Vascular

3D Imaging Assistance and Reduced Contrast Agent Usage in Stent Graft Interventions. – Using Trinias C16s with SCORE Opera

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1. Introduction

Daini Osaka Police Hospital **(Fig. 1)**, located in Tennoji-Ward, Osaka City, includes the Aorta and Vascular Center, the Limb Salvage and Wound Care Center, the Allergy Center, the Sports Medical Center, and the Eye Center. We also have departments such as Nephrology, Rheumatology, and Departments Hematology. Additionally, the Osaka Police Hospital, which provides advanced acute care, is located 10 minutes away by foot, facilitating close collaboration in regional healthcare. On January 1, 2025, these two hospitals will merge to form a new hospital, Osaka Keisatsu Hospital **(Fig. 2)**, with approximately 660 beds, spanning from the basement to the 8th floor.

Fig. 1 Exterior of Daini Osaka Police Hospital

Fig. 2 Rendering of the New Post-Merger Osaka Keisatsu Hospital

2. System Introduction

In July 2022, Daini Osaka International Medical & Science Center installed a Shimadzu Trinias C16s with SCORE Opera angiography system (hereafter referred to as "Trinias system"), in a hybrid room for aortic stent graft interventions (TEVAR and EVAR), PCI, EVT, and other procedures **(Fig. 3)**. We chose the Trinias system for the following four reasons.:

1. We have confidence in Trinias based on our experience using it in our group hospitals.
2. It is a state-of-the-art system released in April 2022, featuring completely model updated hardware and software, particularly Shimadzu's unique catheterization table.
3. SCORE Opera, the AI-Based image processing engine, can be expected to reduce dosage and produce high-quality images.
4. It can provide clear images even with diluted contrast agent, as mentioned later.

Fig. 3 Trinias in the Hybrid Operating Room

3. Background of Introducing Diluted Contrast Agent

The impetus for attempting a diluted contrast agent with Trinias came from requests by cardiovascular surgeons seeking a way to reduce the amount of contrast agent in EVAR procedures for patients with renal impairment. A multidisciplinary team comprising physicians, nurses, clinical engineers, and radiology technologists conducted a conference and two methods were proposed from the Radiology Technology Section : “diluted contrast agent using the DSA dilution mode” and “3D roadmap support adaptable to the endovascular method.” Additionally, the use of intravascular ultrasound (IVUS) to reduce the number of DSA acquisitions was also considered. Furthermore, we predicted dose reduction by a smaller number of DSA that acquisitions.

4. Diluted Contrast Agent

The gold standard for DSA of the abdominal aorta is to use undiluted contrast media, where the diagnostic performance declines if the contrast is diluted.

However, using the DSA dilution mode can maintain good diagnostic capability even with a diluted contrast agent.

The DSA dilution mode maintains the same dose levels as the conventional DSA mode but emphasizes image contrast. While higher image contrast increases noise (mainly from misregistration artifacts due to movement), we suppress respiration with general anesthesia. Additionally, noise from steep C-arm angles does not affect diagnostic performance due to our use of frontal AP for DSA before treatment and more gentle angles for EVAR than for coronary interventions.

Regarding the dilution concentration, taking into account the possibility of using contrast agents for options such as internal iliac artery embolization and inferior mesenteric artery embolization during EVAR, we determined the amount of contrast agent needed for abdominal aorta angiograms as follows. Corresponding images are shown below

1. DSA after stent graft deployment
   Injection conditions (10mL/sec, 20mL, 4x dilution: 5mL contrast agent) **Fig. 4**
2. DSA near the renal artery to determine the placement position of the stent graft
   Injection conditions (8mL/sec, 12mL, 4x dilution: 3mL contrast agent) **Fig. 5**
3. DSA within the stent graft to detect type 3 endoleaks (▲)
   Injection conditions (8mL/sec, 16mL, 4x dilution: 4mL contrast agent) **Fig. 6**

We feel there is no significant difference compared to conventional DSA imaging terms of in determining stent graft placement and detecting endoleaks. This method is highly regarded by physicians for vascular depiction and endoleak detection. We use a Press Duo Elite dual head injector (Nemoto Kyorindo) to perform diluted contrast agent imaging when needed, with Iopamiron 370 as the contrast agent.

