Neuroendovascular Treatment Using an Angiography System with the Hi-Def Detector

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The National Cerebral and Cardiovascular Center is one of Japan's leading centers of expertise in the diagnosis and treatment of stroke. The Center continually expands its work to meet the increasing burden of cerebral and cardiovascular diseases in Japan and provide new treatment options. It is also one of the major centers contributing to the Japan Stroke Database.
Requiring additional space and facilities in order to centralize and integrate its resources and expertise, the Center relocated from Kitasenri, Japan, to a new, larger facility in Northern Osaka Health and Biomedical Innovation Town (NohBIT) in 2019. The new facilities include nine catheterization labs, four hybrid operating rooms, and three rooms dedicated to head and neck.
The high-performance angiography systems installed in these rooms support intracranial endovascular procedures, in which it is essential for us to clearly visualize the various interventional devices used.
This report describes our clinical experiences with use of the Alphenix Biplane system (INFX-8000V, Canon Medical Systems Corporation, Japan) for around 260 cases, and also expresses our opinions on the usefulness of this system for intracranial endovascular treatment.

Enhanced visualization (Alphenix Hi-Def Detector)

It has become increasingly important to ensure that the many new devices used in neuroendovascular procedures are clearly visualized, as well as the more familiar devices employed in conventional coil embolization. In April 2015, three related medical societies (the Japan Stroke Society, the Japan Neurosurgical Society, and the Japanese Society for Neuroendovascular Therapy) established guidelines for flow diverter (FD) treatment of intracranial aneurysms. These guidelines state that, in order to ensure safe placement of an FD, it must be clearly visible in X-ray fluorographic images, and it is therefore recommended that the facility have a high-performance angiography system.
The Alphenix Biplane system installed at our facility is equipped with the Hi-Def Detector. The outstanding spatial resolution of this system allows us to clearly visualize coil behavior, stent struts, and FD deployment.
This report presents several illustrative clinical cases. Please refer to the following report for more detailed technical descriptions.

Case 1

Neck bridge stent-assisted embolization of an unruptured intracranial aneurysm

The working angle (WA) was determined by 3D-Digital Subtraction Angiography (DSA) imaging of the unruptured aneurysm of the left internal carotid artery (Figure 1A). Cerebral Aneurysm Analysis (CAA) (Figure 1B) was used as a support tool. This is an easy-to-use tool that supports semiautomatic depiction of the aneurysm and measurement of the dome height/length/width, as well as neck bridge stent sizing. The results of dome measurement were length = 8 mm, height = 5.6 mm, and width = 4.2 mm with a 3.5 mm neck.
It was necessary to deploy the stent from the origin of the anterior choroidal artery to C3-4 (Fischer's classification), and an LVIS (4.0 mm × 17 mm; Terumo Corporation, Japan) was, therefore, selected. The procedure was performed using the jailing technique,[1]) in which the microcatheter for embolization is introduced into the aneurysm before placement of the LVIS. An Axium™ Prime Frame (5 mm × 10 mm; Medtronic Japan Co., Ltd., Japan) was used as an anchor for navigating the microcatheter, and the LVIS was then placed.
The fluorographic images acquired using the Hi-Def

Detector allowed us to clearly observe the behavior of the coil and microcatheter, as well as stent deployment through high-resolution images, providing extremely effective support during the procedure (Figures 2A and 2B). Then, using the Alpha CT (cone-beam CT) system, the status of stent deployment and crimping of the mother vessel (Figures 3A and 3B) was confirmed, followed by further coil embolization in the inflow zone of the aneurysm. Treatment was completed with a coil packing density of 28.24%. The presence or absence of intracranial hemorrhage was confirmed by Alpha CT, and the sheath was then removed.

