Flow-Diverter Devices for endovascular treatment of cerebral aneurysms

Poster No.: C-1693
Congress: ECR 2016
Type: Educational Exhibit
Authors: R. E. Correa Soto, A. Fraino, A. Blazquez Saez, A. Costales Sanchez, D. C. Vargas Jiménez, M. E. Ibarra Hernandez; SALAMANCA/ES
Keywords: Education and training, Aneurysms, Stents, Fluoroscopy, Catheter arteriography, Neuroradiology brain, Interventional vascular, Arteries / Aorta
DOI: 10.1594/ecr2016/C-1693

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

• To review the pathophysiology and clinical presentation of cerebral aneurysms.
• To explain the diagnostic images of cerebral aneurysms.
• To explain and to review the indications, contraindications, interventional method, images, outcomes, complications and timing of controls, of the Flow-Diverter Devices.

Background

For several years, endovascular treatment has been the first-line treatment in the management of both ruptured and unruptured cerebral aneurysms.

Endovascular treatment of intracranial aneurysms by coiling has become an accepted alternative to surgical clipping, with increasing evidence for lower morbidity and mortality rates, especially in clinical equipoise. However, especially in wide-neck, fusiform, dissecting, and giant aneurysms, incomplete coiling and reperfusion are still a major limitation preventing stable long-term occlusion.

Despite technical developments, the endovascular treatment of intracranial aneurysms still has some limitations. It is not always applicable to complex aneurysms such as fusiform aneurysms or very large neck aneurysms, giant aneurysms. These types of are candidates for aneurysm recanalization.

For the last 25 years, endovascular treatment has been focused on filling the aneurysm with coils. However, another approach is possible and theoretically more physiological: parent vessel reconstruction. Flow diverters are dedicated to this type of approach.

Hemodynamic and Biological effects

The goal is primarily to reconstruct the diseased vascular segment harboring the saccular or fusiform aneurysm pouch:

• **Flow redirection**: the flow diverter crosses the aneurysm neck and diverts the blood flow from the aneurysm sac, thus reducing shear stress on the aneurysm wall and promoting intra-aneurysm flow stasis and thrombosis.
This phenomenon is affected by the amount of metal surface area coverage provided by the stent. The pore density of flow diverters, rather than porosity, seems to be a critical factor modulating device efficacy.

- **Tissue over growth:** the flow diverter provides a scaffolding for the development of endothelial and neointimal tissue across the aneurysm neck. As with flow direction, the magnitude of this effect is proportional to the amount of metal surface area coverage.

Flow diverters induce disruption of flow near the aneurysm neck, inducing thrombosis into the aneurysmal sac while preserving physiological flow in the parent vessel and adjacent branches.

These devices allow for reconstruction of the diseased segment by providing a scaffold for neointima formation while diverting flow away from the aneurysm into the parent vessel. This results in aneurysm thrombosis followed by shrinkage of the aneurysm as the clot organizes and retracts.

**Flow Diverters Devices**

The development of flow-diverter stents has offered the potential of aneurysm occlusion through thrombosis triggered by the disruption of flow into the aneurysm sac.

As a key element of construction, these stents have a braided mesh with a densely covered surface.

Once the flow-diverter is expanded to cover the aneurysm neck, thrombosis is induced by stasis of flow within the aneurysmal sac. The porosity of the flow-diverter mesh and the pressure gradient between parent and smaller adjacent branch vessels preserve flow and patency of the latter even if covered.

**Findings and procedure details**

**INDICATIONS**
• Wide neck Saccular aneurysms (fundus-to-neck ratio > 2 or neck diameter > 4mm)
• Fusiform or circumferential aneurysms
• Dissecting aneurysms
• Blister-like aneurysms
• Large (10-25 mm) and Giant aneurysms (# 25 mm) or those presenting with mass effect
• Incorporation of side branches
• Post-treatment recanalization
• Incomplete coiling and reperfusion of the aneurysm
• Recurrent aneurysm
• In very small aneurysm untreatable by standard coiling technique

**INTERVENTIONAL METHOD**

Transfemoral approach with the patient under general anesthesia.

Guiding catheter was introduced through a femoral sheath into the carotid or vertebral artery.

#

Radiologic examination of the target vessel is performed by using a biplane angiographic system and 3D rotational angiography.

#

Flow diverter length was chosen according to the length of the aneurysm neck with the procedural goal to ensure arterial wall coverage with the inner mesh extending to at least 2 mm beyond both the distal and proximal limits of the neck.

#

For flow diverter delivery, a microcatheter is navigated past the aneurysm neck with a microguidewire or radiofocus guide wire.

#

Under roadmap guidance, unsheath the flow diverter by slowly withdrawing the delivery microcatheter for 2-3 minutes while the delivery wire is gently pushed on to facilitate complete opening and wall apposition of the flow diverter.
An in-stent percutaneous transluminal angioplasty is performed with a balloon microcatheter if incomplete opening is observed on 2D angiography or 3D.

In those cases in which additional aneurysm coiling is performed, a microcatheter is initially positioned inside the aneurysmal sac followed by jailing of the microcatheter between the parent vessel wall and the flow diverter at deployment.

