

Experiences Using a Mobile X-Ray System with a Thin, Large-Field-of-View FPD



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1. Introduction

Kouseikai Urata Hospital (**Fig. 1**) is located approximately halfway between Tokushima City and Naruto City. It is near Tokushima Awaodori Airport that was renamed last April. The hospital was opened as the Urata Clinic in 1938 and established as a medical corporation in 1951. It subsequently functioned as a regional hospital. To provide a strategic point along Route 11 that has become increasingly urbanized, the hospital provides a bridge between acute care and home health care by accepting emergency patients and providing emergency care for home patients. The hospital now comprises seven medical departments with 100 beds and employs more than 170 staff. It offers the environment to provide high-quality regional health and welfare services according to the philosophy of "Respect for nature, value for life, love of people."



Fig. 1 Kouseikai Urata Hospital

2. Background to Introducing the System

Currently, in April 2010, the hospital operates the following radiographic equipment: 0.5 T MRI, 16-slice MDCT, analog fluoroscopy system, general radiography (CR) system, mammography equipment, mobile X-ray system (FPD), and dental panoramic X-ray equipment. Before the introduction of the FPD-type mobile X-ray system we used a capacitance-type mobile X-ray system for CR. A single technologist had to operate these systems. When performing IVH procedures in the wards using the mobile X-ray system, the technologist had to repeatedly carry CR cassettes to the X-ray room on the first floor for development and then take the films back to the ward, which provided a significant impediment to the other radiographic operations. Under these circumstances, we decided to improve our radiography systems. After considering the benefits to the patients, we initially introduced an FPD-type mobile X-ray system, followed by the MDCT and PACS. However, due to the size of this hospital, the hospital director and doctors debated the necessity of introducing an FPD-type mobile X-ray system. Initially, we used demonstrations by each manufacturer to simulate the actual introduction of their system and confirm the utility and necessity of each system. These investigations began in the summer of 2009. After the demonstrations by each manufacturer, we unanimously agreed to introduce the MobileDaRt Evolution (**Fig. 2**) manufactured by Shimadzu Corporation. This decision was based on its extremely easy movement and the built-in image processor that eliminates the fear of theft. Another decisive factor was the thin FPD panel. The system was introduced in December 2009. According to the Shimadzu sales representative, this is the first of these systems introduced into a private hospital in Japan.



Fig. 2 MobileDaRt Evolution Incorporating a New, Thin, Large-Field-of-View FPD

3. System Specifications

Table 1 shows the specifications of the recently introduced MobileDaRt Evolution. Special note should be made of the new, thin, large-field-of-view FPD described above. At just 3.4 kg, it is extremely light and easy to use (**Fig. 3**).

Max. output	32 kW (20 msec)
Rated output	16 kW (100 msec)
X-ray tube voltage	40 to 133 kV
Max. tube current	400 mA
Tube current time constant	0.32 to 320 mAs
FPD	
Effective field of view	35 × 43 cm
Total number of pixels	2208 × 2688
Pixel pitch	160 μm × 160 μm
Output gradations	12-bit (4096 gradations)
Size	480 (W) × 481 (H) × 15 (D) mm (14 × 17 inch), 3.4 kg

Table 1 Specifications of MobileDaRt Evolution



Fig. 3 New Thin, Light, Easy-to-Use Large-Field-of-View FPD

4. Utility of FPDs

This system displays images just three seconds after X-ray exposure. In hospitals like ours where it is often difficult to keep patients stationary, once the FPD has been set, re-imaging is possible immediately if the patient moves. Images are viewed on a 15-inch LCD monitor built into the MobileDaRt Evolution unit. This completely eliminates the replacement of imaging plates that was previously required and reduces the burden on the assisting nurses. Naturally, it is no longer necessary to take the imaging plates to the reader on the first floor, which saves a lot of work. The ability to view the catheter tip on the LCD monitor after just three seconds significantly reduces the time required to perform IVH procedures, in particular. The LCD panel is extremely popular with doctors, as it allows immediate magnification and other image processing operations. The system we introduced features a large-field-of-view FPD but a compact FPD (23 cm × 28 cm) is also available as an option. We are currently considering the utility of introducing this option. The new panel is only 15 mm thick, equivalent to a conventional imaging plate, which eases discomfort to the patient (**Fig. 4**). The FPD can be released from the cable by disconnecting the connector, which makes it extremely easy to set the panel. The FPD was difficult to set during the initial demonstration, as the system used an earlier FPD that was 22.5 mm thick and weighed approximately 1.5 times as much as the new detector. This problem has been resolved in the system that we introduced.



