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CASE REPORT

Multiple pipeline twists encountered during treatment of a symptomatic fusiform ICA aneurysm

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SUMMARY

Pipeline embolisation device (PED) 'twisting' is an intra-operative complication that manifests with the appearance of a 'figure-8' in perpendicular planes on digital subtraction angiography. A twisted PED causes narrowing and/or complete occlusion of the vessel lumen and poses significant risks for thrombus formation and downstream ischaemia. Here, we present a case in which three unique PED implants become twisted during pipeline embolisation of a large fusiform internal carotid artery aneurysm. The twists were remediated by balloon angioplasty and a combination of techniques that allowed the PED to rotate and restore its original axis. Six-month and twelve-month follow-up angiography demonstrated complete aneurysm occlusion with preservation of the parent vessel, proving that proper remediation of PED twisting can still result in successful long-term outcomes.

BACKGROUND

Pipeline embolisation device (PED) 'twisting' is a rare intra-operative occurrence seen during PED deployment for the treatment of cerebral aneurysms. It occurs when the proximal end of a deploying PED rotates around its long axis in relation to the anchored distal end of the device. It can be identified by its characteristic 'figure-8' appearance in perpendicular planes on digital subtraction angiography (DSA). An unremediated twist would likely lead to parent vessel occlusion and/or embolic stroke. Despite the potential for severe consequences, there is little acknowledgment of twisting in the existing literature on flow diversion and no consensus on how to remediate a PED twist. This report describes the management and outcome of a case in which multiple instances of PED twisting were encountered.

CASE PRESENTATION

The patient was a sexagenarian who presented with diplopia and a right cranial nerve six palsy. MRI revealed enlargement of the internal carotid artery (ICA) in the cavernous sinus, exerting a mass effect on the right sixth nerve. DSA showed fusiform dilation of a 3.5 cm span of the ICA along its petrous, cavernous and clinoidal segments, reaching a maximum diameter of 1 cm (figure 1).

TREATMENT

Using a tri-axial catheter setup with the 088 Neuron Max situated proximal to a hairpin turn in the cervical ICA and the catalyst 5 intermediate catheter at the anterior genu of the cavernous ICA, the initial 4.75×30 mm PED was opened in the middle cerebral artery and dragged back to the supraclinoid ICA, covering a large non-fetal posterior communicating artery.[1] Mid-deployment of the first device, a twist developed at the anterior genu which was remediated by wagging and stretching the device, then resheathing it with the Via 27 microcatheter to milk the twist proximally along the braid.[2] The PED was then deployed initially within the intermediate catheter and then within the parent vessel with excellent apposition (figure 1).[3] A second 5×30 mm device was utilised and during its deployment a mid-device twist occurred again. This was remediated by moving the braid forward and backwards. A third PED device used for the construct (5×30 mm) became twisted in two distinct places. The device could not be re-sheathed, so the proximal device was deployed into the intermediate catheter by unsheathing (as opposed to pushing) to prevent locking the twist in. The device was unsheathed from the intermediate catheter by engaging the proximal edge with the Via27 catheter, allowing the twist to unfurl. The second twist was progressively opened by tracking the Via through it over the delivery wire (figure 2).[4] The Via was exchanged for a transform balloon and angioplasty facilitated untwisting (figure 3). A fourth device was deployed in uncomplicated fashion to connect the construct to normal parent vessel proximally.

OUTCOME AND FOLLOW-UP

The patient's sixth nerve palsy resolved. Post-embolisation P2Y12 levels were >200, so she was switched to Prasugrel which was stopped after 6-month follow-up DSA which along with 12-month follow-up DSA demonstrated aneurysm obliteration and restoration of normal ICA diameter (figure 3).

DISCUSSION

This is a report of PED twisting during deployment, which was notable for the fact that multiple twists were encountered, as well as for the technical detail regarding remediation tactics.