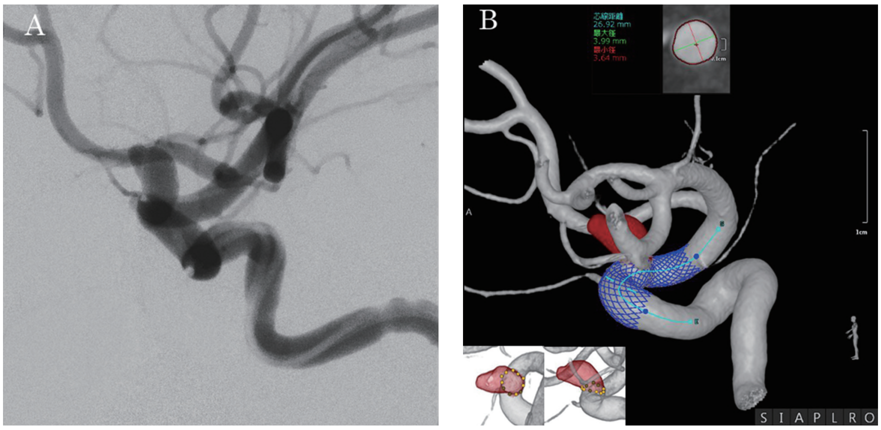


Figure 1A:
Preoperative DSA image of the left internal carotid artery.
Figure 1B:
CAA cerebral aneurysm measurement and stent placement simulation (red: aneurysm, blue: stent, small images at the lower left: neck line editing).

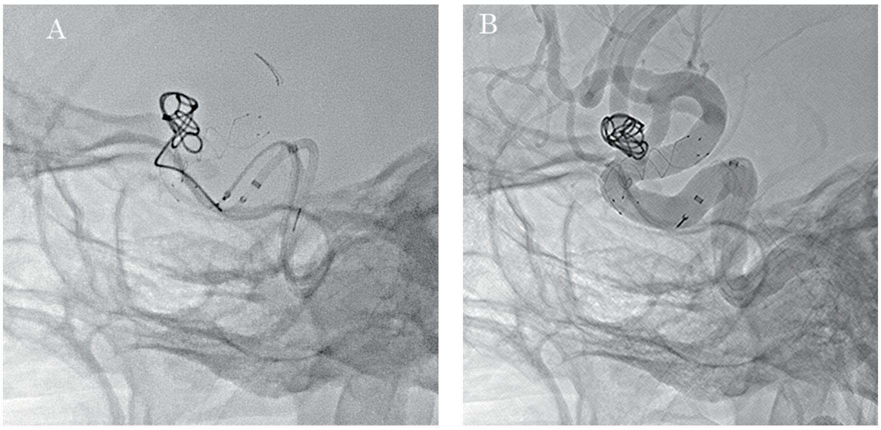


Figure 2A:
Fluorographic image acquired using the Hi-Def Detector (3-inch) during LVIS placement.
Figure 2B:
DSA (native image) during detachment of the Axium PRIME Frame (5 × 10 mm).

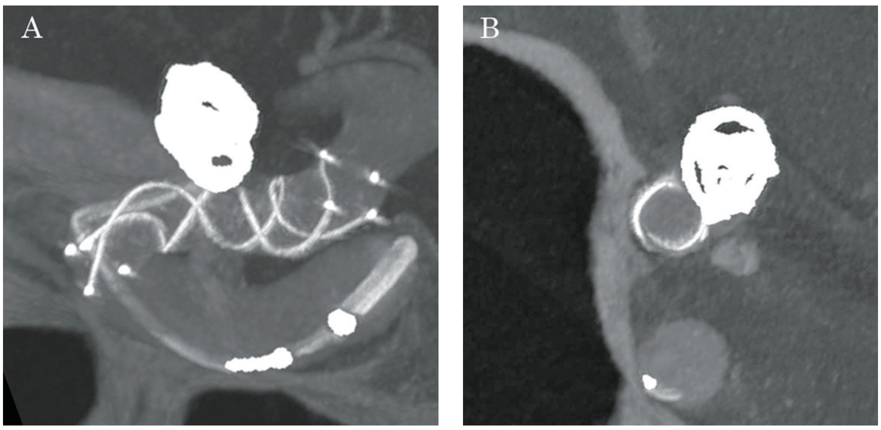


Figure 3A:
Alpha CT multiplanar reconstruction showing the LVIS stent in its entirety
Figure 3B:
Alpha CT multiplanar reconstruction showing a short-axis image of the midpoint of the LVIS stent.

"CAA includes a semiautomatic function that allows the user to perform setting and editing during neckline determination in cerebral aneurysm volume analysis. This is a very useful tool for formulating the optimal treatment strategy."

- Dr. Tetsu Satow, Chief Physician, Department of Neurosurgery.

