NOVEL TREATMENT OF DIRECT CAROTID CAVERNOUS FISTULA WITH XCALIBUR ANEURYSM OCCLUSION DEVICE: A CASE REPORT

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ABSTRACT
To report a case of post-traumatic direct carotid-cavernous fistula (CCF) treated with Merlin's XCalibur as a standalone treatment. XCalibur is a balloon mounted flow diverter covered with polymer biostable membrane. A single device was deployed across the rent which resulted in the complete exclusion of fistula. This is the second case of its kind to be reported for the treatment of post-traumatic direct CCF with an XCalibur device. The device proved to be effective and safe and did not require any additional coiling, thus this paper has immense value and benefit for the medical community at large as it displays a new technique being successfully used.

Key Words: Traumatic, Fistula, Direct, Sstent, Endovascular, High flow

INTRODUCTION
The idea behind treating a direct CCF is to occlude an arteriovenous shunt while preserving the patency of the concerned internal carotid artery (ICA)

Numerous strategies in the endovascular realm have been attempted in the last thirty years in a bid to gear the size and location of fistulous points while simultaneously ensuring venous outflow patterns.

In the past strategies included transvenous or transarterial access routes with detachable balloons, covered stents, coils, and liquid embolic agents. (1)

Transarterial embolization with flow diversion presents an alternative option that is possible and can be used in conjunction with coiling or even potentially standalone treatment method. (2)

In this case, we endeavor to evaluate the experience we had using membrane coated /covered stent (XCalibur Merlin MD) for endovascular treatment of direct CCF. To the best of the author's knowledge, this is just the second publication using XCalibur alone for the treatment of a direct CCF.

CASE DESCRIPTION
A 36-year-old man was referred to our institution complaining of pain in the right eye and displaying redness and swelling for over 2 months. There was no history given of nausea or vomiting but he did complain of having mild blurring of vision, double vision, and severe headaches in the past 2 weeks. A detailed history showed he had suffered a traumatic injury. An electrician by profession he had been electrocuted, receiving a head injury in the process that involved frontal skull fractures,

and resulted in an epidural hematoma with intracerebral hemorrhage. Additionally, he suffered burns and bone injuries on his extremities.

The patient got traditional treatment and was discharged from the local medical clinic following the relief of symptoms. He later developed further symptoms in his right eye 2 months later; this included redness, swelling, a blurring of vision, and visual decline in the right eye. There was no associated history of hypertension, diabetes, or any other infectious disease.

On examination, his visual equity was counting fingers in the right eye and 6/6 in the left. The intraocular pressure in the affected eye was 26mmHg and in the contralateral eye was 16mmHg. On physical examination, the right eye exhibited proptosis up to 23mm, mild ptosis, chemosis, eyelid swelling, and corkscrew hyperemia centered around the cornea. Left eye proptosis was 18mm. Furthermore, there was a slight restriction of movements in abduction and elevation. However, depression and adduction were normal. The left eye was unremarkable. Corneal reflex was intact in both eyes. The vitreous and lenses were clear. Fundoscopic examination showed there was no disc swelling or hemorrhages in either eye. Glaucoma was also ruled out.

INVESTIGATIONS

The MRI of the periorbital locale uncovered a dilatation of the right superior ophthalmic vein, slight thickening of the right lateral rectus muscle, and preseptal swelling. The neurological assessment was unremarkable aside from a periorbital bruit on the affected eye. The diagnosis of traumatic direct type of CCF was made and the patient was sent to the neuro-interventional department.

Investigation included MRI with orbital protocol which showed the right superior ophthalmic vein dilatation with preseptal swelling and thickening of the right lateral rectus muscle. Neurological examination did not reveal anything new except a periorbital bruit on the right side. Thus, a tentative diagnosis of right CCF was made and the patient was sent to a neuro-interventionalist. Digital subtraction angiography was done to identify venous drainage patterns and to plan treatment. The DSA revealed a right direct (post-traumatic) CCF with a fistulous hole involving the anterior genu of the cavernous segment of ICA. The fistula was draining superiorly to the superior ophthalmic vein, angular vein, and common facial vein system, to pterygoid plexus inferiorly and reflux to cortical veins through the superior and inferior petrosal sinuses. Manual cross compression was performed which shows significant contralateral filling. Keeping in view the young age of the patient, we decided to use a membrane-based flow diverter stent, to preserve the parent vessel.

EMBOLIZATION TECHNIQUE

It was decided to treat the CCF with the deployment of XCalibur across the fistula. It is a balloon-expandable device pre-mounted on a balloon delivery catheter. The frame is coated with a porous ultra-thin polymeric film. The film serves to permanently occlude the neck of the aneurysm after deployment.

