# Vascular

## Clinical Experience Using Shimadzu's Latest Bi-Plane Angiography System for Cerebral Interventional Procedure
### —Focusing on Exposure Reduction—

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## 1. Hospital Description

Yamaguchi University Hospital is located in south-west Yamaguchi Prefecture, facing the Seto Inland Sea in Ube City. First founded in 1944 as Yamaguchi Prefectural Medical School, the hospital currently holds 736 beds, and 29 clinical divisions and 23 central clinical facilities. Yamaguchi University Hospital is the only "advanced treatment hospital" in Yamaguchi Prefecture capable of comprehensive diagnosis and procedure of diseases in all fields of medicine **(Fig. 1)**. The Department of Neurosurgery at Yamaguchi University Hospital encompasses all subspecialties of neurosurgery, and performs a central role in the diagnosis and procedure of stroke in Yamaguchi Prefecture. Geographically, most of the small- and middle-sized cities in Yamaguchi Prefecture are located facing the Seto Inland Sea, with other cities scattered inland and on the coast of the Sea of Japan. Large areas of Yamaguchi Prefecture do not have a hospital with a full-time neurosurgeon, and one of the distinctive features of the Department of Neurosurgery at Yamaguchi University Hospital is its work in telemedicine. The department started taking consultations by phone in the year 2000, and currently uses a Telestroke Advance (TELESA) system **(Fig. 2)** to receive image-based consultations for emergency patients by mobile phone from regional hospitals. Yamaguchi University Hospital also started operating a "DocHeli" air ambulance service in 2013. In cases of severe cerebral infarction, we evaluate whether intravenous rt-PA therapy is applicable or not by using Telestroke. If it is applicable, intravenous rt-PA therapy is started at the regional hospital and we actively implement a "Drip-ship" approach with DocHeli to transfer the patient to our hospital. Upon arrival at our hospital, patients are quickly carried to a cerebral angiography room **(Fig. 3)** where thrombectomy therapy is performed.

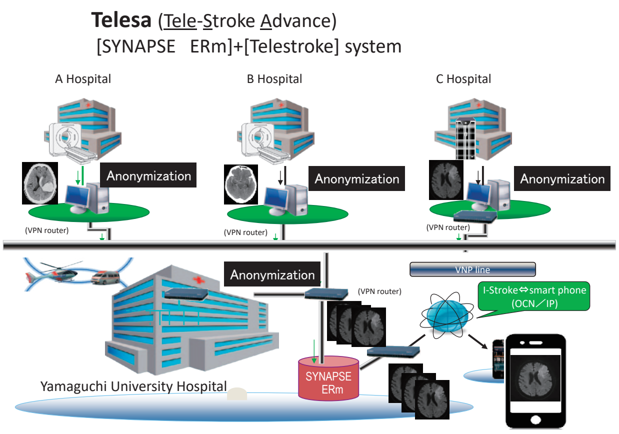



**Fig.2** TELESA Remote Diagnostic Imaging System

**Fig.1** Yamaguchi University Hospital

**Fig.3** Shimadzu 12-Inch Bi-Plane System in Cerebral Angiography Room

## 2. Power of the Telestroke Network

Intravenous rt-PA therapy is an important procedure for hyperacute-stage cerebral infarction that can improve severe cerebral infarction dramatically. However, the potent thrombolytic effect of this therapy comes with a risk of hemorrhagic complications, and determining whether intravenous rt-PA therapy is performed requires specialist knowledge and image diagnosis. As a result, intravenous rt-PA therapy is not performed in regional hospitals where there are no stroke care doctors, and intravenous rt-PA therapy is reportedly used in only 5 % of patients with acute-stage cerebral infarction nationwide in Japan. Telestroke can be the solution to this problem. Intravenous rt-PA therapy can be implemented even at remote regional hospitals by transferring imaging information and simple clinical information about a case to stroke care specialists, who then provide instructions on intravenous rt-PA therapy based on an evaluation of the case. In the USA and Europe, implementation of intravenous rt-PA therapy by Telestroke is reported to be safe, and introducing Telestroke has been shown to increase the implementation rate for intravenous rt-PA therapy. Use of Telestroke has also spread to the "drip-ship" approach, whereby patients with severe cerebral infarction who are determined to require cerebral interventional procedure are transported to our hospital while receiving intravenous rt-PA therapy **(Fig. 4)**. This has increased the chances of regional residents, who were previously unable to benefit from rt-PA therapy, being able to receive hyperacute-stage cerebral interventional procedure.