Case 2

FD treatment of an unruptured aneurysm of the right internal carotid artery

The patient presented with an unruptured aneurysm of the right internal carotid artery (maximum diameter 11.6 mm) and was treated with FD. 3D-DSA imaging was used to determine the WA, and the CAA support tool was used to measure the diameter of the mother vessel (4.26 mm × 4.02 mm at the proximal end, 5.34 mm × 5.0 mm at the midpoint, and 3.71 mm × 3.57 mm at the distal end, with a landing zone of 21 mm) (Figure 4). A Pipeline™ embolization device (PED) (4.75 mm × 16 mm; Medtronic, Japan) was selected based on these measurements, and the aneurysm was treated, while observing Hi-Def Detector fluorographic images (Figures 5A and 5B). The device was deployed from C2 (bifurcation of the posterior communicating artery) to C4, and FD deployment and the crimping status of the mother vessel were confirmed by Alpha CT (Figures 6A and 6B). Poor deployment was observed at the proximal end of the FD (Figures 7A and 7B), and PTA was, therefore, performed. DSA showed a slight eclipse sign. The images were also carefully checked for any missing arteries before treatment was concluded. The sheath was removed after confirmation of the presence or absence of intracranial hemorrhage by Alpha CT.

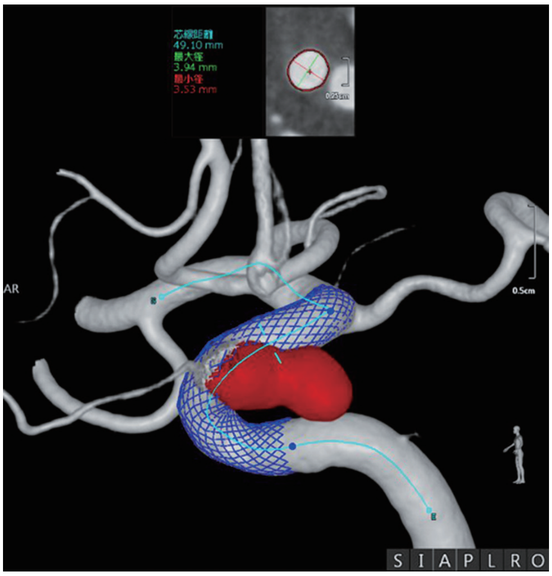


Figure 4: CAA simulation of flow diverter (FD) placement (red: aneurysm, blue: FD).

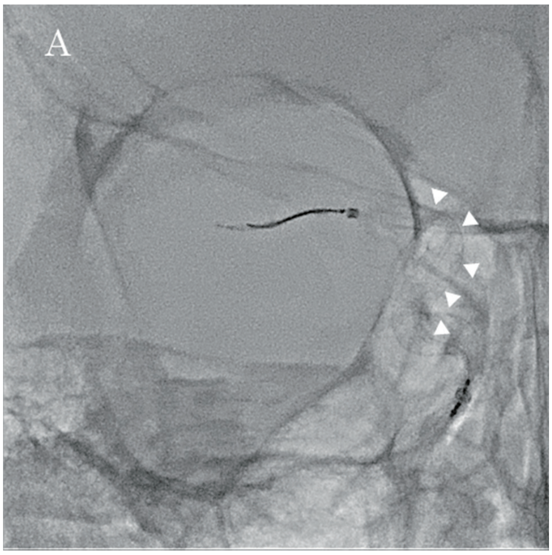


Figure 5A: Frontal fluorographic image acquired using the Hi-Def Detector (3-inch) during FD placement.

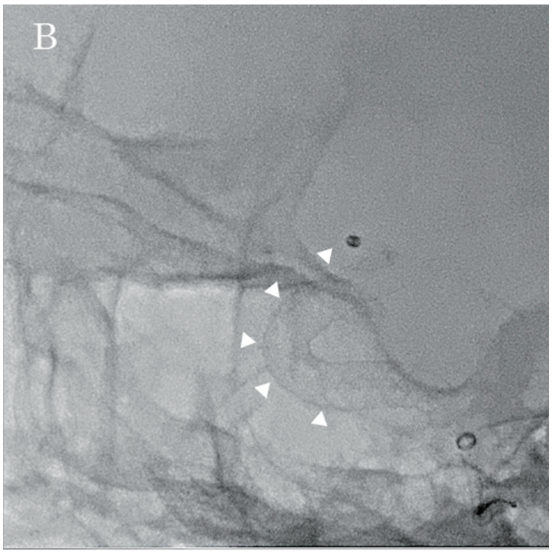


Figure 5B: Lateral fluorographic image acquired using the Hi-Def Detector (3-inch) during FD placement.

