CASE REPORT

XCalibur aneurysm occlusion device for the treatment of direct carotid cavernous fistula: expansion of armamentarium

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SUMMARY

We report the first case of a post-traumatic direct carotid cavernous fistula (CCF) treated with the XCalibur aneurysm occlusion device, which is a balloon mounted stent with flow diversion effect. Two devices were deployed across the fistula in an overlapping manner, resulting in complete occlusion of the fistula. Flow diversion with this device can provide a safe and alternative treatment option in direct CCF.

BACKGROUND

Multiple endovascular treatment options are available for direct carotid cavernous fistulas (CCFs). Endovascular treatment has undergone refinement from the early days of a detachable balloon to the use of coils and liquid embolic agents.[1] Flow diverters, as a sole device or as an adjunct to coils and Onyx, have expanded the scope of endovascular treatment of direct CCFs.[2] We present a case of a post-traumatic direct CCF treated with the XCalibur aneurysm occlusion device (AOD) (Merlin MD, Singapore; figure 1). No other adjuvant embolic materials were used.

CASE PRESENTATION

A 22-year-old man presented with a throbbing sensation in his left eye, with gradually progressive axial proptosis, 8 months after a road traffic accident. On examination there was pulsatility over his left eyeball with a palpable thrill and an audible bruit. Congestion and chemosis of the left eye were noted, with a peripherally contracted visual field and sluggish pupillary reaction. The visual acuity was 6/6 in both eyes. A clinical diagnosis of direct CCF was made.

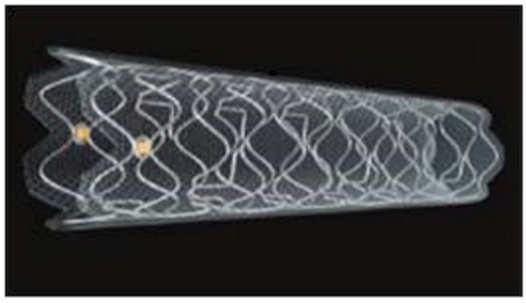

Figure 1 XCalibur aneurysm occlusion device. Illustration of the microporous polymer membrane covered implant. Reproduced from product brochure, Merlin MD, Singapore).

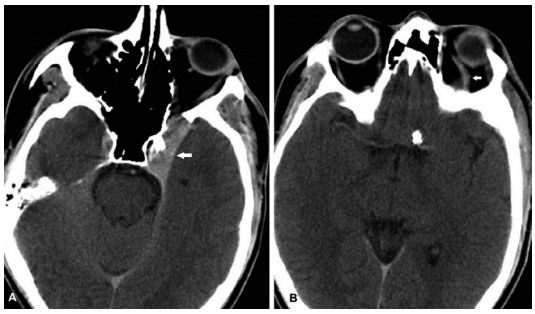

Figure 2 (A) Axial CT image showing bulky and enhancing left cavernous sinus (arrow) with mild proptosis on the left side. (B) Axial CT (superior section) showing a prominent left superior ophthalmic vein (arrow).

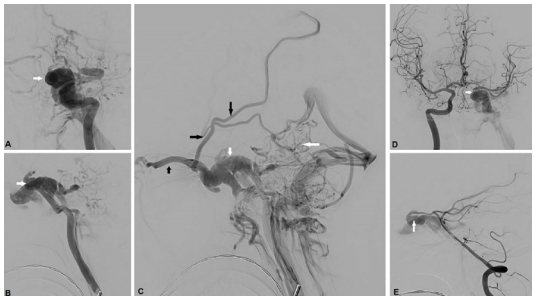

Figure 3 (A) Left internal carotid artery (ICA) angiogram (anteroposterior view). (B) Left ICA angiogram (lateral view) showing the carotid cavernous fistula (CCF) with the single rent located at the anterior genu of the left cavernous ICA (arrow) with steal. (C) Left ICA angiogram (lateral view, delayed) showing prominent posterior venous drainage (short white arrow) and congested posterior fossa veins (long white arrow). The left superior ophthalmic vein is dilated (short black arrow) with retrograde reflux into the cortical veins (long black arrows). (D) Right ICA angiogram (anteroposterior view, cross compression) showing the retrograde filling of the left CCF (arrow) with opacification of the left anterior cerebral artery and middle cerebral artery trunk and its branches. (E) Left vertebral angiogram (lateral view, cross compression) showing opacification of the left cavernous sinus through the rent (arrow) via the posterior communicating artery.

