# Experiences Using the Trinias C12 Package for Cardiovascular Diseases

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## 1. Introduction

The Clinical Radiology Service of Kyoto University Hospital has a total of 4 angiography rooms, with 2 cardiovascular examination rooms, 1 cerebrovascular and multipurpose examination room, and 1 abdominal vascular and multipurpose examination room that is also equipped with IVR-CT. In 1 year, the 4 rooms process around 3,300 cases of angiography/interventional radiology (IVR) and non-vascular examinations/IVR, of which cardiovascular examinations and procedures account for 1,600 or around half of these cases.
When upgrading the I.I. system in 2 cardiovascular examination rooms, a Shimadzu Trinias C12 package (hereinafter "Trinias C12") was introduced for a single-plane system (1 room) and was put to clinical use from April 2013. In this article, we report on the system configuration as a whole, which was a focus of the renovations, and our experiences using the system.

## 2. Trinias C12 System Configuration and Characteristics

The Trinias C12 was introduced to an examination room where ischemic heart disease interventions (such as PCI), chest and abdominal aorta stent graft procedures, PTA in the extremities including shunt PTA, and device placements such as pacemaker placements are performed. The system we obtained is comprised of a ceiling-mounted C-arm, indirect-conversion 12-inch FPD (CsI), 56-inch large display, and a video system **(Fig. 1)**.
Our focus for the renovation was to configure a system and an environment capable of supporting examinations and procedures for cardiovascular diseases both from the perspective of the X-ray technologist, and from the line of sight of the doctor performing the procedure.

