Experience Using the RADspeed Pro with Auto-Positioning Function

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1. Introduction – Overview of Hospital

The University of Tokyo Hospital is surrounded by many important historical and cultural sites. For example, the hospital grounds include famous sites such as the Sanshiro Pond, Yasuda Auditorium, and the Akamon gate from the former residence of the Maeda clan. Near the hospital grounds is the Rinshouin (family temple of Lady Kasuga) and if you go to Ueno Park, there is a statue of Takamori Saigo and a grave where the Ueno Shogitai troops that fought for the Bakufu (shogunate) government in the Battle of Ueno, at the end of the Tokugawa period, are enshrined. The Ueno Toshogu shrine is famous for its peony and cherry blossoms in spring and is popular with foreign tourists as a shrine where they can view traditional Edo period architecture up close.
Furthermore, due to the orientation of the patient wards, the great views not only from the restaurant on the top floor, which has a beautiful view of the Tokyo Skytree tower, but also from the other cafeterias in each ward are very popular with our inpatients.

The number of beds, inpatients, and outpatients at our hospital are indicated below.

- 1,162 general and 60 psychiatric beds
- Outpatients (fiscal 2011)
  750,926 total (average 3,077 per day)
- Inpatients (fiscal 2011)
  384,042 total (average 1,049 per day)

Fig. 1 University of Tokyo Hospital

Fig. 2 Tokyo Skytree (taken from the hospital)

2. Background of Introducing the RADspeed Pro System

Our hospital has three radiography rooms for bone radiography. Based on our experience using an Ysio radiography system (Siemens) in one of those rooms, which includes an X-ray tube with auto-positioning function, we felt that an X-ray tube for multipurpose radiography needs not only remote controllability (wireless), but also shorter radiography times and higher X-ray tube functionality for heavy usage periods. Since the X-ray tube was getting older and needed to be replaced soon, and we wanted to further increase the number of multipurpose radiography rooms, we visited various facilities that use an X-ray tube with auto-positioning function. As a result of that study, we decided to replace the two X-ray tubes that were in one of the rooms with a single Shimadzu RADspeed Pro X-ray tube.

3. Radiography System Configuration

Instrument	Manufacturer	Model, etc.	Remarks
X-ray high-voltage generator	Shimadzu	UD150B-40	
X-ray tube support	Shimadzu	CH-200	
Automatic movable collimator	Shimadzu	R-300	
Radiographic table	Fujifilm ("Fuji" below)	DR-CALNEO MT	
Radiographic stand	Fuji	DR-CALNEO U	
Image processor	Fuji	Console Advance(V6)	2 units
Mounted reader		RUL-13	Hand rail is currently under review.
Radiographic stand	Obayashi Mfg.		
Image reader	Fuji	XL-2	2 units (CR: Long view and other CR radiography)
FPD cassette	Fuji	17 × 14 CsI (SQ) type	
		17×17	

Fig. 3a Using a Radiographic Stand

Fig. 3b Using a Radiographic Table

4. Utilizing Various Radiography Systems

- Bone radiography: DR-CALNEO MT radiographic table and DR-CALNEO U radiographic stand
- Thoracoabdominal radiography: DR-CALNEO MT, U, 17 × 17
- Special cervical spine radiography: Radiographic stand + special cervical spine radiography seat
- Long view radiography: RUL-13 mounted reader, long view cassette (CR)
- For other general bone radiography, the CsI (SQ) type 17 × 14 FPD and CR cassette are used in combination.

Shimadzu operation panel: The operation panel on the UD150B-40 X-ray high-voltage generator is mounted on an Ergotron arm, which allows it to be conveniently adjusted to various angles for different technologists in charge of radiography (Fig. 4).

Fig. 4 Left: UD150B-40

Status of Bone Radiography at Our Hospital and How the Radiography Room Has Been Used After Introducing the RADspeed Pro System

Before introducing the RADspeed Pro system, general radiography systems (for bones) at our hospital were classified into three basic categories—knee joints, thoracolumbar regions, and hip joints; cervical vertebrae, shoulder joints, and long view radiography; and hands/feet and extremities. However, after introducing the RADspeed Pro system, these categories changed somewhat. Now thoracoabdominal and head radiography, which was previously performed in a separate radiography room, can be performed in the same radiography room as bone radiography. The reason is because the X-ray tube support unit with auto-positioning function is capable of such a wide range of movement that it allows using a single system to easily position the X-ray tube for standing, supine, or cervical spine radiography, for long view radiography, and for portable-FPD radiography. In particular, for patients with difficulty walking or requiring multiple exposures, all radiography can be accomplished in the same radiography room, which saves time moving between different radiography rooms and reduces the time required for them to get ready. These patients are grateful because it also reduces their physical and mental stress.