Fig. 4 DSA after Stent Graft Deployment

Fig. 5 DSA near the Renal Artery

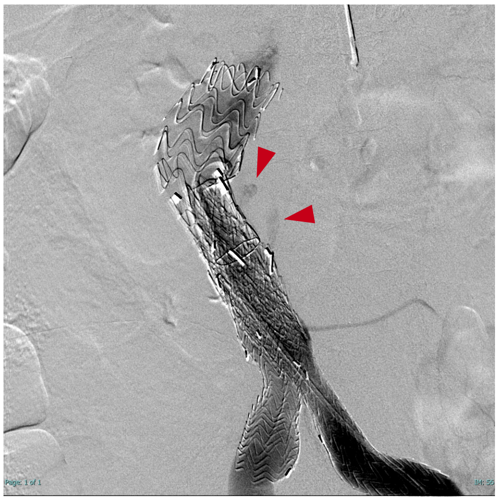

Fig. 6 Type 3 Endoleaks

5. 3D Roadmap (SCORE Navi)

Trinias's 3D application platform uses software developed by Ziosoft, providing a high performance workstation. This allows easy creation of VR images needed for 3D roadmaps **(Fig. 7a)**, so that optimal images can be provided for procedures. For example, identifying intercostal arteries during procedure is difficult with angiography alone, often requiring counting vertebrae in fluoroscopy as a substitute. However, identifying the necessary arteries beforehand and creating color-coded VR images **(Fig. 7b)** ensures easy visual identification during angiography, which reduces both procedure time and radiation dose levels. While 3D images cannot show the origin of intercostal arteries or blood vessels running behind the aorta, making the aorta transparent by hollowing it out **(Fig. 7c)** allows easy identification of dorsal vessels **(Fig. 7d)**. Creating these images takes about 5 minutes, showing the high performance of the 3D application platform.

As a radiologist involved in EVAR, I believe it is crucial to understand the treatment strategy and create supportive images in advance. Additionally, at our hospital, we perform non-contrast EVAR for patients who cannot undergo contrast-enhanced CT due to renal impairment by creating VR images from plain CT **(Fig. 8a)** and by using a 3D roadmap in combination with IVUS imaging. Creating VR images from plain CT is feasible, but requires manual work due to low image contrast. However, using unmodified VR images for the 3D roadmap makes it difficult to identify vascular origins due to low image contrast. Therefore, we use color-coding to assist in identifying origins **(Fig. 8b-e)**. Since evaluating the vascular lumen with plain CT is challenging, we use IVUS to determine the stent graft size and placement. This imaging support reduces both procedural time and radiation dose levels.

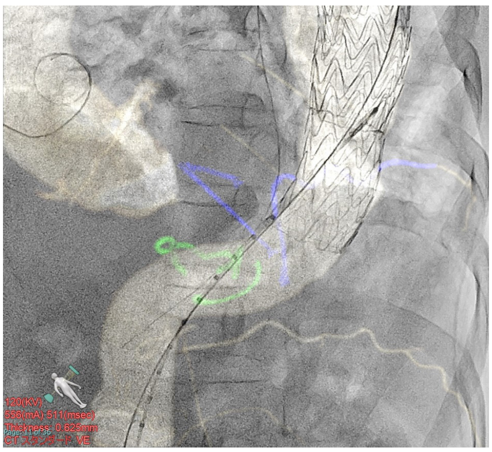

Fig. 7 a) 3D Roadmap with Overlay of VR Image Created in **Fig. 7d** and Fluoroscopy

