

## Experiences Using New General Radiographic Systems



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### 1. Introduction

Otsu Red-Cross Hospital started with the opening of the Japan Red-Cross Society Shiga Prefecture Branch Hospital close to Shiga Prefectural Government Building in 1904. This year, we celebrate the 100<sup>th</sup> anniversary of our establishment. With 25 departments and 887 beds, this hospital offers a comprehensive range of medical services. Our relationship with Shimadzu Corporation goes back a long way. Following Genzo Shimadzu Jr.'s success in taking X-ray images in 1896, Shimadzu's first X-ray device to run on a commercial power supply was installed in this hospital. (Fig. 1.)

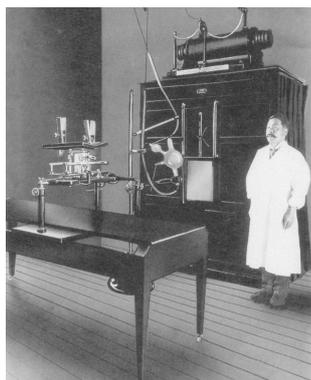


Fig. 1 Early X-ray Equipment

Radiodiagnosis has an important position in medicine today. In terms of numbers, a large proportion of examinations are based on plane radiography, which is used to examine many different parts of the body with a wide variety of radiographic techniques. For this reason, a high level of operability and safety to the patient are demanded from general radiographic systems.



Fig. 2 UD150B-40



Fig. 3 CH-200M

Against this background, Shimadzu's new UD150B-40 X-ray high-voltage generator (Fig. 2.) and new CH-200M ceiling type X-ray tube support (Fig. 3.) were installed at our hospital in the autumn of 2003. In this article, I will give a brief description of our experiences with, and thoughts about, these products. I will also provide some examples of examinations that illustrate a major benefit of using these products, namely, the X-ray tube's large movement range.

### 2. General Features

#### 2.1 UD150B-40 Inverter-type X-ray High-voltage Generator

- The UD150B-40 has a novel, rounded design that has received the Japanese Good Design Award.
- A color LCD display is used as the control console for setting radiography parameters.
- There are illuminations around the control console and in the hand switch that, together with sounds, indicate X-ray tube selection, for example, or that preparation for X-ray exposure is complete or that exposure is in progress. (Fig. 4.)



Fig. 4 Illumination

- Up to 400 anatomical programs can be registered.
- Setting the exposure parameters manually using the hybrid dials makes it possible to complete the required settings more quickly than with conventional products.
- It is possible to record and display up to 64 sets of previous exposure parameters.

#### 2.2 CH-200M Ceiling Type X-ray Tube Support

- Smooth movement is facilitated by the aluminum ceiling rails, which have a dual structure incorporating hardened spring steel.

- The support incorporates a "Center-Find" function as a standard feature. This function stops the assembly at a previously set point. (With other companies' products, this feature is either available as an option or is not available at all.)
- The vertical motion range for the X-ray tube is an impressive 160 cm, ensuring a wide imaging range.
- The X-ray tube can be rotated about the support axis and stopped at the desired angle by turning ON the brake from the control panel. This feature is useful in emergencies, for example, when taking images of the patient lying on a stretcher. (Fig. 5.)

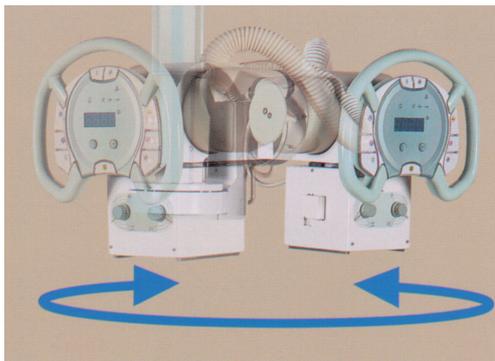


Fig. 5 Free Rotation about the Support Axis

- There are rear switches (for collimator lamps and controlling movement of the X-ray tube) located on the side opposite the collimator control unit at the bottom of the support. When taking images of the patient lying on a stretcher, for example, the X-ray tube can be moved without the operator having to go to the collimator control unit's side. (Fig. 6.)
- The large operating handle is easy to use. The break-release switches can be allocated in a way that suits the user and frequently used switches, such as the vertical-travel switches, can be allocated to the most accessible positions. (Fig. 7.)

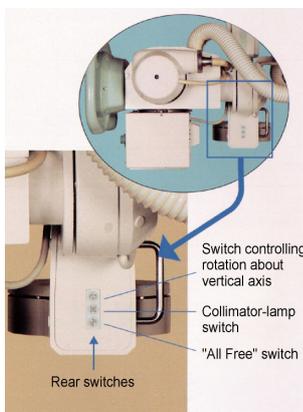


Fig. 6 Rear Switches



Fig. 7 Large Operating Handle

### 3. Mechanisms and Operability

#### 3.1 Operating Panel

Medical equipment continues to become more advanced and more compact. One problem that is related to this is

the heat generated by the control panel. There are many devices that require cooling fans to dissipate heat. With general radiographic systems, the area around the control panel is at the center of the line of travel, and is therefore subject to a large amount of dust. One cause of faults in systems using conventional cooling fans is the suction of dust inside the control panel. With this system, the quantity of heat is carefully calculated so that no fan is required and no dust is sucked inside the equipment. One other benefit of not having a fan is that there is no chance of failing to hear the sounds indicating X-ray irradiation when taking images.

