R/F

Experiences Using the SONIALVISION safire Series

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1. Introduction

The Shingu Municipal Medical Center (**Fig. 1**) is located in Shingu City, Wakayama Prefecture which is sandwiched between coastal and mountainous areas. It is a regional core hospital that offers 18 clinical departments with 304 beds and treats an average of approximately 600 outpatients per day. The medical center handles an extensive medical district, centered on the south of the Kii Peninsula. It extends from Totsukawa, Nara Prefecture, in the north to the south of Mie Prefecture to the east.
Almost ten years have passed since the Shingu Municipal Hospital was renamed "Shingu Municipal Medical Center" and moved into a new building in 2001.
We subsequently switched to full digital/filmless operation in 2009, with the introduction of electronic medical records and PACS. A feature of the Department of Radiology is that all technologists share the operating skills and technical ability to handle emergency medical treatments, such as radiography for the hyperacute stage of cerebral infarction using an MRI system and head and cardiac catheterization examinations. This ensures that we can adequately handle emergency situations. The 11 radiological technologists currently employed at this medical center strive daily to provide excellent images.

Fig. 1

2. Background to Introducing the System

We previously operated two I.I.-DR units and an R/F table in the endoscopy room (all manufactured by Shimadzu Corporation). However, due to the aging of the R/F table, we newly introduced a SONIALVISION safire system in January 2011. The reasons for choosing this system were its direct-conversion 17-inch flat panel detector (FPD) that offers high-definition, distortion-free images over a large field of view, and the great applications such as tomosynthesis (multislice tomography) and slot radiography (long view radiography).

3. Expectations and Concerns

As this was the first time an FPD had been introduced for any modality at this medical center, we held great expectations about the wide dynamic range, low halation, and high spatial resolution it offers. After using the system for approximately three months, we are satisfied with the performance of our SONIALVISION safire. The fluoroscopy and radiography image quality and the fluoroscopic observations over a wide field of view are extremely useful, and make us feel uncomfortable about the I.I.-DR that we used to use. **Fig. 2** shows images of cases of DIP and enema examinations using the 17-inch field of view.

Fig. 2 (a)

Fig. 2 (b)

We previously used 14 × 17-inch cassettes for DIP examinations, but we felt that inserting the cassettes and transporting them from the fluoroscopy room to the operation room for processing was somewhat inconvenient. Adopting the 17-inch field of view has dramatically enhanced our work efficiency. A large overall image is suitable for enema examinations and we believe that the large field of view should reduce the number of images taken.

However, introducing the FPD has led to operational issues, such as (1) which of the diverse fluoroscopic examinations by the numerous departments should be performed with the FPD, and (2) how to handle tomosynthesis and slot radiography in the fluoroscopy room that uses a reservation system. In particular, we previously performed auto stitching radiography of the lower extremities or full spine in the plain radiography room on the basis of same-day orders. However, slot radiography has to be performed in the fluoroscopy room that works on a reservation system, which made us concerned whether suitable time frames would be available. In practice, the time required for slot radiography is affected by the state of the patient but in quick cases can be finished in two or three minutes. Therefore, slot radiography can often be adequately handled by inserting the patient between other patients who are booked for fluoroscopic examinations.

4. Slot Radiography

The principle of slot radiography is omitted here, as it has been covered previously in Medical Now [1), 2)]. I will simply describe my impressions of using it. We previously used auto-stitching cassette radiography at this medical center but this was an inconvenient technique that required a lot of time and effort for positioning during radiography, image reading, and linking the images. On the other hand, once the imaging range has been determined, slot radiography is a fully automated procedure from exposure to image display on the monitor. It achieves extremely high work efficiency and contributes to shorter examination times. Using the exposure field lamp to determine the head and foot positions and then making fine position adjustments under fluoroscopy simplifies the pre-radiography checks and helps minimize the X-ray exposure dose.

Slot radiography of the lower extremities in standing posture results in an unexpectedly high patient standing position. The majority of patients at our medical center are elderly female patients. We take measures to eliminate their anxiety, such as tilting the tabletop to an angle of 80°, rather than using a simple hip belt for restraint. Radiography of the lower extremities often involves not only an order for slot radiography alone but also simultaneous orders for plain radiographs of the knee in three directions. Frontal or lateral radiography of the knee is possible on the R/F table but special radiography techniques, such as skyline radiography, have to be performed by plain radiography. Therefore, even patients who have difficulty walking must move from the plain radiography room after knee radiography is complete to the fluoroscopy room for slot radiography of the lower extremities.