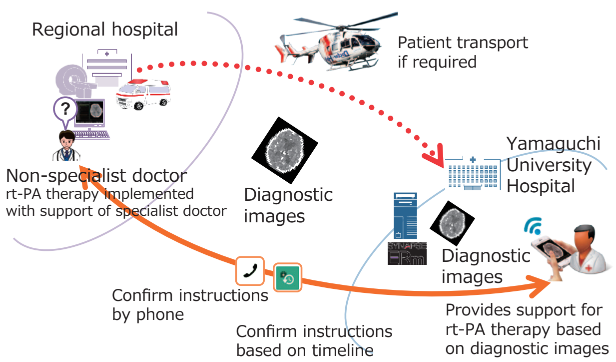



Fig.4 Telestroke Network

## 3. Reducing Radiation Exposure

Thrombectomy therapy has been demonstrated to be effective for hyperacute-stage cerebral infarction, and is playing an increasingly major role in cerebral interventional procedure. Although the minimally invasive aspect of cerebral interventional procedure is emphasized, craniotomy procedures are substantially less risky in some circumstances, so the saying "safety first" is very relevant for these procedures. As operators, we may be attracted to the quality of angiography images, but the ultimate aim of procedure remains how we can send the patient home safely.

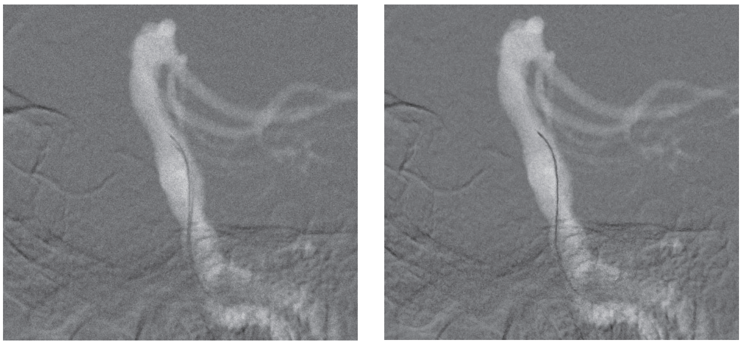
Cerebral interventional procedure involves extended fluoroscopy times and a large number of acquisitions, so reducing exposure is an important topic both for patients and for us as operators. We must therefore always implement basic radiation exposure reduction practices, such as being aware of field-of-view sizes and fluoroscopy times, and having the FPD as close to the patient as possible. The cover assembly on the 12 × 12 inch FPD built into Shimadzu's angiography system is designed to be extremely compact, so the FPD can easily be positioned close to the patient even with the C-arm at an angle. This makes the system very easy to manipulate for the operator. Shimadzu's SCORE PRO Advance radiation exposure reduction technology also achieves an unprecedented and dramatic reduction in radiation exposure.

## 4. Radiation Exposure Reduction Technology SCORE PRO Advance

Conventional recursive filtering of fluoroscopy images has reduced background noise by utilizing a preceding noisy frame. This method is effective for bones and other anatomical structures that do not move, but with moving objects such as guide wires, this method results in image lag that reduces visibility.

SCORE PRO Advance improves the visibility of these kinds of moving objects. SCORE PRO Advance performs motion tracking processing **(Fig. 5)** that involves accurate recognition of the target object in each frame (pattern extraction), and correction for frame-to-frame differences caused by target object movement. This provides noise reduction by applying integration processing to each frame in chronological order, and allowing for proper implementation of procedure even at low fluoroscopy rates of 7.5 pps. Using the "Low mode" with a thick filter built-in collimator also reduces exposure by 43 % compared to the normal fluoroscopy mode **(Fig. 6)**.