#### 3.2 Setting Exposure Parameters

In general, the exposure parameters are set by selecting the required conditions with the advanced "Anatomical Programs" (hereafter referred to as "advanced APR") that are already registered. (Fig. 8.) Setting the conditions for the most frequent imaging position as the home position makes it possible to set the exposure parameters for that position in an instant just by pressing the "Home" button on the generator control console, significantly increasing work efficiency. It is also possible to record and display the past 64 sets of exposure parameters. This feature makes it possible to double-check the exposure parameters of previous images.

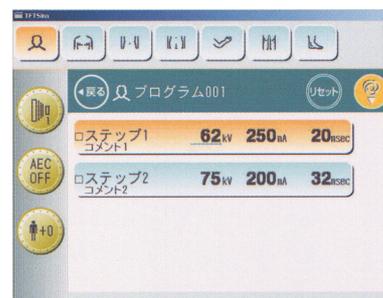


Fig. 8 Advanced APR

		Shimadzu	Company A	Company B	Company C
Vertical motion (for a ceiling height of 285 cm)	Focal distance from the floor (cm)	40 to 200	52 to 202	49.5 to 199.5	49.8 to 199.8
	Vertical stroke (cm)	160	150	150	150
Horizontal motion (for a 400cm fixed rail and a 200cm moving rail)	Longitudinal motion (cm)	295	330	322.4	282
	Lateral motion (cm)	140	112	135	132

Table 1 Comparison of Ceiling Type X-ray Tube Supports Made by Different Companies

When taking images of a patient lying on a bucky table in a radiography room where two x-ray tubes are used, after setting the supine imaging parameters for one X-ray tube, it may be necessary to quickly switch from one tube to the other if the operator cannot get the patient to move in the way required. With this device, the exposure parameters for the same position are retained even after switching tubes, allowing X-ray imaging of small children and imaging in emergency situations to be performed quickly.

### 3.3 Imaging Range Attained by Movement of Support

In general radiography, many different parts of the body are examined and the condition of the patient can vary a great deal; it is often necessary to use all available space in the imaging room. In these cases, it must be possible to move the X-ray tube to the required place. The horizontal area covered by Shimadzu's ceiling-type X-ray tube compares favorably with that of other companies' products. A transverse travel motion range of 140 cm and a longitudinal travel range of 295 cm combine to ensure ample horizontal coverage with standard specifications. (Table 1.)

X-ray tubes have "home positions" in imaging rooms. These may include the X-ray tube's storage position or the position of the X-ray tube used to perform a common imaging procedure. Using the Center-Find function to return the tube to its home position is very effective. At our hospital, where we have set the chest imaging position (focus-film distance: 200 cm) as the home position, the position was displaced by no more than 0.1 cm after three months of use, demonstrating the high precision of this function. The high repeatability and convenience of the Center-Find function has been praised by the staff that perform imaging procedures on a daily basis. It is also worth noting that there is much less knocking of the X-ray-tube support when stopped than there is with conventional supports.

### 3.4 X-raying of Knee Joint in Standing Position

Recently, in order to diagnose osteoarthritis of the knee joint, X-raying in the standing position (i.e., with weight applied) and X-raying with the Rosenberg method have increased. When X-raying the knee joint in the standing position, the range is restricted by the extent to which the X-ray tube can be lowered. The vertical stroke of the X-ray tube with earlier systems was relatively small, making it necessary to have the patient stand on a stool or a bucky table. For patients suffering from knee-joint disorders, and in particular for elderly patients, this was

rather dangerous. With Shimadzu's ceiling type X-ray tube support, the vertical stroke of the focus is 160 cm, giving a larger focus range than that offered by other companies' products. We found that the average height of the knee joint above floor level is 43.9 cm (45.1 cm for men and 42 cm for women with shoes on). (Fig. 9.) With Shimadzu's product, setting the distance of the focus from the floor to a value in the range 40 to 200 cm makes it possible to take images of the knee joint in the standing position. (Fig. 10.) At our hospital, however, we set up the support to move the focus in the range 55 to 215 cm for the following reasons:

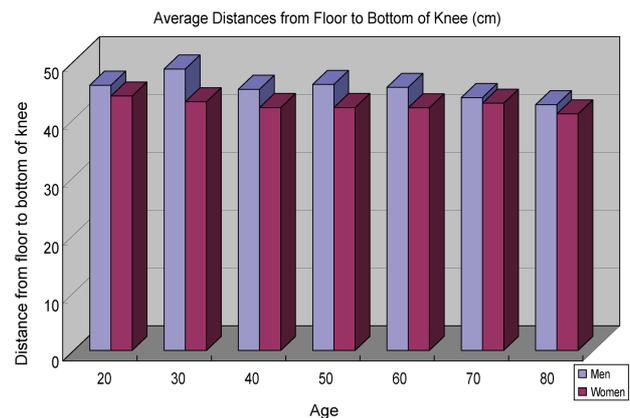


Fig. 9 Average Distances from Floor to Bottom of Knee

- The ceiling rails were originally at a height of 3 m.
- If the focus were set up in the range 40 to 200 cm, the height of the bottom side of the assembly when the X-ray tube is stored at the highest position