Shapiro *et al* have described the mechanism by which twisting or torsion occurs as rotation around the long axis of the PED device after the initial portion is deployed and apposed to the parent vessel wall.[5] This phenomenon is well illustrated by another case of a sexagenarian who presented with

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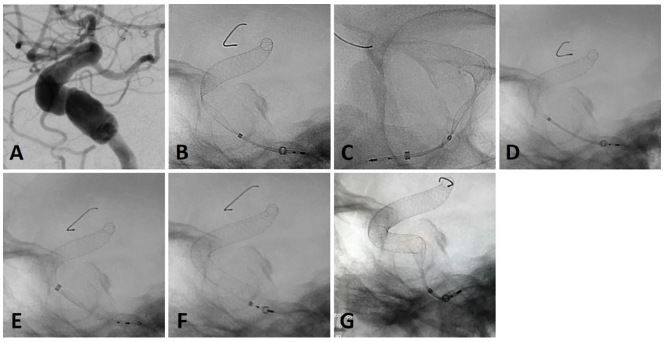

Figure 1 (Clockwise from top left) (A) Fusiform aneurysm affecting 3.5 cm of the petrous, cavernous and clinoidal internal carotid artery reaching a maximum diameter of 1 cm. (B and C) Lateral and anterior–posterior digital subtraction angiography (DSA) showing twist of the first 4.75×30 mm pipeline emboli sation device manifest as figure 8 in perpendicular planes. (D) Resheathing the twist to milk proximally along the device and (E) deploying inside the catalyst 5 intermediate catheter to allow passive untwisting before (F) final deployment with excellent parent vessel apposition (G) lateral DSA depicting twist in second device.

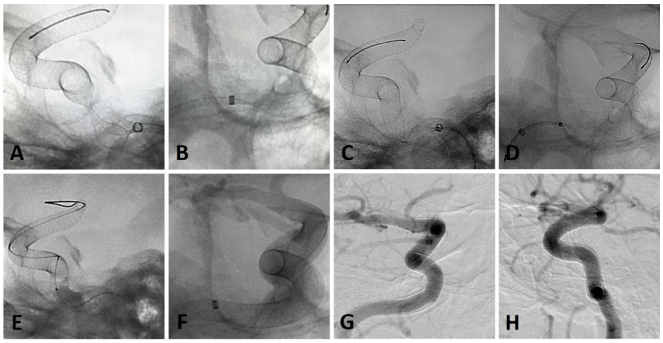

Figure 3 (Clockwise from top left) (A and B) Lateral and anterior–posterior digital subtraction angiography (DSA) showing two twists in the third device (C) figure 8 appearance of twist in perpendicular planes. (C and D) Biplanar fluoroscopy showing residual proximal twist after remediation of the distal twist. (E) Serial dilation of the twist with Via 27 microcatheter exchanged for transform balloon with angioplasty used to facilitate final untwisting and achieve (F) excellent parent vessel apposition. (G and H) Six-month follow-up DSA showing complete aneurysm occlusion and restoration of parent internal carotid artery vessel diameter.

eye pain, diplopia, sixth nerve palsy and a 4-cm cavernous ICA aneurysm (figure 4). In that instance, the twist could not be remediated, the twisted device was removed and the parent vessel was sacrificed after the patient passed a balloon-test occlusion.

We believe the key to remediating a twist is to allow the device to rotate and restore its original long axis. Others have advocated for wagging the PED to remediate a twist, but we caution against an over-reliance on manoeuvres designed to forcefully expand the device, which may lock the twist in.[6 7] Rather, we have found that gentle wagging with an emphasis on stretching the device can help to milk the twist toward the proximal end of the braid. A twist located more proximally in the device is more likely to untwist spontaneously during deployment, and can be more easily opened with angioplasty. A twisted device may be deployed as long as access is preserved, and then can usually be opened by tracking serially larger diameter catheters and wires through, beginning with the delivery microcatheter and building to a balloon or the intermediate catheter. As with the third device in this case, angioplasty can facilitate untwisting, particularly of devices that lack the static friction of parent vessel wall apposition. An alternative angioplasty strategy recommended by Shapiro *et al* is to use a non-compliant balloon used to fracture the stent braid which they then cover with another device.[5]