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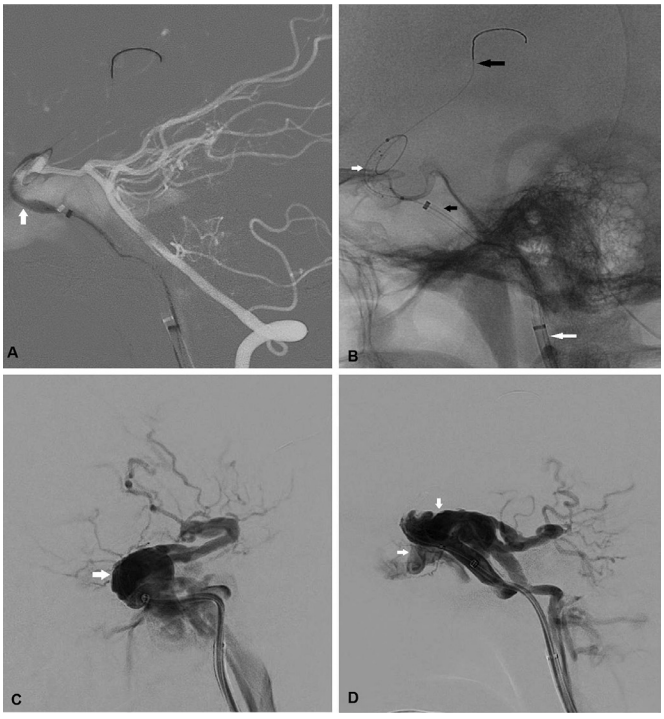

Figure 4 Deployment of the first XCalibur device. (A) Angiogram of the left internal carotid artery (ICA) (lateral view under roadmap) showing balloon inflation for deployment of the XCalibur device (3.75×20 mm) in the left supraclinoid and cavernous ICA across the fistula site (arrow). (B) Lateral fluoroscopic image showing the deployed XCalibur device with radiopaque markers at its proximal and distal ends (short white arrow). Note is made of the coaxial access system: Neuron MAX guide catheter (long white arrow), Navien distal access catheter (short black arrow), and Traxcess 014 wire (long black arrow). (C) Left ICA angiogram (anteroposterior view). (D) Left ICA angiogram (lateral view) showing filling of the carotid cavernous fistula (arrow) secondary to endoleak with prominent posterior venous drainage.

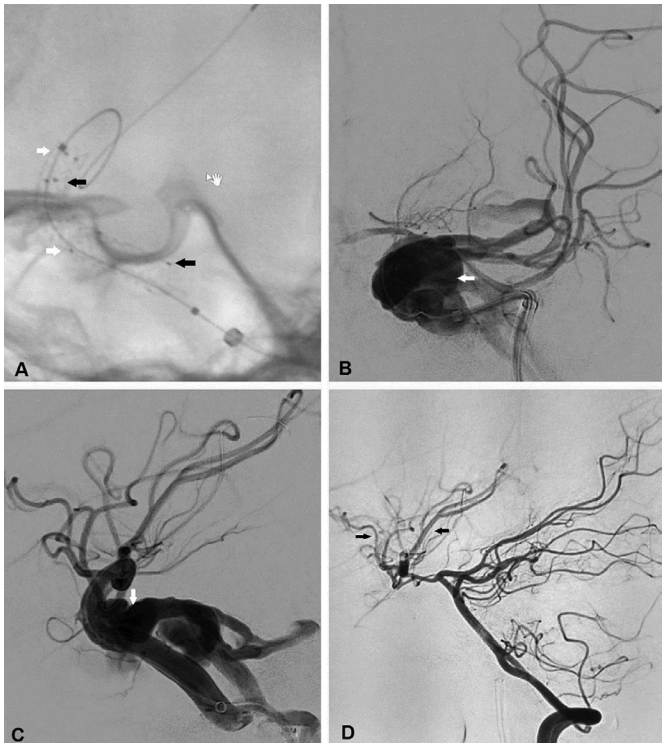

Figure 5 (A–D) Deployment of the second XCalibur device in an overlapping fashion. (A) Lateral fluoroscopic view showing the overlapping XCalibur devices (white arrows for the first device (3.75×20 mm) and black arrows for the second device (4.25×25 mm) (B), (C) Left ICA angiogram (anteroposterior and lateral views) showing residual filling of the carotid cavernous fistula (arrows) with established antegrade flow. There is a significant reduction of fistula with stasis. (D) Left vertebral angiogram (lateral view) showing antegrade flow across the posterior communicating artery into the left anterior cerebral artery and middle cerebral artery (arrows). No filling of the fistula is seen.

INVESTIGATIONS

A contrast CT scan of the brain showed findings suggestive of CCF (figure 2A and B). The patient underwent a diagnostic digital subtraction angiogram (DSA) for characterization of the CCF, its drainage pattern, and for treatment planning.

DSA showed a left direct CCF with rent involving the anterior genu of the cavernous segment of the left internal carotid artery (ICA). Steal was noted with non-visualization of the left ICA distal to the clinoidal segment and non-opacification of the ophthalmic artery.

Venous drainage of the fistula was noted to the superior ophthalmic vein–facial–angular system, pterygoid plexus, cortical veins (superficial middle cerebral–Trolard–Labbe veins) through the lateral sphenoparietal sinus, superior and inferior petrosal sinuses with stenosis of their distal parts causing venous reflux in the posterior fossa veins (mesencephalic and cerebellar veins), which are seen draining to the vein of Galen–straight sinus system (figure 3).