During imaging, SCORE PRO Advance improves the visibility of vessels by extracting and enhancing the line structure components of the image, which



Conventional Recursive Filtering　　Motion Tracking Processing

**Fig.5**

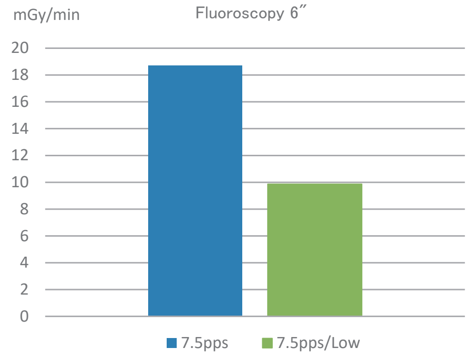



**Fig.6** Comparison of Dose Rates at Patient Exposure Point with Acrylic 20 cm and SID100 cm

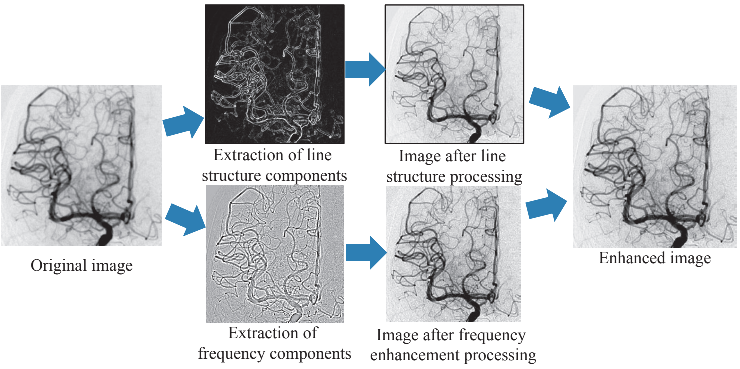



**Fig.7** Outline of Acquired Image Processing

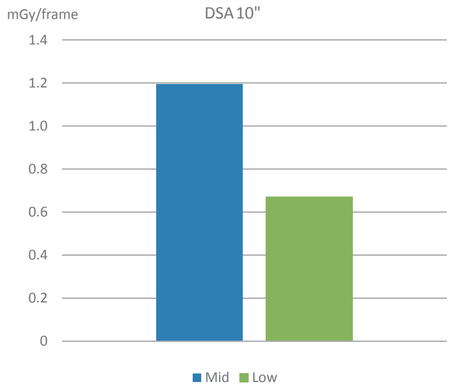
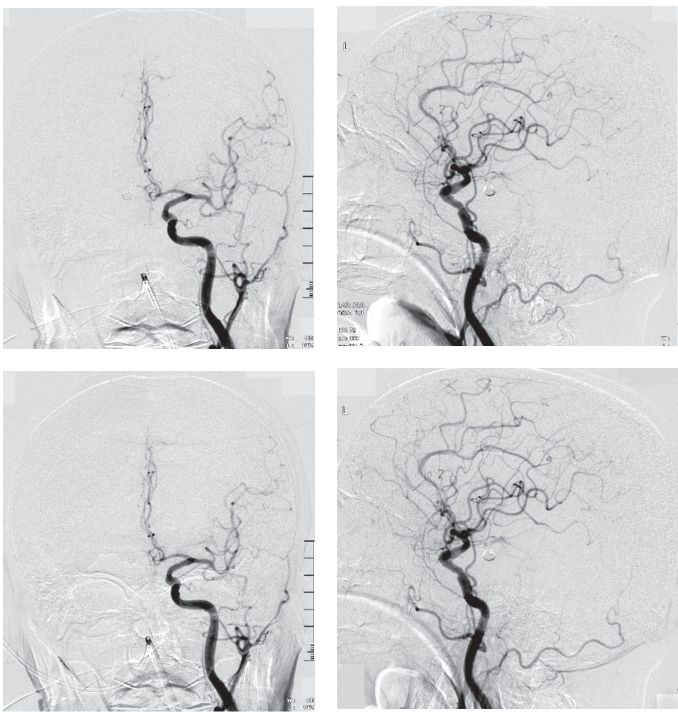


