CASE REPORT

Advanced digital subtraction angiography and MR fusion imaging protocol applied to accurate placement of flow diverter device

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SUMMARY

In recent years there has been a progressive increase in interventional neuroradiology procedures, partially due to improvements in devices, but also to the simultaneous development of technologies and radiological images. Cone beam CT (Dyna-CT; Siemens) is a method recently used to obtain pseudo CT images from digital subtraction angiography (DSA) with a flat panel detector. Using dedicated software, it is then possible to merge Dyna-CT images with images from a different source. We report here the usefulness of advanced DSA techniques (Syngo-Dyna CT, three-dimensional DSA iPilot) for the treatment of an intracranial aneurysm with a flow diverter device. Merging MR and Dyna-CT images at the end of the procedure proved to be a simple and rapid additional method of verifying the success of the intervention.

BACKGROUND

Since 2009, treatment of cerebral aneurysms with a flow diverter device (FD), with or without platinum coils, has increased greatly.^{1 2} These endovascular devices, when correctly placed within the parent artery (PA) across the aneurysmal neck, reconstruct the lumen vessel to redirect arterial flow, thus facilitating vessel healing by gradual thrombosis of the aneurysmal sac.³ Therefore, in order to obtain the best hemodynamic effect, good vessel wall apposition of the FD is crucial.

We present our experience where the success of the endovascular procedure benefited from the combined use of advance post-processing digital subtraction angiography (DSA) techniques.⁴

CASE PRESENTATION

A 69-year-old woman with a history of hypertension, visual disturbances, and headache was incidentally diagnosed with an unruptured wide neck

aneurysm. Angio-CT and MR angiography (MRA) demonstrated the presence of a left paraophthalmic aneurysm measuring 8 mm in diameter, with a 6 mm neck, close to the origin of the ophthalmic artery (figure 1A, B). After multidisciplinary discussion, endovascular treatment with FD was proposed and, after obtaining the patient's consent, the procedure was successfully performed.

TREATMENT

Following diagnostic intracranial angiography, including Matas maneuver,⁵ under general anesthesia and systemic heparinization, with double antiplatelet therapy for 1 week, pretreatment three-dimensional (3D) DSA of the left internal carotid artery was acquired (Artis Zee, Siemens) using a 6 F Envoy guide catheter (Cordis). The corresponding volume rendering technique was reconstructed (Leonardo workstation; Siemens). The best working position was determined, and measurements of the aneurysm and PA were carefully carried out to correctly size the FD (4×20 Pipeline; Covidien), according to the vascular architecture (figure 1C). The procedure was performed under Syngo-iPilot guidance merged with standard roadmap DSA to provide the best 3D live roadmap visualization during microcatheter navigation and FD positioning (figure 2).

The angiographic controls showed antegrade flow into the PA and contrast medium stagnation in the aneurysmal sac, with no evidence of thromboembolic changes. To precisely demonstrate the appropriate opening of the device along the PA and across the aneurysmal neck, post-treatment Dyna-CT acquisition was performed (figure 3). In addition, to clarify the position of the FD at the level of the tortuous carotid siphon, pretreatment MRA row data images were directly superimposed on the post-treatment Dyna-CT axial images, using an automated

Figure 1 Three-dimensional (3D) time of flight MR, coronal (A), MIP reconstructions (B), and 3D rotational angiography volume rendering technique reconstruction (C) of the left internal carotid artery. The ophthalmic artery origin is close to the aneurysmal neck (arrow). Note pretreatment measurements of the parent artery and the aneurysmal sac.

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Figure 2 Standard intraprocedural native (left), roadmap digital subtraction angiography (center), overlapped with Syngo in space three-dimensional (3D) rotational angiography (right), utilizing the Syngo-iPilot system, allows a more accurate live 3D intravascular navigation during the release of the flow diverter device (FD). Distally, the microwire extends above the tip of the microcatheter (arrow) inside the middle cerebral artery. The FD, slightly radio-opaque, is progressing within the microcatheter, still unsheathed (arrowheads).