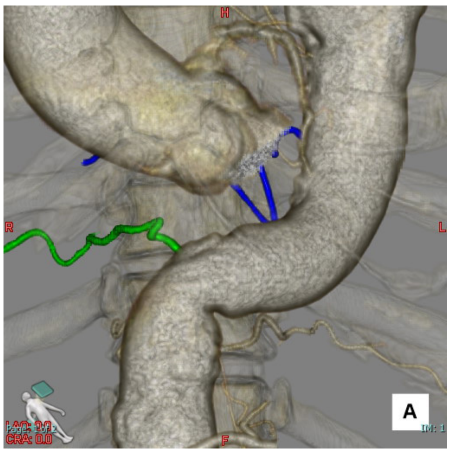

Fig. 7 b) Color-Coded Intercostal Arteries in VR Image

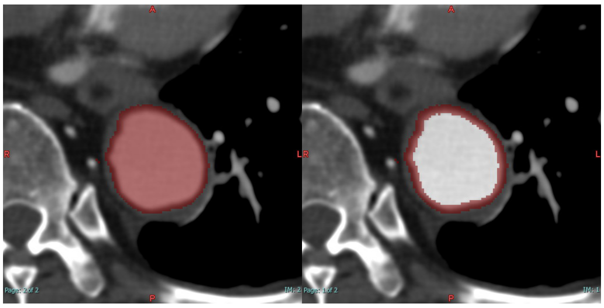

Fig. 7 c) Before (left) and after (right) Hollowing out Aorta

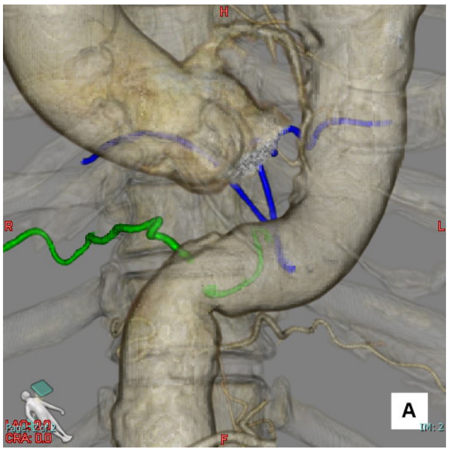

Fig. 7 d) Dorsal Vessels with Transparent Aorta in VR

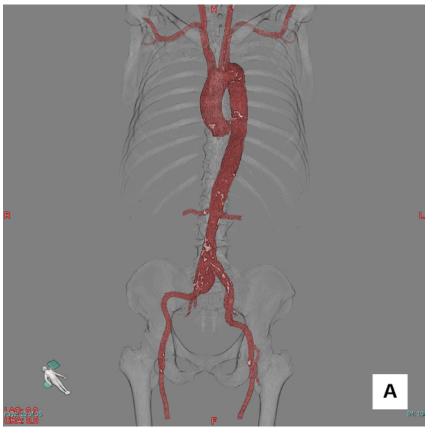

Fig. 8 a) VR Image Created from Plain CT

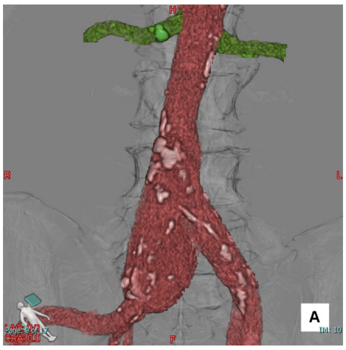

Fig. 8 b) Coded Renal Artery Origin

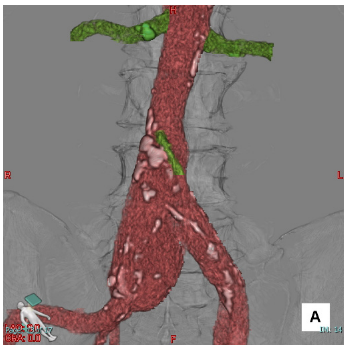

Fig.8 c) Color-Coded Inferior Mesenteric Artery

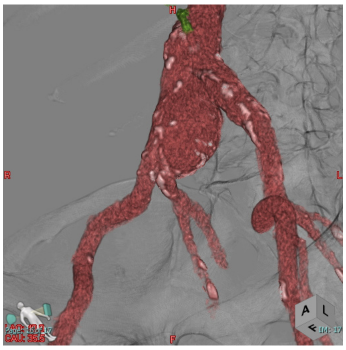

Fig. 8 d) Internal Iliac Artery at a Different Angle

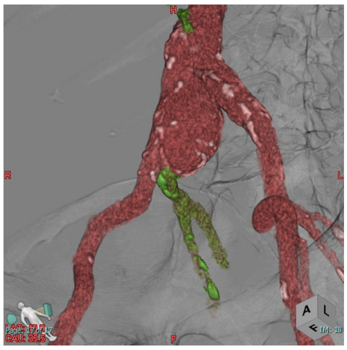

Fig.8 e) Color-Coded Internal Iliac Artery

6. Future Prospects

These techniques have received positive feedback from physicians as essential for interventional procedures. To fully utilize the performance of these systems' and our skills, multidisciplinary team collaboration, including physicians, is indispensable, along with meticulous preoperative planning with physicians As radiology technologists, we sometimes involved in developing strategies. That requires deep understanding of interventional procedures, knowledge of angiography, and precise imaging skills for procedural support, thus gaining trust within the team.

7. Conclusion

By adopting the above methods, the amount of contrast agent used in EVAR procedures at our hospital has been reduced to less than half compared to before their implementation. In some cases, the amount of contrast agent used has been reduced to less than 10mL. Furthermore, fully utilizing the performance of the Trinias system can lead to reducing procedural time, radiation dose, and contrast agent usage, which helps minimize patient invasiveness in procedures beyond EVAR. We look forward to the further development of We are committed to fully harnessing its capabilities.