> *"One frame digital acquisition (in which plain X-ray images are acquired one at a time) has conventionally been used to check the status of FD deployment. However, acquiring high-definition fluorographic images using the Hi-Def Detector has been found to be extremely effective because it allows continuous visual confirmation."*
>
> *– Dr. Satow.*

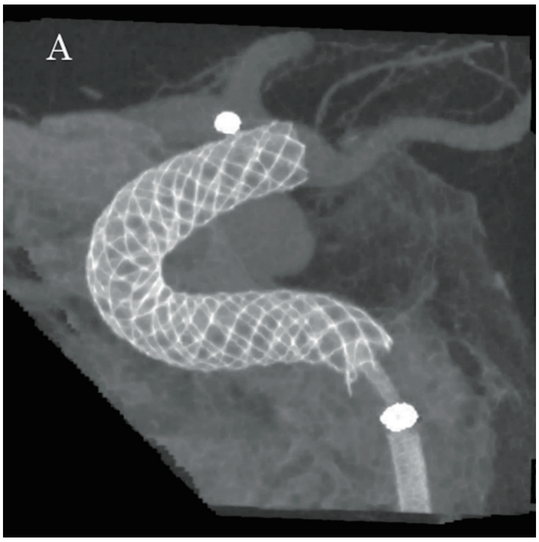


Figure 6A: Alpha CT maximum intensity projection after FD placement.

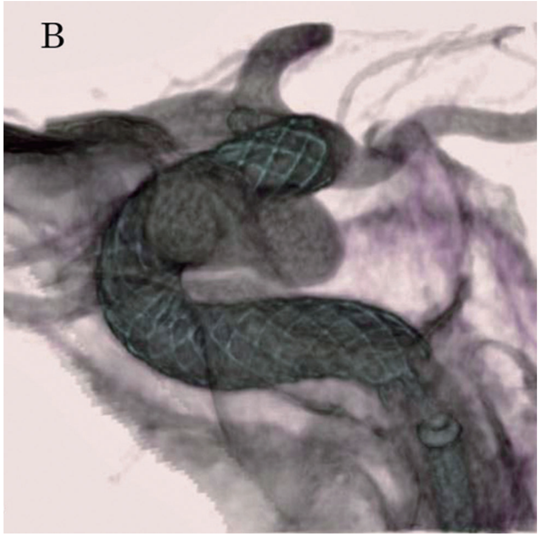


Figure 6B: Alpha CT volume rendering after FD placement.

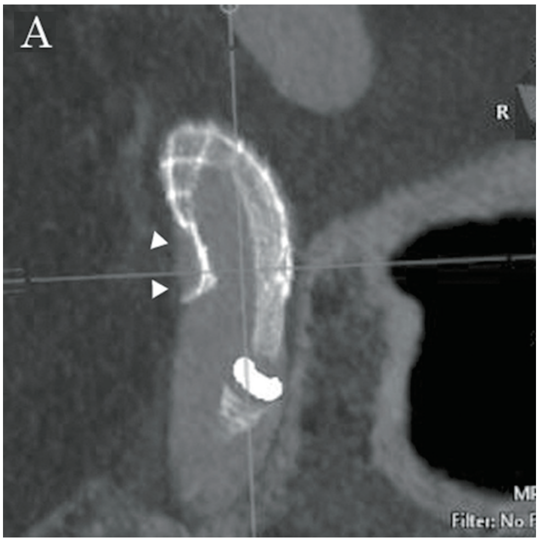


Figure 7A: Alpha CT multiplanar reconstruction after FD placement. Arrowheads: signs of poor deployment (long axis at the proximal end).