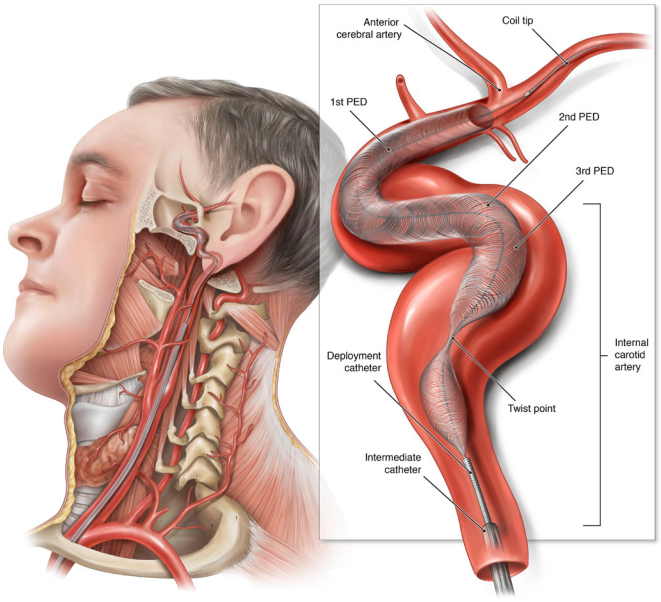

Figure 2 Artist's illustration demonstrating the second pipeline embolisation device (PED) twist seen during deployment of the third device in a four-stent PED construct.[4]

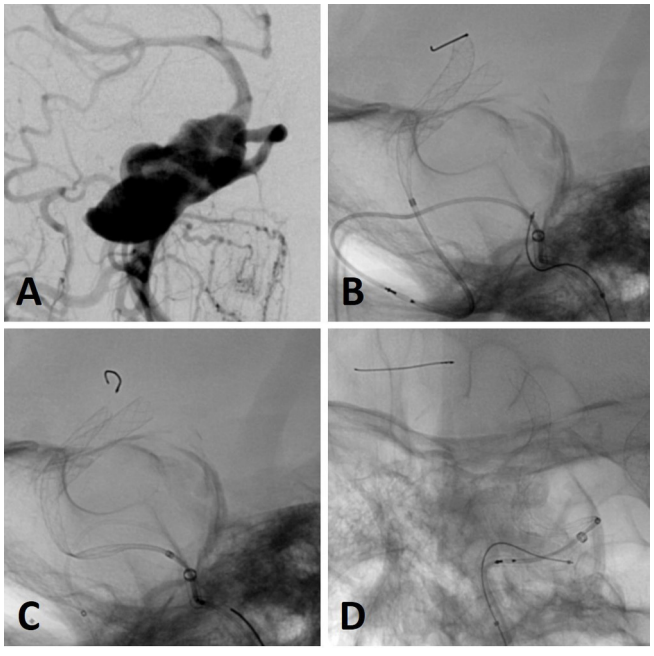

Figure 4 (Clockwise from top left) (A) 4 cm partially-thrombosed petrocavernous internal carotid artery aneurysm. (B) Partial deployment of pipeline embolisation device (PED) prior to reduction of a loop within the aneurysm causes rotation around the long axis of the stent and PED. (C and D) Lateral and anterior–posterior digital subtraction angiography showing bow-tie appearance of the PED in perpendicular planes.

Pipeline twisting is a phenomenon acknowledged by all high-volume practitioners of flow diversion, but which has received little to no attention in the literature. An unremediated twist will lead to parent vessel occlusion or embolic complications. Discussion of this intra-procedural complication is particularly timely as new flow diversion technologies with different deployment techniques come to market.

Learning points

- Twisting is a rare occurrence during pipeline embolisation device (PED) deployment that if not fixed could lead to vessel occlusion or embolic complications.
- Twisting occurs due to rotation around the long axis of the PED after the proximal stent is deployed and anchored to the parent vessel.
- Remediation techniques (including gentle wagging, device stretching, resheathing, deployment within an intermediate catheter and post-deployment balloon angioplasty) work by unfurling the twist and restoring the longitudinal axis.
- With proper management, a twist can be eliminated and the PED deployed with good parent vessel apposition, no clinical sequelae and satisfactory occlusion outcomes.
- Further investigation is necessary to determine the incidence, risk factors and outcomes associated with PED twisting.

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Contributors RWY drafted and revised the paper and contributed to image collection. MTB revised the paper and contributed to image collection. GPC revised the paper. ALC proposed the idea, revised the paper and contributed to image collection. He is the guarantor.

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