The patient was premedicated with a daily dose of aspirin 150mg and clopidogrel 75mg for 7 days. The right femoral artery access was made with a 6Fr long sheath Neuron MAX 088 (Penumbra USA) which was navigated up to the cervical segment of the right ICU. A 6Fr distal access catheter Navien (Medtronic USA) was navigated through the Neuron MAX catheter over a 035 guidewire and placed above the fistula at the cerebral segment of the right ICA.

The balloon-expandable stent of size (4.5mm x 15mm) was navigated through the 6 Fr guider over a Trexxas 014 microwire (Microvention) and deployed across the fistulous hole covering the rent with inflation of the balloon. The non-compliant balloon attached at the distal end of the catheter is designed to inflate the device to a controlled diameter at a given pressure.

After deployment, angiography showed significant device opening but an incomplete wall approximation at the inferior aspect causing an endoleak. Further, device expansion was done using an NChant rapid exchange balloon of size (4.75mm x 7mm). It was a non-compliant post-dilatation balloon used for post-deployment dilation of XCalibur AOD. Control angiogram after post-deployment dilation with the balloon showed complete obliteration of the fistula.

Position of neuron guiding catheter and long 6 Fr sheath, Traxcess microwire visualized at right MCA distally, deployment balloon over which the flow diverter is mounted showing proximal and distal markers, flow diverter is also showing proximal and distal marker, post balloon angioplasty image showing complete expansion of device with no endoleak.

Immediate angiogram after deployment of XCalibur AOD in arterial and venous phase showing complete obliteration of fistula with delayed stasis in venous phase

OUTCOME AND FOLLOW UP

The patient was discharged on the third postoperative day and was continued with dual antiplatelets. A Follow-up angiogram to be performed after 6 months of the initial procedure showed complete exclusion of the fistula due to flow diversion. Clinically there was complete resolution of symptoms and the bruit had disappeared. The proptosis was 18mm in both eyes. The vision was improved from counting fingers. The eye movements were normal in all dimensions in the affected eye. Clopidogrel was stopped at 6 months and oral aspirin was prescribed for life.

DISCUSSION

Endovascular treatment of direct CCF has undergone an evolution over the past few years. The aim of treatment in direct CCFs is occlusion of tear between the ICA and the cavernous sinus while simultaneously keeping the ICA patent. (2)

The ideal method of occlusion of a fistula in the early days used to be arterial embolization using detachable balloons or the sacrificing of the parent artery if a defect was too large. (3) Balloons gained popularity in the early days but were unexpectedly withdrawn from the market in 2004. The transvenous or transarterial access routes used covered stents, coils, and liquid embolic agents and evolved as newer modalities came to the forefront. (1) Flow Diverting devices are intended for the treatment of complex cerebral aneurysms yet strategies and indications for FD keeps on advancing. As of late published case reports indicated promising outcomes for the treatment of direct CCF with FD. (1) Over time its off-label indications have extended to incorporate carotid-cavernous fistulas (CCFs). (4) Case reports being published these days show promise with varied treatment modalities of diCCF with the use of flow diverters. (1)

Mahendran Nadarajah et al in their work described the first-ever case of a direct CCF treated solely with flow-diverting stents in 2012. (5) There are several cases described in the publications where direct CCF are treated with FD stent deployed inside the injured internal carotid artery and coils set inside the large sinus. (6) Various cases have in literature pointed to a direct CCF being treated with FD stent placement within the injured region of the carotid artery and coils being placed on the cavernous sinus. (6). Other studies demonstrate the intraprocedural direct CCF that developed immediately after flow diversion for the treatment of asymptomatic paraclinoid right internal carotid artery aneurysm and the use of another FD to close the fistula. (7) Further studies show that intraprocedural direct CCF were developed immediately after the flow diversion technique took hold and asymptomatic paraclinoid right internal carotid artery aneurysms were being treated with another FD to close the fistula. (7) The flow diverter is also used in those cases of Barrow type 'B' CCFs that have no vascular access (neither venous nor arterial). (8) Flow diverters have better flexibility and are easy to navigate in tortuous anatomy, hence they can be deployed easily. However, theoretically high flow fistulas cannot be treated alone by flow diverters due to patency of side branches, therefore several FD layers, additional venous coil occlusion, and embolization with liquid embolic agents is needed as adjuncts. Complete obliteration of a direct CCF may take a long time and long-term double antiplatelet therapy is mandatory. (1) On the contrary, XCalibur is a single device treatment, there is no need for coiling support. The point is to build metallic coverage and limit porosity in tear at the ICA segment with fistulous communication. The XCalibur AOD has a metallic coverage of roughly 65% (9) (10) in comparison to 10-20% of others, and hence it works properly.