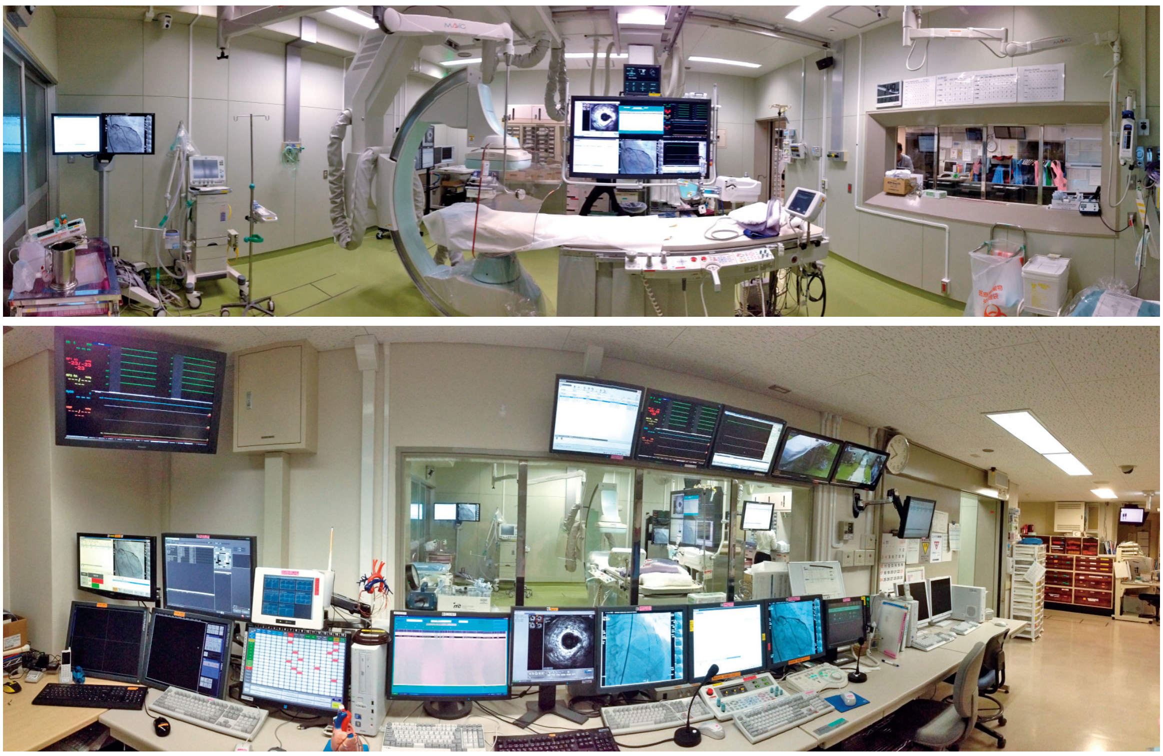

**Fig. 1** Trinias C12 System (view inside the examination room and the control room)

### 2.1. An Easy-to-Operate and Intuitive Environment for the Operator

The ceiling-mounted C-arm has a wide range of movement and therefore allows for treatments to be performed without changing the position of the patient, including PTA of peripheral branches of the popliteal artery. A ceiling-mounted support that travels in the transverse direction also makes table rotation unnecessary even during radial arterial puncture and shunt PTA **(Fig. 2)**. The system also provides an intuitive and easy-to-control environment for the operator, including a grip-type controller that combines the C-arm controller with table controls, and the ability to set the CAG radiography angle directly using pictogram-like switches. However, areas that could be improved include the connectivity between the C-arm and the catheter table, and the safety mechanism that makes use of contact sensors. To set the C-arm angle safely using only the direct memory button requires the operator have a thorough understanding of how the system moves and is positioned.

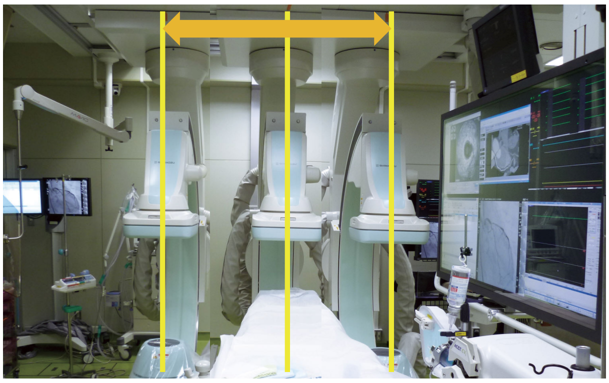

**Fig. 2** Transverse Range of Movement of the Ceiling-Mounted C-Arm

### 2.2. Convenient FPD Size

The 12-inch FPD is between the normal sizes for large FPDs and small FPDs, and retains an effective field of view required for procedures from PCI to PTA, while resulting in minimal conflict between the table and the arm supporter. A 12-inch FPD is an appropriate size for performing a wide range of IVR procedures for the treatment of cardiovascular diseases.

### 2.3. Video System That Supports IVR

The video system consists of the following inputs for monitor displays: (1) live video, (2) real-time playback of reference radiography and fluoroscopy images, (3) DMS used as a video reference, (4) video network system (Nahri), (5) workstation able to display CT/MR/3D, (6) polygraph (2 screens), (7) DVI and VGA terminals for external inputs such as IVUS, OCT, FFR, and US, (8) terminals for electronic patient records, and (9) observation cameras that show the patient's face or the operator's hands.

Display monitors used inside the examination room for showing various kinds of images and information include a ceiling-mounted large display monitor for the doctor performing the procedure, and a four-screen standing monitor and a two-screen standing monitor for use as backup displays, and for the use of clinical engineers and nurses. The control room contains two display monitors that can be used for a variety of purposes, including to display live video, observe the patient, and show the polygraph.

A high-performance switcher is needed to display all these various input sources on the appropriate display monitors.

By introduction of a switcher with 16 inputs and 16 outputs, the system is capable of supporting IVR.

The base configuration of the large display monitor splits the screen into six areas (each equivalent to a 21-inch display), but how the display screen is split and the size of display areas is freely configurable and can be adjusted according to preference prior to use. Configuring the large display monitor with a display area equivalent to a 28-inch screen will preclude the need for inch-up (enlargement) during fluoroscopy, which helps to lower the exposure dose. Furthermore, the ability to change the arrangement of images being displayed allows images that need to be kept in view to remain easily visible depending on the technique being performed and the doctor's field of view, which reduces stress for the doctor. During pacemaker implantation, we observed physical interference between the ceiling-mounted C-arm and the ceiling-mounted large display that meant images could not be placed in the field of view of the doctor. We resolved this issue and accommodated the wishes of the doctor by placing the four-screen standing monitor at the head of the patient **(Fig. 3)**.