5. University of Tokyo Hospital Statistical Data—Bone Radiography

Skeletal Area	Outpatients	Inpatients
Spine (including newborns and infants less than 3 years old)	5,169	1,595
Pelvis (including newborns and infants less than 3 years old)	561	276
Upper extremity (including newborns and infants less than 3 years old)	5,697	1,101
Lower extremity (including newborns and infants less than 3 years old)	11,382	2,884

6. Linking the RIS Console via the Image Processor to the UD150B-40

Each instrument above is linked together to display the imaging area, radiography parameters, X-ray tube movement parameters (X-ray tube angle), exposure field size, and patient information, such as the patient name and imaging area, on the LCD screen at the radiographic stand, which enables verifying patient identity.
Patient radiography information sent from the RIS console (Fujitsu) is linked to the UD150B-40 X-ray high-voltage generator via the image processor (Fuji). This allows automating all the tasks of setting radiography parameters, moving the X-ray tube for standing, supine, or other positions, and setting the exposure field size, which were previously performed by the radiography technologist in charge. Since the patient name and exposure area is displayed on the LCD monitor at the radiographic stand, it is used to verify patient identity. Patients are grateful for how these functions reduce the physical stress from repositioning due to patient's physical limitations or from undergoing multiple exposures in different radiography rooms. In particular, we have designed an efficient instrument layout for the radiography room to accommodate radiography from below gurneys or beds, which has paid off in providing a wider operation space. Together with the linked system mentioned above, the new layout has made the radiography room even more convenient for the radiography technologist.
Since June 2006, imaging systems in the Division of Radiology were switched to filmless technology, where we use a PACS system (GE) that links the HIS (Fujitsu) and RIS (Fujitsu) units.

7. Remote Control (Wired) of Auto-Positioning Function

• Ease-of-Operation and Safety

Remote control is used in two locations, inside and outside the control room. Both remote control units are wired, with a cord length of 4 and 5 meters. Wired remote control units allow the technologist to perform positioning while standing closer to the patient, positioning movement stops immediately when the remote control switch is released, and an alarm sound is emitted during movement, so wired remote control is probably safer than wireless.
When operating the wireless units in the other radiography rooms, the X-ray tube can be operated even from outside the radiography room, so we try to only use remote control in locations where the patient is visible. This also applies to the wired units.

• Instantaneousness of X-Ray Tube and Benefits to Workflow

Our current X-ray tube cannot be moved in the vertical axis direction, so it is difficult to say for sure, but based on the prototype system demonstration we saw, it appears the demonstrated system is capable of fairly smooth movement. We look forward to the day when such functionality will be available in future upgraded versions, which will help reduce the waiting time for patients.
Our hospital uses a large number of pre-registered X-ray tube positions for various imaging areas, such as for standing, supine, and cervical spine radiography, for long view radiography, and for extremity radiography. Consequently, this requires setting roughly 40 parameters, so when we are busy, needless to say, it is more efficient to have one technologist specialize in positioning the imaging area and X-ray tube and another technologist specialize in taking the exposures.
The fact that the X-ray tube can be repositioned easily and reliably is very convenient as well.

8. Methods for Having Cumulative Exposure Dose Information Displayed on the RIS Console in the Future

To better educate patients about the safety of radiography examinations (reduce anxiety about radiography examinations) and prevent radiation skin damage, since July 2005 the Division of Radiology at our hospital has been managing patient exposure levels by using a radiation measurement system to monitor cumulative exposure dose levels during radiologic examinations.
From the data resulting from such monitoring, an NDD-M calculation of radiography parameters, X-ray tube performance, back scattering, and other factors is used to calculate values for four areas, mainly for general radiography—the head, chest, abdomen, and extremities, and incorporate the results in information displayed on the RIS console, thereby alerting the doctor if the exposure exceeds 2 Gy for a single examination.
The Shimadzu system we introduced includes a function that calculates exposure dose using ultrasound to measure FSD based on the measured distances. Therefore, we plan to determine the error factor between these measured and estimated exposure dose values, which will provide valuable reference information when replacing our RIS consoles in the future. Also, some of our radiography rooms have radiography systems that include an area dosimeter. Therefore, we will also compare that data to help build our next exposure dose management system based on reliable data from an MPPS that is

reflected in RIS console information. Consequently, we intend to pay close attention to our Shimadzu RADspeed Pro system as we head toward the future.

9. Results from Introducing the RADspeed Pro

Due to the large number of radiography examinations performed at our hospital, as indicated in the statistical data for bone radiography shown in section 5, the waiting room hallways can become very congested for knee examinations on Tuesdays and hip joint examinations on Thursdays. However, due to the linked system and auto-positioning function, and now that we have two multipurpose radiography rooms, it has resulted in shorter patient waiting periods. Furthermore, the fact that different radiography methods can be used in the same radiography room has reduced the physical stress on patients, especially those with physical handicaps, which has resulted in patients thanking us.

Fig. 5

In addition, the system helps reduce the waiting times of general radiography patients somewhat, for example, by allowing us to treat patients requiring thoracoabdominal radiography in a bone radiography room to alleviate radiography room congestion on days of the week when the thoracoabdominal radiography room is busy.

Currently, we cannot automatically rotate the X-ray tube around the vertical axis, so the system is not optimally equipped yet, but once that movement is possible, then I am confident we can further reduce radiography times.

New issues that have resulted from introducing the system include reducing the variability in image quality between X-ray image monitors in different radiography rooms and training new employees on X-ray tubes featuring an auto-positioning function while enhancing their expertise on radiography methods that require manual X-ray parameter setup and X-ray tube positioning. The former is being addressed with help from Fuji (in charge of image quality) to optimize X-ray image quality by minimizing variability of primarily chest, bone, and obstetrics and gynecology radiography on monitors viewed by doctors. The latter is recognized as an important issue for developing our next generation of personnel. Therefore, though we are currently still taking a trial and error approach, we are proactively addressing this issue.