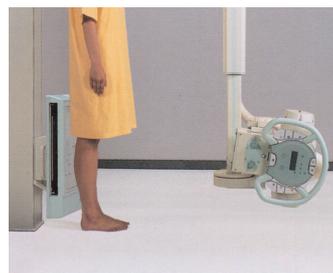


Fig. 10 X-raying of Knee Joint in Standing Position

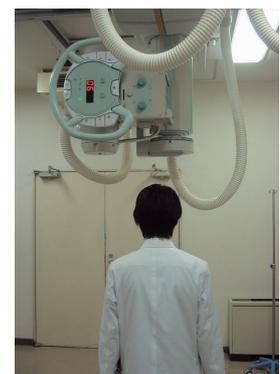


Fig. 11 Position of Tube with Focus at Height of 215 cm

would be 175 cm. In this case, tall patients' and operators' heads may come in contact with the equipment. Lowering the ceiling rails might also make patients feel uncomfortable

If the vertical travel range of the focus were 15 cm bigger, X-raying of the knee joint would be possible in the standing position without having to worry about the installation conditions. Therefore, I would appreciate it if points such as the size of the part supporting the X-ray tube and the operating force required to move the X-ray tube vertically were given further consideration.

#### 4. Points to Note about Installation

The design and coloring of this device are well coordinated, allowing it to fit in well with the surroundings when it is installed. The cables attached to equipment can make the patient feel uncomfortable and are rather unattractive. This device, however, is designed with the patient in mind and, wherever possible, covers are provided for the cables. (Fig. 12.)



Fig. 12

There are many ways in which this device can be customized to ensure ease of operability for the user. Items that can be changed by the user (e.g. advanced APR) can be adjusted in accordance with the user's requirements after installation. The biggest problem faced during installation, however, is the direction in which to mount the X-ray tube onto the support. There are two ways of mounting the support and there are four ways of mounting the X-ray tube with respect to the vertical axis, making a total of eight combinations. (Fig. 13.) It is therefore necessary to discuss the best mounting orientation before performing installation, giving consideration to imaging positions commonly used in the radiography room where the device is to be installed and to the orientation of the X-ray tube used. If the ceiling rails, which allow such a large range of movement, are not installed in an appropriate way, it can restrict the focus range and result in interference with other equipment. Because there is such a high degree of freedom available through customization, sufficient time must be spent on discussions and simulations before actually performing installation.

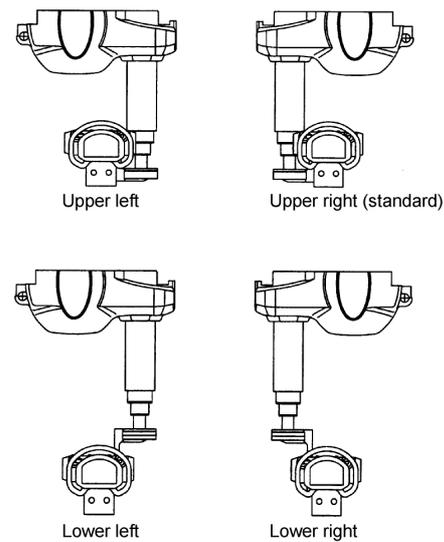


Fig. 13

#### 5. Conclusion

These devices were developed in order to deliver a high level of user operability and the functionality for highly precise X-ray control, and to reduce the burden on patients undergoing examinations. I think that these devices are indeed easy on both users and patients. I feel that the design is not only aesthetically pleasing, but also reflects practical consideration of the movement of the patient. It reduces the feeling of being overpowered by the equipment and can help provide medical treatment in a relaxed way. A good example of this is the way that the problem of ensuring the patient's safety when imaging the knee joint in the standing position has been mitigated. It goes without saying, however, that medical facilities must continue to pursue ways of improving operability and safety, and thereby create systems ensuring a high level of safety for patients.

Nowadays, most medical equipment is digital and general imaging systems are no exception. Compared to CT and MR systems, however, general radiographic systems have very long renewal cycles and, although there are differences between facilities, there are places that continue to use the same systems for more than 10 years. The durability of these systems varies significantly due to differences in usage frequency and method, but I believe that daily maintenance and regular inspections are important factors.

This system supports the mounting of an optional surface-exposure dose monitor. This monitor makes it possible to calculate and display the surface dose incident on the patient without using an expensive dose-area dosimeter, and is thought to be effective tool for regulating the exposure to the patient. I keenly anticipate new developments that will produce systems that are easy on both users and patients.