I have some ideas that I would like to see incorporated into future systems. For example, procedures that can be performed on the R/F table, such as epicondylar view radiography using the SONIALVISION safire series introduced in the Medical Now [2)] and other measures during radiography that reduce the burden on the patient while providing the required information to the orthopedic surgeons.

5. Tomosynthesis

Tomosynthesis reconstructs images on any required section from the data acquired during a single imaging operation (approximately 5 seconds). It significantly reduces the time that the patient has to hold a posture or is restrained and the imaging can be completed in two or three minutes, similar to slot radiography. The images taken are automatically transferred to the side station, where the image reconstruction takes two or three minutes. The process is not at all stressful. Image reconstruction in the side station can be broadly categorized into reconstruction by the shift-and-add method or the filtered back projection

(FBP) method. We use filtered back projection reconstruction at this medical center because it provides high-resolution images that clearly display trabecular bone and offer superior diagnostic capacity. Using various reconstruction filters for different slice thicknesses, artifact suppression, and contrast provides a powerful tool for reducing metal artifacts and observing bone fusion.
Fig. 3 shows a reconstructed image of the carpal bones taken using tomosynthesis. Careful selection of the appropriate reconstruction filter for the FBP method offers clear observations of the trabecular bone.

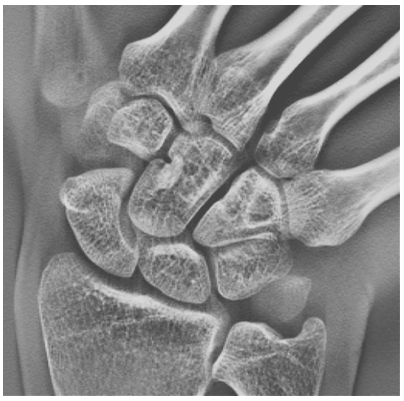

Fig. 3

At this medical center, 3-D and MPR 3-direction CT are becoming almost routine on CT orders for suspected limb fractures. Therefore, we are concerned whether the information from a single tomosynthesis direction could satisfy the orthopedic surgeons, and we feel that tomosynthesis reconstruction is somewhat inferior to CT in situations where sagittal tomographic images are required besides coronal images, and tomosynthesis must be repeated in this direction. However, tomosynthesis is superior to CT in other ways, such as for tomographic imaging in the standing posture under load, which is not possible using CT, and in postoperative cases after placement of metal implants. Rather than using tomosynthesis for all cases that we previously handled using CT, such as examinations of the limbs, we feel that carefully selecting the cases to use tomosynthesis for should benefit both the orthopedic surgeons and the patients.

6. Shunt DSA

Shunt angiography is one examination that maximizes the advantage of the large field of view. Using a 15-inch or 17-inch field of view can easily capture the shunt vessels within the view field. The ability to observe blood vessels up to the subclavian area with a single contrast medium injection from the elbow amazes and impresses dialysis physicians.

As the SONIALVISION safire system sets the optimal fluoroscopy mode according the imaged position, it obtains images with lower halation and higher contrast than conventional I.I. images. The image quality is highly regarded for the observation of guidewires and balloons.
With our previous I.I.-DR systems, we had to take three images of the elbow, upper arm, and subclavian areas, but the SONIALVISION safire with 17-inch FPD can observe this range in a single image (**Fig. 4**).