Additionally, the device contains a biocompatible polymer membrane, and does not get absorbed but instead endothelized. The fundamental downside to this strategy, as other FD stents, is the requirement for double antiplatelet treatment because of the danger of in-stent thrombosis. This should be adjusted against the danger of further hemorrhage with regards to a CCF.

Declaration of Conflict of Interest

The author(s) declare that they do not have any potential conflicts of interest concerning the research, authorship, and/or publication of this article with Merlin MD Pte Ltd.

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FIGURE LEGENDS

Figure 1: Pre and post-procedure images demonstrating the reduction in redness and swelling of the right eye.

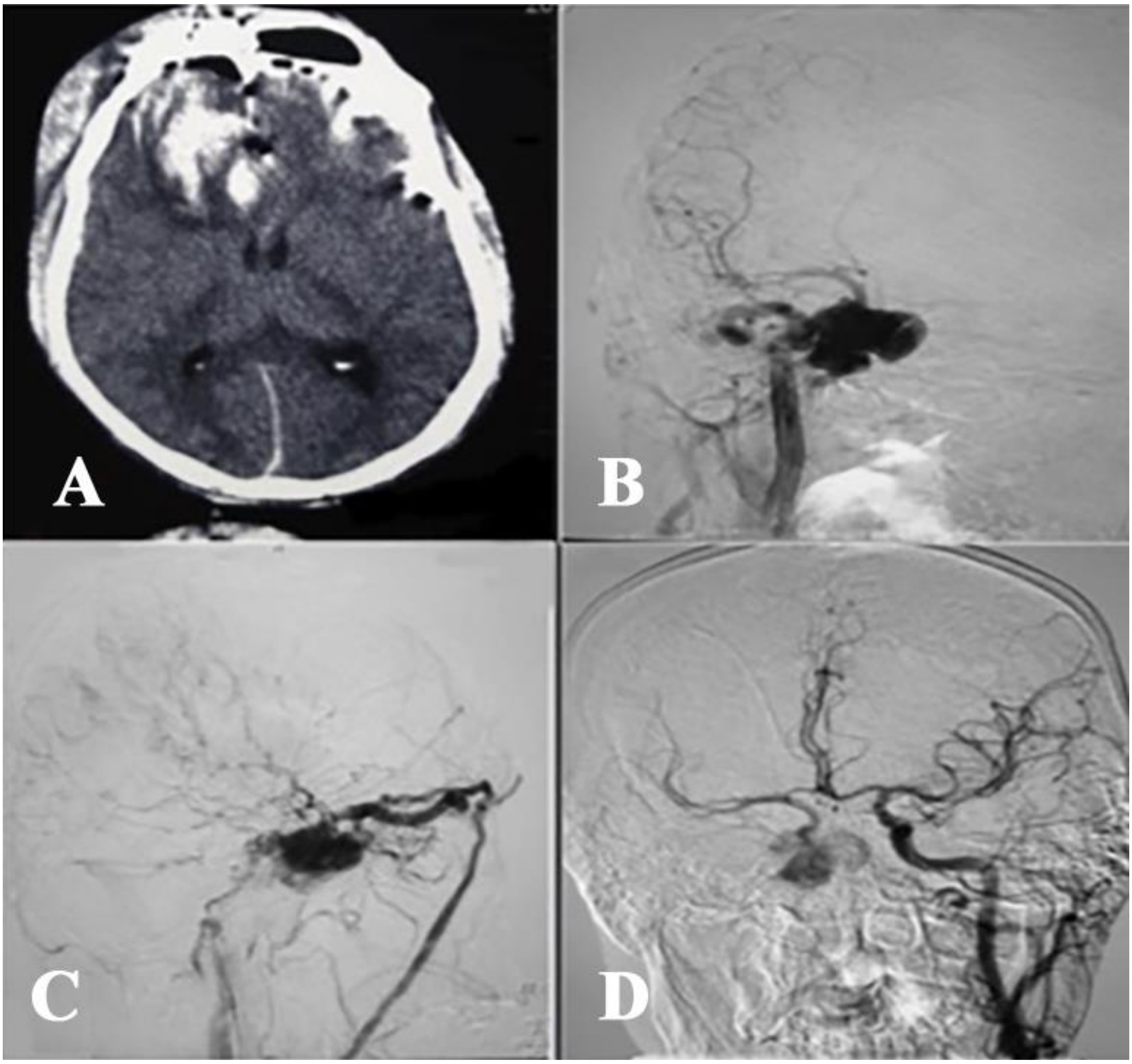

Figure 2: A) NCCT head axial section showing right frontotemporal epidural hematoma and intraparenchymal hemorrhage done 2 months before endovascular treatment. B-C) Diagnostic angiogram of right ICA showing right high flow CCF draining into superior ophthalmic vein and facial vein system. D) Diagnostic angiogram of left ICA (cross compression) showing filling of fistula from contralateral ICA.