Figure 3 Post-treatment Syngo-Dyna CT, oblique volume rendering technique reconstruction, showing the flow diverter device well deployed across the aneurysmal neck inside the parent artery, covering the ophthalmic artery origin. The aneurysmal sac is faintly opacified by contrast stagnation (arrows).

post-processing program (Syngo-InSpace-3D/3D-Fusion; Siemens).⁶ Good apposition of the FD and the precise relationship between the aneurysmal neck, ophthalmic artery, and nerve were demonstrated in the same setting (figure 4).

DSA follow-up after 6 months showed complete aneurysm disappearance with preservation of antegrade flow in the ophthalmic artery (figure 5). The patient remains asymptomatic.

DISCUSSION

To our knowledge, this is the first case report in which MRA and DSA (Dyna-CT) fusion were performed successfully during endovascular treatment for intracranial aneurysm.⁷ All of the technological advances introduced into the neurointerventional field in recent years can be usefully employed in the treatment of brain aneurysms.⁸⁻⁹ At the time of diagnostic evaluation and treatment preparation, adding 3D acquisition to standard DSA allows more precise planning of the treatment strategy. Studying the vessel architecture with accurate measurements of angle and length is essential in identifying the following: (1) arterial approach (including a tri-axial system for tortuous anatomy); (2) correct device (coils alone, stent and coils, multiple stents, flow diverters, or a combination); and (3) possible working projections. Potential technical complications can also be evaluated and preventive measures taken into account.

During the procedure, 3D roadmap can provide an additional tool for assessing intravascular navigation and device deployment. This technology provides accurate superimposition and fading between a live fluoroscopic image and its matching two-dimensional projection of the 3D dataset, contributing to more live anatomic information on one additional display.¹⁰ At the end of the procedure, Dyna-CT imaging without contrast represents a convenient and easy to use adjunct to traditional DSA.⁴

At present, the system offers contrast and spatial resolution that are comparable with conventional CT, and therefore are adapted to rule out any possible neuroendovascular procedural complication (eg, subarachnoid or intraparenchymal hemorrhage).⁹ Moreover, Dyna-CT performed during injection of low dose contrast medium can give vital information about the

Figure 4 Corresponding axial images of pretreatment time of flight angio-MR (A) and post-treatment Syngo-Dyna CT (B) at the level of caudal edge of the aneurysmal neck. The image obtained by the fusion process between the two techniques (C) enhanced the anatomical relationship between the device and the surrounding anatomical structures. Note the excellent visualization of the ophthalmic artery (arrow in A and C), and of the flow diverter device, highly radiolucent, fully deployed (B, C).

Figure 5 Six month follow-up digital subtraction angiography shows complete occlusion of the para-opthalmic aneurysm with normal opacification of both the ophthalmic (arrows) and the parent arteries.

result of the procedure, such as FD opening, as well as the relationship with the vessel wall and aneurysmal neck.⁴

Despite the obvious advantages, some limitations remain intrinsic to the technique. The soft tissue of the brain is poorly distinguishable and recognizable with the DSA and Dyna-CT techniques. For this reason, we decided to add MR resolution by merging the Dyna-CT images with the MRA data. The final result allows visualization of the stent simultaneously with the anatomical structures that are better appreciated by resonance images (ie, ophthalmic nerve and carotid cavernous sinus), with a possible 360° angle rotation in the whole spatial plane.

CONCLUSION

In standard practice, we routinely perform pretreatment 3D DSA and final Dyna-CT with or without low dose contrast medium. In selected cases, such as this one, we add diagnostic value using multimodality fusion techniques. We believe that this approach can increasingly contribute to improving case management for neuroendovascular therapy.

Learning points

- For endovascular intracranial aneurysmal cure, in order to obtain the best hemodynamic effect, good vessel wall apposition of the flow diverter device (FD) is crucial.
- The procedure performed under Syngo-iPilot guidance merged with standard roadmap digital subtraction angiography (DSA) provides excellent three-dimensional live roadmap visualization during microcatheter navigation and FD positioning.
- The pseudo-CT images from DSA (Dyna-CT) allow good visualization of the FD after the endovascular procedure.
- The advanced DSA-MRI fusion technique enabling simultaneous visualization of FD, vascular structures, and soft tissues, helps to select the best operative approach, increasing the safety of the result.

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Competing interests None.

Patient consent Obtained.

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