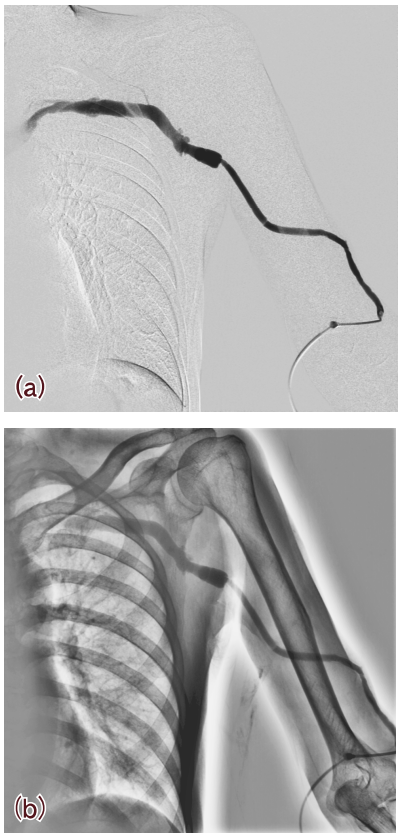

Fig. 4

7. Videofluoroscopic Swallow Examinations

We used to perform videofluoroscopic swallow examinations with the old I.I.-DR systems at this medical center. As we had to directly film the fluoroscopic images displayed on a monitor with a video camera, the lights had to be turned off when performing the examination to prevent reflections of the lights on the fluoroscopic images. In addition, editing the images taken by the video camera seemed quite inconvenient. The revolutionary videofluoroscopic swallow examination system offered by the SONIALVISION safire is introduced below.

1) Positioning
The new SONIALVISION safire system can increase the clearance between the table and X-ray tube unit to extend the SID to 1500 mm. This

allows positioning of patients in wheelchairs and simplifies examination set-up. It ensures adequate space for both lateral and frontal examinations to alleviate the patient's feeling of oppression (**Fig. 5**).

Fig. 5

2) Dedicated Chair

When the new system was introduced, we also procured a dedicated chair for videofluoroscopic swallow examinations (**Fig. 5**). We previously used a reclining wheelchair for these examinations. However, due to restrictions on the X-ray tube stroke, pillows or blankets had to be placed on the seat to maintain the field of view, and this made the patient's position unstable. The new dedicated chair for videofluoroscopic swallow examinations offers an electrically driven (and rechargeable) height-adjustment function that makes positioning extremely simple.

3) Video Recording

The fluoroscopic images are stable images with little noise, and are highly regarded for the clear observations of motion during swallowing (**Fig. 6**).

A DVD recorder with a hard disk drive was introduced for image recording. Recording is synchronized with the fluoroscopy footswitch. The recorder is paused and data is recorded only during fluoroscopy while the footswitch is pressed, which is extremely convenient. As it is a domestic DVD recorder, transferring the data to DVD is stress-free (**Fig. 7**).