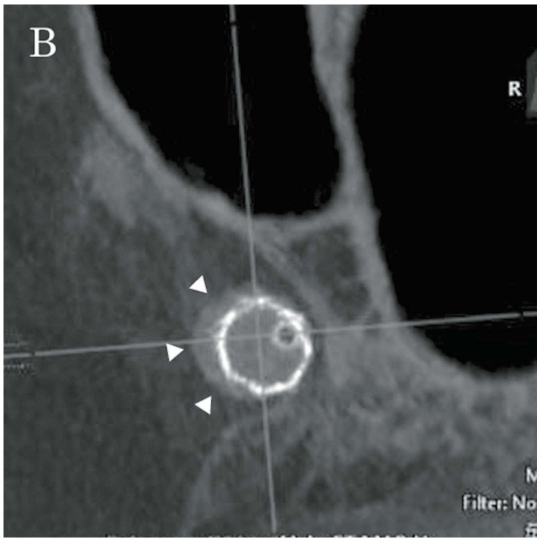


Figure 7B: Alpha CT multiplanar reconstruction after FD placement. Arrowheads: signs of poor deployment (short axis at the proximal end).

Case 3

Transvenous embolization and transarterial embolization of a cavernous sinus dural arteriovenous fistula (CSdAVF)

Before performing transvenous embolization and transarterial embolization of a CSdAVF by superselective shunt occlusion (SSSO)[2], it is essential to identify the shunt point in preoperative DSA images (Figures 8A and 8B).
However, the DSA images need to be checked many times.
A support tool, known as Parametric Imaging (PI), is available to address this issue. PI displays the arrival times of contrast medium in different colors based on the angiographic images and also shows the changes over time (Figures 9A and 9B). However, when using this tool, a certain level of skill is required to understand the direction of blood flow, because the information is displayed as a static image.
A new parametric color coding imaging method (Color Coded Circulation, CCC) (Figures 10A and 10B) allows the changes in color to be observed as a dynamic image, making it easier to understand the direction of blood flow. CCC images can be generated in post-DSA processing, allowing the changes in blood flow to be observed during the procedure. In this case, preoperative DSA clearly demonstrated retrograde flow to the superficial middle cerebral vein (SMCV), and the pouch,

in which the shunts points converged was confirmed by CCC (Figures 10A and 10B, yellow ROI). The feeder was targeted from the left cavernous sinus (CS) and ascending pharyngeal artery (AphA) but could not reached. The feeder of the left middle meningeal artery (MMA) was then packed with coils, and the fistula was obliterated.

AphA was embolized, and then the area through the left CS up to the confluence with the right CS was embolized via the inferior cavernous sinus (ICS). The procedure was completed after confirming antegrade flow in the superior ophthalmic vein (SOV) and SMCV.

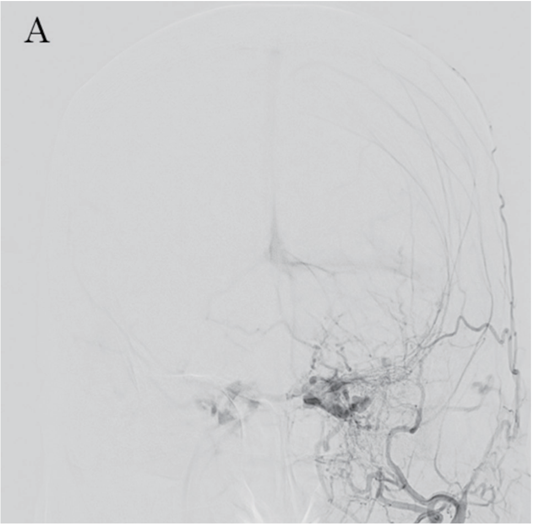


Figure 8A: DSA of CSdAVF, frontal view 1

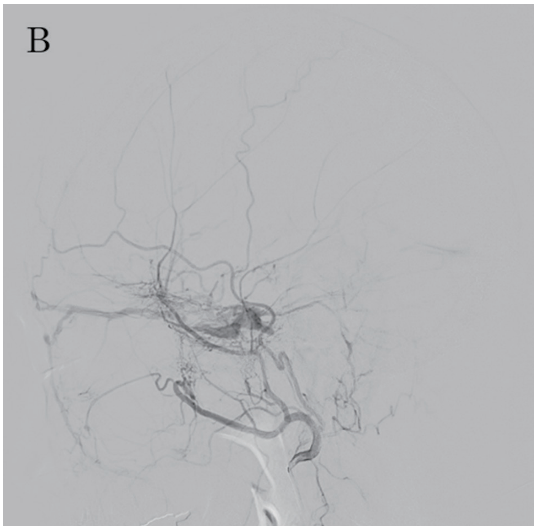


Figure 8B: ADSA of CSdAVF, lateral view.