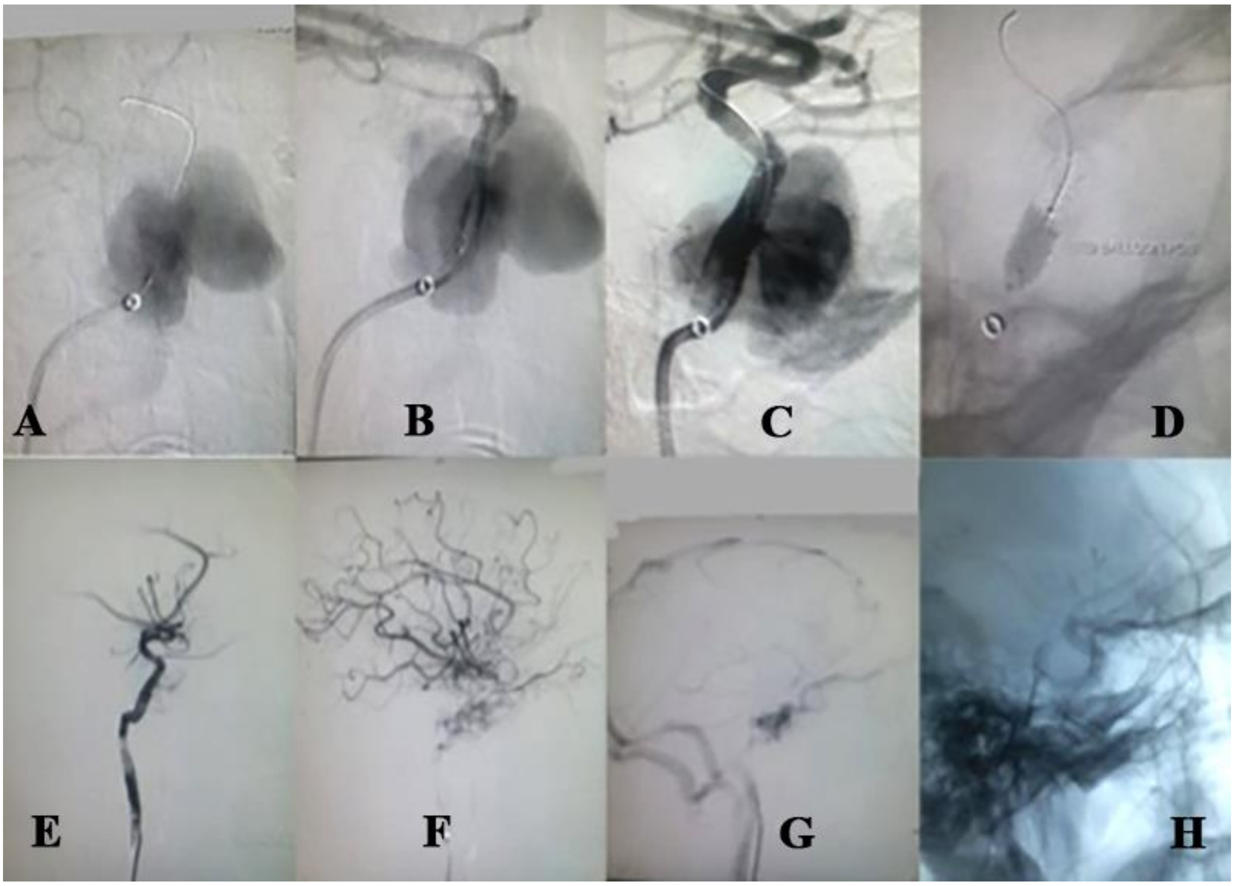

Figure 3: (A-B-C-D) Intraprocedural and post procedural (E-F–G-H) angiograms

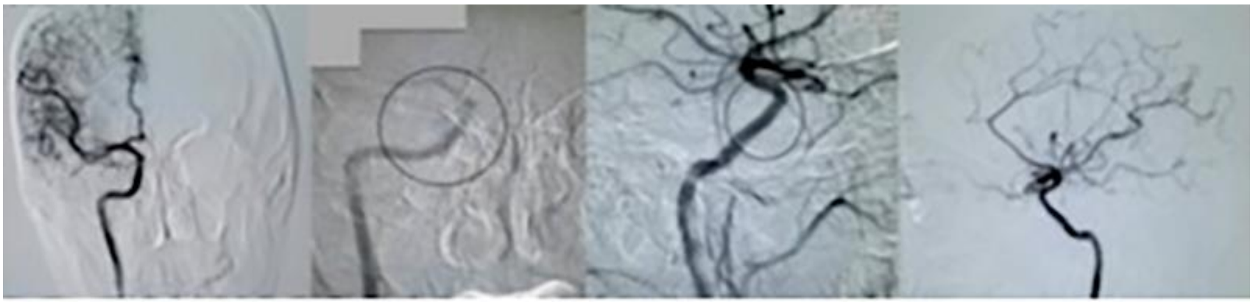

Figure 4: Follow up angiogram (right ICA, left ICA) after 6 months interval