**ANTICOAGULATION AND ANTIPLATELET THERAPY**

Patients are prepared; with aspirin, 100 mg, and clopidogrel, 75 mg (loading dose of 300 mg), 5 days before treatment.

During the procedure; anticoagulation is initiated with a bolus of standard heparin (70 -100 IU/kg) followed by intravenous administration to maintain an activated clotting time of standard heparin (70 -100 IU/kg) followed by intravenous administration to maintain an activated clotting time of 250 seconds.

After the procedure; a daily dose of clopidogrel (75 mg) and aspirin (100mg) is given for 3 and 6 months, respectively.

Platelet inhibition is tested by using the light transmission aggregometry (LTA) method on the day before or immediately before starting the procedure.

- If according to this test, the patient is considered a non-responder (LTA result of 6), an LTA test with 2-MeS-AMP (selective P2Y12-adenosine diphosphate receptor antagonist) is performed.
- In case of an LTA result with 2-MeS-AMP 5, a pharmacokinetic response is suspected and a reloading dose of clopidogrel (300 mg) is administered.
- In the case of repeated tet failure even after reloading or an LTA result with 2-MeS-AMP 5, pharmacodynamic resistance is assumed and prasugrel is substituted for clopidogrel.

Patient with ruptured aneurysms, tirofiban is administrated intravenously during the endovascular procedure before FD deployment and aspirin and clopidogrel are started after the procedure.
FOLLOW UP

Detailed follow-up examinations were performed with both DSA (Digital subtraction angiography) and MRI imaging at 3 months.

After 6 months, MRI was exclusively performed.

To evaluate thrombosis of the aneurysm and shrinkage of the aneurysm sac, measure the maximum diameters of all lesions on preprocedural MRI images in the axial plane with 2 additional orthogonal planes and compare them with MR imaging at 3 and 6 months.

Aneurysm morphometry on MR imaging categorized into 3 groups:

1) complete or partial decrease
2) stable
3) progressive

COMPLICATIONS

Peri-procedural death or major stroke

Hemorrhages

- Early aneurysm rupture during the latency period or post treatment delayed ruptures.
- Intracerebral hemorrhages

Thromboembolic complications

- Ischemic stroke
• Occlusion of perforating arteries or other side branches, with secondary ischemic complications.

Minor neurologic complications

• Transient ischemic attack
• Small cerebral infarction
• Cranial nerve palsy

Late complications are usually related to device occlusion, although exceptionally delayed hemorrhages have been observed up to 5 months after flow diversion.

Technical complications included inadequate device opposition against the parent artery wall, a factor that may predispose to device thrombosis or late stenosis, and proximal migration of the device with subsequent “diversion” of flow within the aneurysm with resultant delayed rupture.

Images for this section:

Fig. 1: INDICATIONS. MRI, Coronal MIP. Giant aneurysm (30 mm) of right cavernous carotid artery (red arrow).

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
**Fig. 2:** INDICATIONS. Arteriography. Giant aneurysm (32 mm) of right cavernous carotid artery (red arrow). Aneurysm (3 mm) of right carotid artery, immediately above the origin of the ophthalmic artery (yellow arrow).

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
**Fig. 3:** INTERVENTIONAL METHOD. 3D reconstruction. Giant aneurysm (32 mm) of right cavernous carotid artery (red arrow). Aneurysm (3 mm) of right carotid artery, immediately above the origin of the ophthalmic artery (yellow arrow). Virtual Flow-Diverter Device (green arrow).

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
Fig. 4: INTERVENTIONAL METHOD. Arteriography. Giant aneurysm (32 mm) of right cavernous carotid artery (red arrow). Flow-Diverter Device (green arrow). "The sign of the eclipse", the name given to the retention of contrast medium into the aneurysm immediately after placing the Flow-Diverter Device (blue arrow).

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
Fig. 5: INTERVENTIONAL METHOD. 3D reconstruction. Giant aneurysm (30 mm) of right cavernous carotid artery (red arrow). Flow-Diverter Device (green arrow). "The sign of the eclipse", the name given to the retention of contrast medium into the aneurysm immediately after placing the Flow-Diverter Device (blue arrow).

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
**Fig. 6:** FOLLOW UP. Angiography: follow-up 3 months after endovascular treatment with a flow-diverter device (on the right). Complete obliteration of the cavernous aneurysm.

© RADIODIAGNÓSTICO, HOSPITAL CLINICO UNIVERSITARIO SALAMANCA - SALAMANCA/ES
Conclusion

• According to the current series published in the literature, the treatment of intracranial aneurysms with flow diverters is associated with a high rate of complete aneurysm occlusion.

• The Flow Diverter Devices for treatment of difficult-to-treat or otherwise intractable intracranial aneurysms are a safe and effective treatment.

• Long-term durability and safety still remain to be proved by larger series and after prolonged follow-up.

Personal information

References


• Pietro I. D'Urso, MD; Giuseppe Lanzino, MD; Harry J. Cloft, MD, PhD; David F. Kallmes, MD. Flow Diversion for Intracranial Aneurysms A Review. Stroke. 2011;42: 2363-2368.