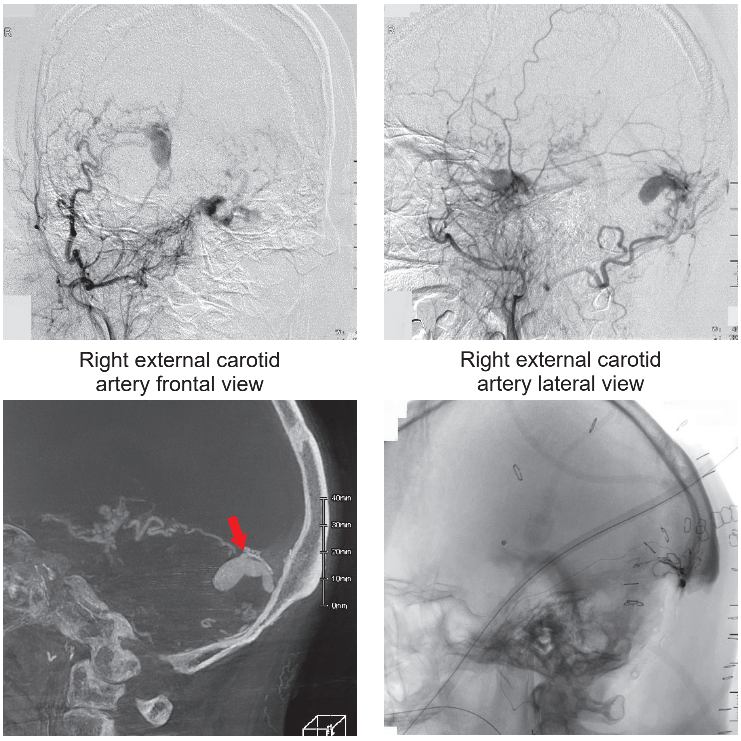

**Fig.8** Comparison of Normal Mode and Low Mode Exposures



Normal mode

Low mode

**Fig.9** Comparison of Normal Mode and Low Mode Images



Right external carotid artery frontal view

Right external carotid artery lateral view

Cone Beam MIP image
Arrow: shunt point

Shunt point obstruction with liquid embolic agent introduced from middle meningeal artery

**Fig.10**
Dural Arteriovenous Fistula That Developed due to Cerebellar Hemorrhage
Arteriovenous shunting revealed in cavernous sinus and cerebellar tentorium

are vessels injected with contrast media, while simultaneously performing frequency enhancement processing **(Fig. 7)**. This results in a dose/single pulse in low mode DSA that is 44 % below middle mode DSA **(Fig. 8)**. For normal imaging, this technology results in almost no difference between the DSA images obtained in low mode compared to images previously obtained in the normal (middle) mode **(Fig. 9)**. Since using the low mode at our hospital, we have seen exposure doses decrease by approximately 20 to 50 % across all cerebral angiography examinations, including fluoroscopy examinations.

## 5. Cone Beam CT (SCORE CT)

The improved spatial resolution of cone beam CT provided by the new 12-inch bi-plane system has been particularly effective in the procedure of dural arteriovenous fistula. Shunt points are clearly visualized in MIP images on the workstation by acquiring images with 100 % contrast media injected for 20 seconds at 1 mL/second. This is a degree of efficacy we have never seen before, and we expect this technology will significantly advance the procedure of dural arteriovenous fistula. For acute cases with occluded arteriovenous shunting that are difficult to reach intravenously, a radical cure has been obtained in some cases by acquiring the target with cone beam CT, and approaching intra-arterially with a liquid embolic agent **(Fig. 10)**.

## 6. Summary

I have reported on using Telestroke at our hospital and our efforts in reducing radiation exposure of patients. Our new 12-inch bi-plane system with SCORE PRO Advance has resulted in a substantial reduction in radiation exposure without sacrificing image quality. The spatial resolution of cone beam CT has also been improved, and is making a substantial contribution in our approach to cerebellar interventional procedure.