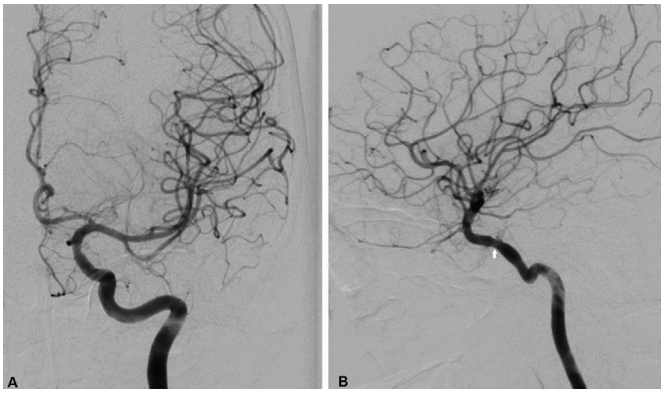

Figure 6 Check digital subtraction angiograms on post-procedure day 3. (A) Left internal carotid artery (ICA) angiogram (anteroposterior view). (B) Left ICA angiogram (lateral view) showing complete reconstruction of the cavernous ICA without any residual fistula and antegrade flow in the left middle cerebral artery and anterior cerebral artery. Mild focal stent stenosis (arrow) is seen at the proximal end of the second flow diverter.

TREATMENT

It was decided to treat the CCF with deployment of the XCalibur AOD across the fistula. It is a balloon mounted microporous polymer membrane covered flow diverter made up of stainless steel. The patient was premedicated with a daily dose of aspirin 150 mg and clopidogrel 75 mg for 5 days.

Right femoral arterial access was made with a 6Fr Neuron MAX 088 guide catheter (Penumbra, California, USA), which was carefully navigated to the left cervical ICA. A 6Fr Navien (eV3) was navigated through the Neuron MAX catheter over a

035 Terumo guide wire (Terumo IS) and parked across the fistula in the clinoidal segment of the left ICA. An XCalibur AOD 3.75×20 mm was taken through the 6Fr Navien over a Traxcess 014 microwire (Microvention) and deployed across the fistula with balloon inflation. Further device expansion was done using a 4.5×25 mm NChant rapid exchange balloon (Merlin MD). After deployment, angiography showed optimal device opening but incomplete wall approximation at the superior aspect of the proximal inflow zone, causing an endoleak. Persistent flow across the fistula was noted with predominantly posterior drainage and reflux into the posterior fossa veins (figure 4).

A decision was then made to deploy an additional XCalibur AOD in an overlapping manner, covering the fistula as well as the endoleak. A second XCalibur AOD of size 4.5×25 mm was deployed with overlapping as intended. An angiogram after deployment of the second device showed sluggish flow across the fistula with reduced posterior fossa venous reflux (figure 5).

It was then decided to perform a check angiogram on post-procedure day 3 to look for resolution or persistence of the fistula.

OUTCOME AND FOLLOW-UP

A check angiogram performed at post-procedure day 3 showed complete exclusion of the fistula due to flow diversion (figure 6). The patient was prescribed oral aspirin 150 mg/day for life and clopidogrel 75 mg/day for 6 months. Clinical and imaging follow-up was suggested after 6 months.

DISCUSSION

Endovascular treatment of direct CCF has undergone evolution over the past few years. In the early days, detachable balloon[3] or ICA sacrifice was the mainstay of treatment.[1] However, since 2004 the detachable balloons have been withdrawn from the market in the USA[4] and transarterial or transvenous embolization using coils or liquid embolic agents (Onyx and Squid) has slowly gained in popularity. The use of covered stents or stent grafts in the treatment of CCF was first reported in 2006.[5] These techniques have been associated with an occlusion failure rate of 12–32%.[1]

Use of a flow diverter as the sole device in the treatment of direct CCF was first reported in 2012 by Nadarajah *et al*.[2] There have been many publications on the treatment of direct CCFs (Barrow type A) using a flow diverter alone or as an adjunct to coils or Onyx embolization. Flow diverters have also been used to treat Barrow type B CCFs[6] and fistulas developing secondary to cavernous ICA aneurysm rupture after flow diverter treatment.[7] In the study by Wendl *et al*[4] only five out of 14 patients could be successfully treated using a flow diverter alone.[4]

In contrast to stent grafts, flow diverters have better flexibility and trackability and hence are easier to deploy, especially in tortuous anatomy. Theoretically, high-flow fistulas may not be possible to treat by the standalone use of flow diverters, considering their analogy with the patency of the side branch after deployment of the flow diverter due to the pressure gradient. However, high coverage of the XCalibur AOD secondary to covered membrane would be the probable reason for fistula exclusion.

To the best of our knowledge, there is no previous published literature on the use of the XCalibur AOD in the treatment of CCF. After Nadarajah *et al*[2] and Wendl *et al*,[4] this will be the seventh case where flow diversion alone has been successfully used in the treatment of direct CCF. This device may provide an effective alternative treatment option for direct CCF. The major disadvantages would be cost and the lifelong requirement for an anticoagulant. A clinical study is required to assess the efficacy and safety of the device.

Learning points

- Flow diverters with high coverage can be used as standalone treatment for direct carotid cavernous fistulas

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