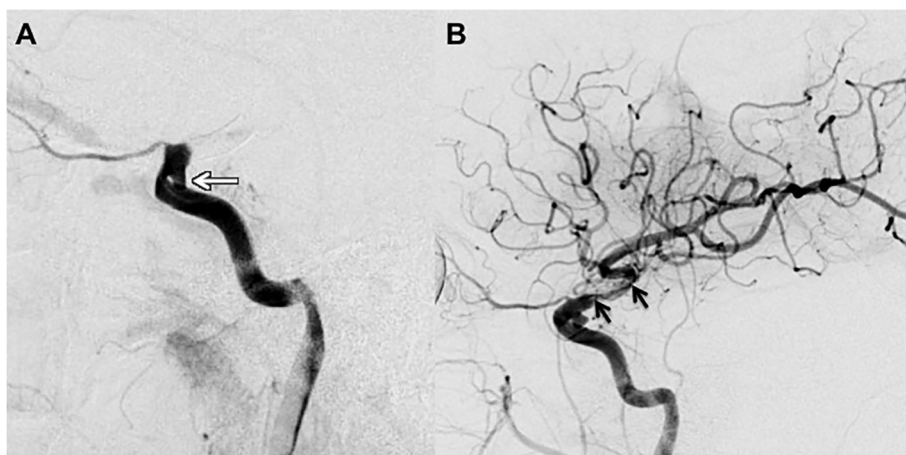
We report a 24-year old female who presented electively for flow diversion of a left paraclinoid aneurysm. She had been started on dual anti-platelet therapy 7 days before treatment with 75 mg clopidogrel and 325 mg aspirin daily. Her P2Y12 was 194 PRU on the day of treatment. Intra-operatively, she was found to have a  $4.1 \times 5.0 \times 4.8$  mm aneurysm in the vicinity of the superior hypophyseal artery (Fig. 1A), and an appropriately-sized Pipeline Embolization Device ( $3.5 \times 12$  mm) was placed without complication under therapeutic heparinization. Immediate post-placement angiography revealed stagnation within the aneurysm dome with no evidence of impaired flow (Fig. 1B). Upon emergence from general anesthesia, the patient was initially moving all extremities

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**Fig. 1.** Diagnostic cerebral angiography during PED placement. (A) Lateral angiography following left ICA injection demonstrating a left paraclinoid aneurysm and (B) successful placement of a PED across the neck of the aneurysm. Black arrows note the proximal and distal ends of the PED.



**Fig. 2.** Diagnostic cerebral angiography during thrombectomy. (A) Lateral angiography following left ICA injection revealing complete occlusion of the left ICA as well as unsheathing of the previously covered aneurysm (white arrow). (B) Distal migration of the PED with successful TIC1 2b revascularization. Black arrows note the proximal and distal ends of the PED.

symmetrically. While still on the operative table, she developed acute right hemiparesis and a right facial droop. Angiography was emergently repeated, which revealed complete thrombosis of the stent and proximal MCA. The PED was noted to have migrated to the supraclinoid ICA (Fig. 2A), after which the patient received intra-arterial tissue plasminogen activator and attempted thrombus aspiration. She was maintained on abciximab overnight. Despite TIC1 2b revascularization (Fig. 2B), the patient unfortunately suffered a dominant left MCA infarct.

### 3. Discussion

Despite the efficacy seen in intracranial aneurysms treated with the PED, certain complications may occur, notably ischemic events, hemorrhagic complications and stent migration. While proximal migration during or shortly after deployment is frequently observed, it rarely generates clinical sequelae [5]. Distal PED migration has been previously reported in a delayed chronic fashion, believed to be secondary to chronic in-stent thrombus formation. Specifically evaluating follow-up angiography in PEDs, in-stent stenosis was observed in 39% with no evidence of distal migration, while Silk Flow Diverters (Balt Extrusion, Montmorency, France) demonstrated in-stent stenosis in 38% with distal migration in 13% of cases [7]. Of note, in-stent stenosis and delayed

migration was asymptomatic in all patients with the exception of one who developed transient ischemic attacks, requiring stent angioplasty.

While proximal stent migration appears to be secondary to PED foreshortening during or shortly after deployment, given the association between in-stent stenosis and migration of flow diverting stents, distal PED migration appears to be secondary to an underlying thrombotic pathology. Despite pre-procedural dual anti-platelet therapy, a pre-procedural PRU value within therapeutic range and adequate intra-procedural heparinization, our patient developed a complete occlusive thrombus shortly after the procedure had been completed. This was the likely etiology underlying device migration, and despite revascularization, the patient unfortunately suffered a significant clinical neurologic deficit. While delayed flow diverting stent migration has been reported with minimal clinical sequelae, we report the first case of acute distal migration of a PED, secondary to severe in-stent thrombosis despite adequate anti-platelet and anticoagulant therapies, immediately after treatment.

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