A switcher used to display necessary information in the locations where it is needed is an essential function for doctors and medical staff performing IVR procedures as a team **(Fig. 4)**.

The Trinias C12 has a reference function capable of real-time video playback of radiography and fluoroscopy images, a feature that might be described as characteristic to Shimadzu products. This feature contributes to quicker decision-making and safe conduct of procedures during IVR.

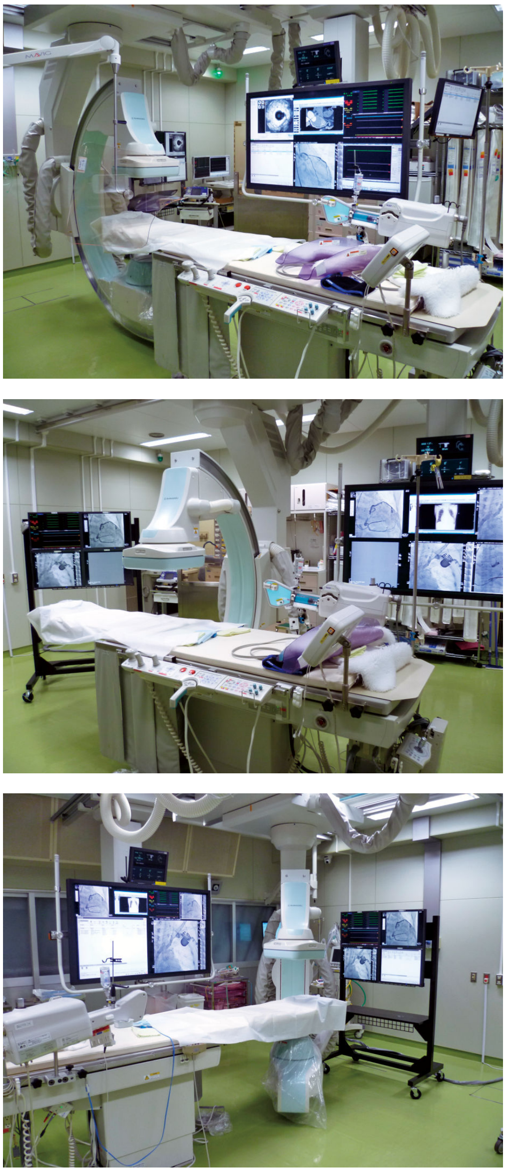

**Fig. 3** Layouts
Top: CAG/PCI
Middle: PTA in the Lower Extremities
Bottom: Pacemaker (left pocket)

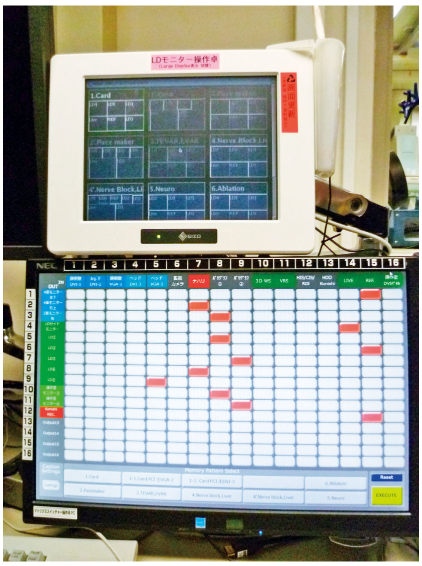

**Fig. 4** Large Display Monitor Control (top)
Image Switcher (bottom)

### 2.4. Combined Workstation-Type and Button-Type Control Panel

X-ray controllers have recently been transitioning to workstation-type designs. Control, from protocol selection to viewing reference images and saving fluoroscopy images, must be performed via a computer mouse. However, the old method of using buttons still allows for quicker and more reliable control for some operations, such as when selecting a frequently used mode or quickly saving an image.