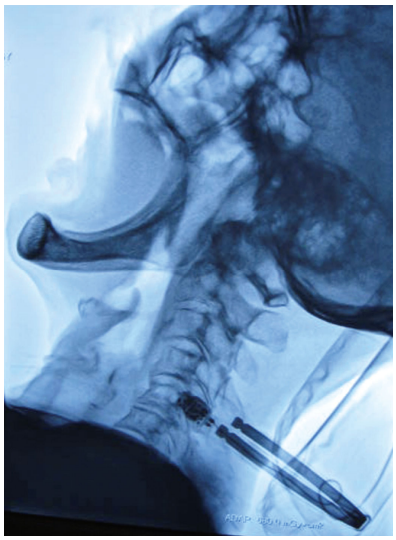

Fig. 6 Fluoroscopic Image Taken During Videofluoroscopic Swallow Exam

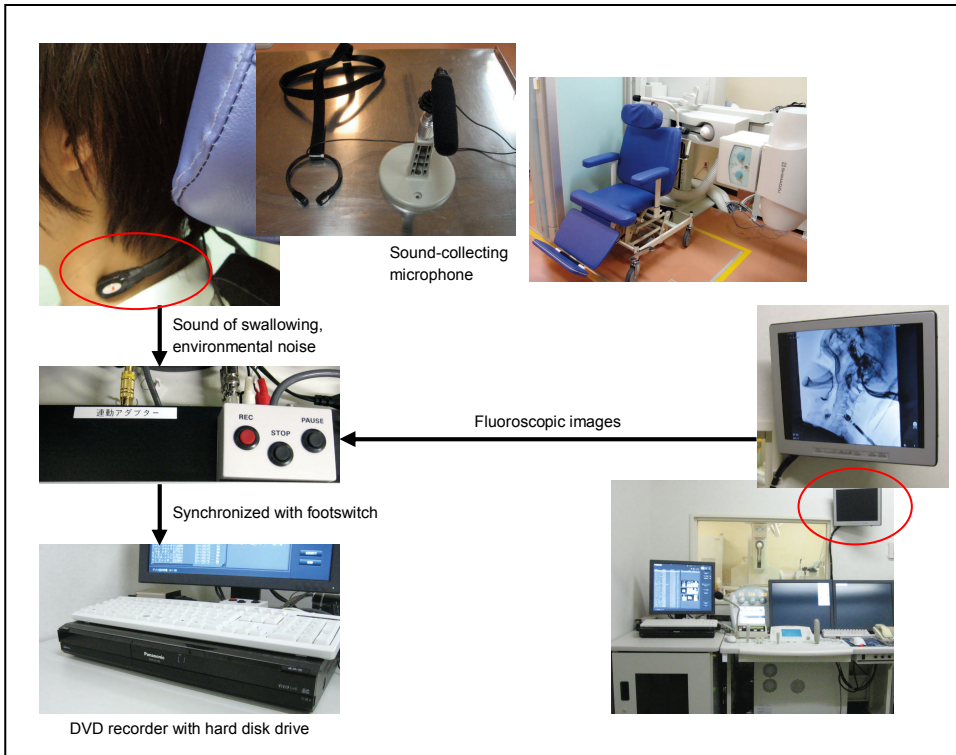

Fig. 7

4) Others

The sound-collecting microphone is also connected to the DVD recorder with a hard disk drive. It permits recording of the sound of swallowing and environmental noise while capturing the fluoroscopic images (**Fig. 7**).

8. Area Dosimeter

A DIAMENTOR M4 area dosimeter (**Fig. 8**), manufactured by PTW in Germany, is supplied with the R/F table for exposure dose management.

When exposure starts, the cumulative area dose is displayed on the fluoroscopic image on the monitor (**Fig. 9**). Exposure dose management is performed by dividing the automatically displayed area dose value by the actual area used, and multiplying the result by back scattering and other correction coefficients. The calculated value is then loaded into the radiography information system (RIS). Care is required, as the exposed area and correction coefficients vary due to the SID, FPD size, aperture, and body thickness.

The cumulative area dose value is reset when the examination screen is closed. It would be useful to be able to subsequently check the previous value, and a separate display of the exposure dose for radiography and radiography would also be convenient.

Fig. 8 Area Dosimeter

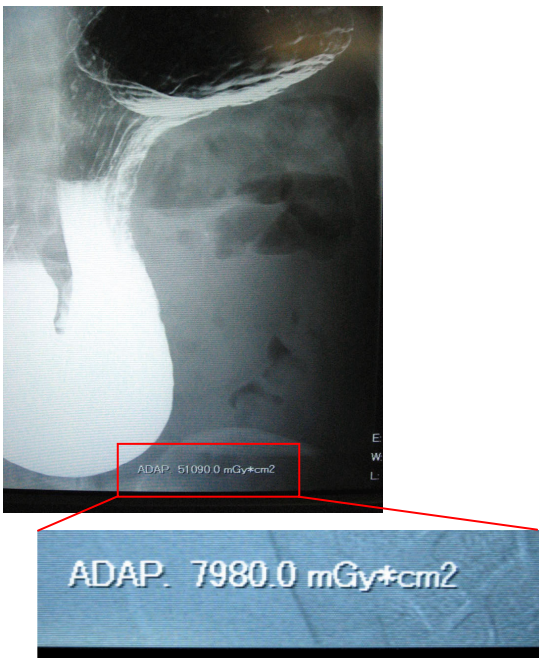

Fig. 9 Cumulative Area Dose Displayed at Bottom-Left of Fluoroscopic Image Display

9. Summary

The SONIALVISION safire system provides satisfactory image quality for radiography and fluoroscopy. However, it still has room for further improvements that I hope Shimadzu will tackle in the future. As the area dosimeter indicates the cumulative area dose when the examination is complete, I would like to see measures, such as changing the fluoroscopy mode and creating a manual of radiography conditions, to allow dose management that can minimize the X-ray exposure dose on the patients.

References

1) Nobuhito Handa: Clinical Experience Using the Slot Scan Function with an X-Ray Fluoroscopy System, MEDICAL NOW No.65, 19-22, 2009
2) Kazuya Goto: Clinical Experience with Slot Radiography using SONIALVISION safire II, and Its Utility –Lower Limb Region–, MEDICAL NOW No.65, 23-26, 2009