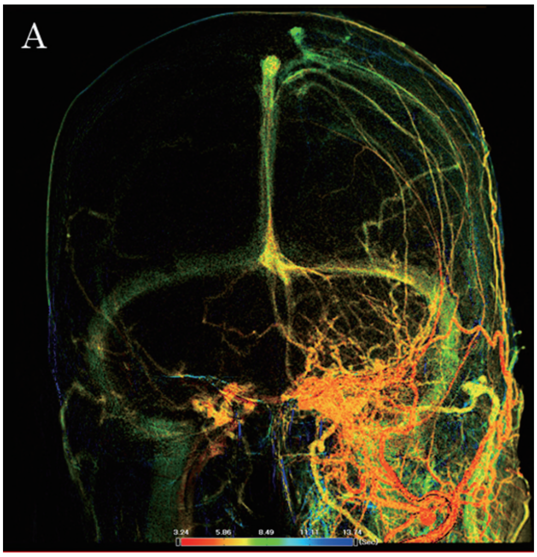


Figure 9A: Time-to-peak image of CSdAVF (frontal view) obtained using Parametric Imaging (PI).

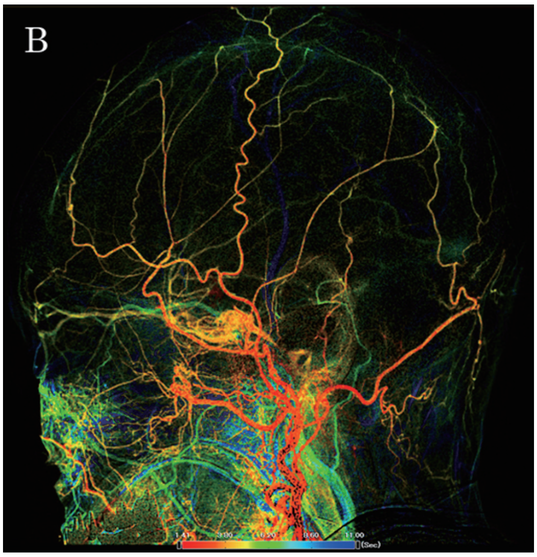
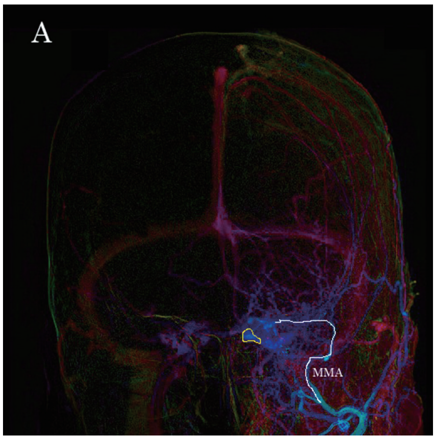


Figure 9B: Time-to-peak image of CSdAVF (lateral view) obtained using Parametric Imaging (PI).

"CCC provides outstanding visual support, and the images can be reconstructed in real-time. As it uses previously acquired DSA images, it does not require any additional contrast medium injection or X-ray exposure. We have found CCC to be extremely useful."

– Dr. Satow.



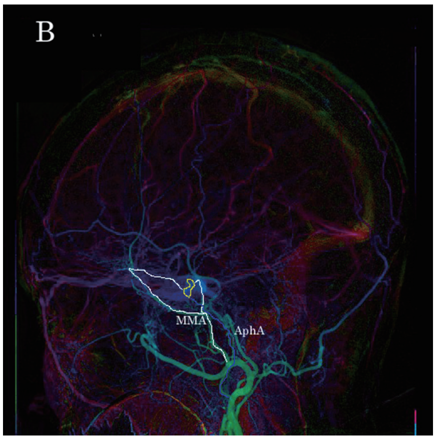
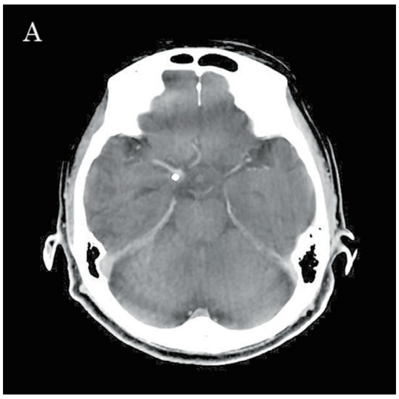