The fluoroscopy image save function used by Trinias C12 does not require additional radiography for a confirmation, which is useful for reducing exposure. The save function can be controlled via the use of a dedicated button instead of the mouse, so the save function can be used immediately without introducing a time delay or interrupting the examination. Keyboard shortcuts can also be configured for selection of radiography protocols or SCORE StentView modes to allow quick responses to doctor demands.

### 2.5. Esteemed Image Quality with Dose Reduction

The Trinias C12 introduced at our hospital was Shimadzu's first indirect-type FPD (CsI), and so until its arrival our anxiety exceeded our expectations. But after introducing the system, our concerns with the clinical images were laid to rest by a brief review of the image processing parameters. It did not take long for physicians in the cardiovascular department to rate the system highly. Although the image quality was highly regarded, we investigated a low dose protocol that reduced incident dose on the FPD by around 40 %. The low dose protocol was found to worsen image granularity somewhat, but not to an extent that was particularly problematic, and this low dose protocol is currently in use. Together with Shimadzu, we are now investigating further reduction of the skin dose while maintaining image quality by achieving improvements in image quality through image processing, using additional filters, and re-examining X-ray tube voltage.

When the system was first introduced, it did not support a dose reporting (DICOM Radiation Dose Structured Report) feature for dose control, but support for this feature was introduced as of the winter of 2013. At the time of publication of this issue of Medical Now, Shimadzu is planning to provide any support. Two features we would like to see implemented and supported by the system manufacturer are a maximum skin dose control function and a dose monitoring function active during ongoing examinations.

### 2.6. Image Processing Required for Treatment: SCORE StentView and SCORE RSM

PCI for CTO, double vessel diseases, and triple vessel diseases can sometimes involve a skin surface dose in excess of 3 Gy. The operator is made aware when the skin surface dose reaches 1 Gy, and depending on the circumstances the treatment protocol is changed to a low dose protocol. Low dose protocols do not provide sufficient visibility for the placement of overlapping stents or delineating the stent after balloon inflation, and tend to need a larger number of radiographic scans to show the stent and impose a longer fluoroscopy time. In such circumstances, the image processing performed by SCORE StentView, which superimposes images to enhance the view of the stent, is useful not only for improving stent visibility but also plays a part in reducing the exposure dose during PCI. One issue with StentView is the software can sometimes invert the top/bottom and distal/proximal ends of the image depending on the angle of radiography. Shimadzu is currently making improvements in the software.

For arteriosclerosis obliterates (ASO) of the lower extremities, normal DA radiography is unable to acquire enough information to render the peripheral blood vessels due to severe stenosis and collateral circulation, while DSA radiography is effective at this task. However, DSA radiography does not allow panning, and requires repeated radiographic scans. Furthermore, the more peripheral are the blood vessels, the more pain the contrast agent stimulates in the blood vessels and the patient is unable to refrain from moving as a result. In such circumstances, SCORE RSM is useful. By performing DSA-like image processing, SCORE RSM is able to make the blood stream more viewable than DA radiography, while also responding to movement of the patient. However, because DSA radiography shows blood vessels with higher contrast than SCORE RSM, it can be used with a lower concentration of contrast medium, and due to this difference DSA mode is often used for PTA in certain circumstances.

## 3. Conclusion

With the opportunity to use the Trinias C12 system, we rediscovered the high image quality it is capable of and the ease with which the system can be used for cardiovascular examinations. However, we have not yet implemented 3D-DSA or CB-CT clinically, and have therefore yet to exploit the Trinias C12 to its full potential. We intend to make preparations and review these features to put them to clinical use in the future.

In addition to what has been stated above, some areas of system operation such as image output settings (compressed, non-compressed, processed image output, etc.) and transmission error displays need improvement, and we expect Shimadzu to continue its work in resolving these problems while creating a system capable of supporting safe, high-quality, and reliable medical care.