Fig. 4 (a) Setting the FPD, (b) Edge-on View of FPD

5 Experience Using the System

5.1 X-Ray Output

The maximum system output is 32 kW (20 msec), which significantly reduces the frequency of re-imaging due to movements. The 300 KHU X-ray tube with a 0.7/1.3 mm focal point takes sharp images. The images surpass those from the fixed system in the radiography room.

5.2 Power-Assist Function

As we sensed during the initial demonstration, the power-assist function makes the system extremely easy to use. The operator's intentions can be directly imparted to the system for intuitive movements. The products demonstrated by all the manufacturers offered power-assist function. However, while it is difficult to explain in words, the MobileDaRt Evolution really did operate just as the operator intended. While there were no major problems with the other manufacturers' products, the point of difference of the MobileDaRt Evolution is its smooth, natural movements. It considerably reduces stress during travel (Fig. 5).



Fig. 5 Maneuvering the Unit in an Elevator
Power-assist function permits maneuvering in a confined space.

5.3 Safety Alarm

This alarm is turned on during travel through corridors and off in the wards and at night. It is extremely convenient for notifying others that the unit is approaching around a corner, for example. Travel movement stops immediately when the bumper gently contacts an object (Fig. 6).



Fig. 6 Front Bumper

5.4 Illumination

Illuminated indicators are provided as standard on the unit and collimator. The color indicates the Standby, Ready, or Exposure status (Fig. 7). Although we didn't anticipate it initially, this illumination function has now become indispensable at this hospital. Generally, one or two nurses assist during X-ray imaging. Previously, the technologist had to give them instructions to retreat before each exposure. Now, the nurses simply watch the indicators and retreat when necessary. In addition to the illumination, a sound indicates the system status.



Fig. 7 Illuminated Indicators
Colors indicate the Standby, Ready, or Exposure status.

5.5 All Free Buttons

These buttons are located on the collimator and on the horizontal arm. Pressing one of these buttons allows simultaneous pivot rotation, arm extension, and tube vertical movements. The All Free button on the horizontal arm is particularly convenient.

The technologist can perform rough positioning after the unit is moved to the bedside. The technologist then moves to the opposite side of the bed to insert the FPD and to make the final positioning using the switch on the collimator before returning to take the image. Any further fine positioning required can be performed using the All Free button on the horizontal arm without having to go around the bed again. This is an extremely convenient function (Fig. 8).



Fig. 8 All Free Buttons

5.6 Infrared Remote Controller

No such controller was available on the previous system but since we started using it, it has become indispensable. It simplifies control of a range of operations, including the collimator lamp, exposure preparation, and exposure operations. The combination of the illuminated indicators and the IR remote controller ensures extremely smooth operations, from the nurses retreating to X-ray exposure. We initially considered installing protective screens, but the remote controller makes them unnecessary. The Shimadzu sales representative strongly recommended us to try the infrared remote controller and we are extremely grateful for that advice (**Fig. 9**).



Fig. 9 X-Ray Exposure Using the Infrared Remote Controller

5.7 Inch-Mover Buttons

The inch-mover buttons on the front of the collimator move the MobileDaRt Evolution backwards or forwards. We do not use these buttons very often at this hospital, as the assistance of the nurses makes positioning easy. However, these buttons are very convenient, as they allow a single technologist to perform radiography from the bedside on the opposite side to the unit, without having to move round the bed for fine positioning (**Fig. 10**).



Fig.10 Inch-Mover Buttons

6. CR and DR Film Consistency (Parameters)

Since PACS went into operation this February, all data has been stored in a DICOM server for fully filmless operation (except for the analog fluoroscopy system). Currently, parameter adjustment is performed for CR and DR (FPD) images. Initially, we attempted to adjust the parameters on 2 M resolution monitor but this was unsuccessful, so that we currently compare images on film. I hope to have the opportunity to present this data in the future.

7. Future Potential

In the near future, we plan to transfer MobileDaRt Evolution images to the server over a wireless LAN. Currently, we move the mobile X-ray system to the server in the X-ray room and connect it to a LAN cable to transfer the data to the server (**Fig. 11**).



Fig. 11 Data Transfer over a LAN

8. Conclusions

The introduction of the MobileDaRt Evolution has significantly improved the work flow of the technologist. Initially, we believed that this system was extravagant for a hospital of this size. This feeling has now been dispelled and the MobileDaRt Evolution has now become an indispensable piece of equipment. It is currently used only for mobile diagnostic imaging in the wards but, when the wireless LAN infrastructure becomes available, we plan to also use the system for emergency applications.