Figure 10A:
Color Coded Circulation image of CSdAVF (frontal view).
Yellow ROI: shunt pouch, white line: MMA – feeder

Figure 10B:
Color Coded Circulation image of CSdAVF (lateral view).
Yellow ROI: shunt pouch, white line: MMA – feeder

Case 4
Head Alpha CT following surgery for an unruptured aneurysm of the right internal carotid artery (at the anterior choroidal artery bifurcation)

CAA measurement of the unruptured aneurysm of the right internal carotid artery showed that the length was 4.6 mm, the height was 3.6 mm, the width was 4.3 mm, and the neck was 3.2 mm. Three coils were used, and the procedure was completed with a coil packing density of 26.27%.
After the presence or absence of intracranial hemorrhage was confirmed by Alpha CT, the sheath was removed.



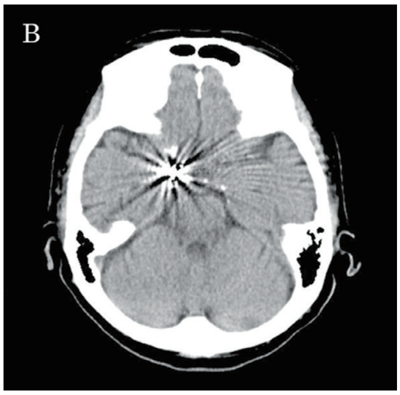


Figure 11A:
Axial Alpha CT image of the head (with MAR).
The presence or absence of intracranial hemorrhage can be confirmed.
Figure 11B:
Follow-up axial CT image of the head (without MAR) 1 day after the procedure.
It is impossible to confirm the presence or absence of hemorrhage around the coil due to the presence of metal artifacts.

"Head Alpha CT permits the presence or absence of intracranial hemorrhage to be confirmed in the catheterization lab. Metal artifact reduction (MAR) is extremely useful for postoperative evaluation. In follow-up examinations, Alpha CT with MAR (Figure 11A) clearly demonstrates its outstanding clinical value as compared to conventional CT without MAR (Figure 11B)."

- Dr. Satow.

Conclusion

Dr. Satow commented the Alphenix is light and nimble in operation and meets all of our hospital's needs.
The Hi-Def imaging is extremely effective for FD treatment and allows procedures to be performed with confidence, while minimizing stress on both operators and patients.

Summarizing our clinical experience with Alphenix
We previously used a biplane system equipped with 19-inch diagonal FPDs for procedures in the head and neck, but the FPDs sometimes interfere with each other when we are setting the WA. This problem is almost completely eliminated when we use our Alphenix with 12-inch FPDs, allowing us much greater flexibility during WA setting.
· When treating patients with shunts, we sometimes find that the entire region of interest cannot be included in the field of view when setting the WA in magnified fluorographic views. The 7-cm vertical movement range and the expanded range of lateral movement with two frontal C-arm axes and a lateral Ω-arm allow us to select more complex WA settings.
· CAA includes a semiautomatic function that allows editing by the user. This is very useful for optimizing treatment strategies.
· CCC makes it easier to identify the shunt points in patients with shunts.
· Alpha CT with MAR is extremely effective, providing precise information for evaluating the status of stents and FDs after deployment and for confirming the presence or absence of intracranial hemorrhage after the procedure.

The Alphenix system has great evolutionary potential and achieves the optimal balance between image quality and X-ray dose. It is an excellent example of Japanese dedication to master craftsmanship. //

References
1 *Sakai N et al. Advanced endovascular procedures for treating intracranial aneurysms. Japanese Journal of Neurosurgery. 2012;21:949-958.*
2 *Satow T et al. Superselective shunt occlusion for the treatment of cavernous sinus dural arteriovenous fistulae. Neurosurgery. 2013 Sep;73(1 Suppl Operative):ons100-5.*

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