showing complete obliteration of fistula with no evidence of in-stent thrombosis

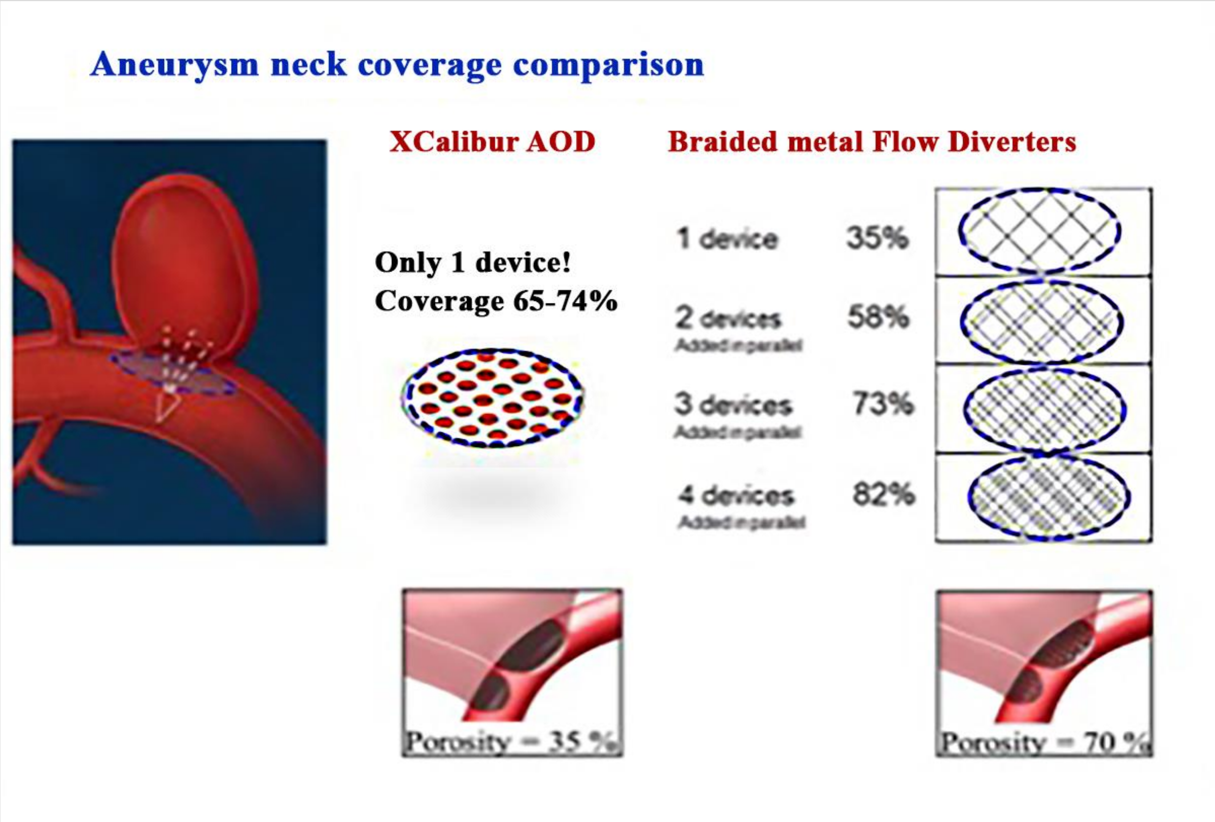

Figure 5: Demonstrating the coverage pattern of XCalibur in comparison to other Flow Diverter (Courtesy of Merlin MD)