X-ray / White paper

Initial clinical experience with the latest functions of digital X-ray radiography system Zexira i9

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Introduction

Tokyo Women's Medical University Yachiyo Medical Center was established in 2006 with the aim of achieving a good balance between warmhearted patient care and high-level acute medical services, functioning as a core hospital valued and trusted by the local community. With the addition of a new 501-bed hospital ward and a heliport, the medical center achieved Joint Commission International accreditation in 2020.

Our center has two fluoroscopic examination rooms, one of them is a multipurpose room and the other is a specialized room for endoscopy procedures. When the time came to replace the fluoroscopy system in the multipurpose examination room, we decided to install a Zexira i9 digital X-ray radiography system in August 2021.

Background of installation

In addition to general gastrointestinal angiography, we perform a wide range of diagnostic and therapeutic fluoroscopic procedures, including fistulography in the fields of gastroenterology and surgery, myelography and nerve root blocks in the field of orthopedics, bowel repositioning and voiding cystourethrography (VCUG) in the fields of pediatrics and pediatric surgery, and ureteral catheterization in the field of urology. These procedures are often performed with ultrasound and/or endoscopy used in combination.[1]

Because the center has only one multipurpose fluoroscopy examination room, Zexira i9 was selected as a system that provides the largest possible work space in the small examination room, that allows fluoroscopy to be performed at any location on the patient table for maximum flexibility in a wide variety of diagnostic and therapeutic procedures, and that offers outstanding reliability to ensure minimum downtime.

Our previous system had to be installed parallel to the control room, so the work space in the examination room was extremely limited, making it difficult to bring in patient beds. Zexira i9, on the other hand, can be placed against the wall with a total footprint depth as small as 173 cm, so our system could be installed perpendicular to the control room (in the longitudinal direction), which freed up a large area in front of the system (figure 1).

Latest functions available in Zexira i9

Zexira i9 is the latest digital radiography system combining a newly designed image processing unit (DR) with a 43 cm Flat Panel Detector (FPD) manufactured by Canon Inc. The density resolution of the FPD has been increased from 14 bits to 16 bits. The DR system has also been redesigned with a new user interface (figure 2) for easier and more intuitive operation, including patient registration using a touch panel and a wide variety of function settings based on study protocols, bringing the system fully up to current specifications. The most impressive of these new features is i-fluoro. This function allows the FOV to be moved without the need to reposition the imaging system or the tabletop, eliminating the additional radiation dose required for repositioning and ensuring safer examinations.

Figure 1: Overall view of the multipurpose fluoroscopy examination room with digital X-ray radiography system Zexira i9

The system is compact and can be placed against the wall, freeing up a large area in front of the system.

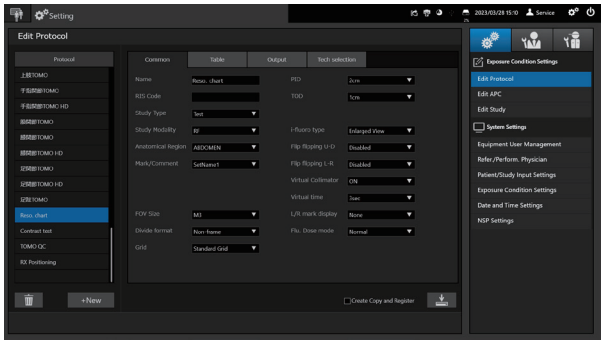

Figure 2: DR with a newly designed user interface for intuitive operation.

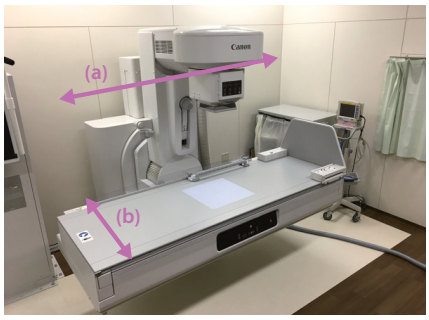

Figure 3: Moving the FOV when a conventional fluoroscopy system is used

The FOV is moved by physically repositioning the imaging system in the longitudinal direction (a) and the patient table in the lateral direction (b).

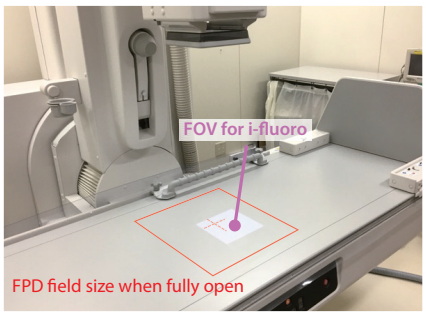

Figure 4: Moving the FOV when i-fluoro is used

The FOV can be moved anywhere within the fully open field size of the FPD, eliminating the need to reposition the imaging system or the patient table.

Figure 5: i-fluoro lever

The i-fluoro lever is conveniently placed next to the levers for controlling the imaging system and patient table, allowing smooth transition to operation of the i-fluoro function.

i-fluoro

During fluoroscopy procedures, depending on the specific objective, we use the "inch-up" function to move the FOV, allowing us to precisely track the movements of the catheters and guidewires. In a conventional fluoroscopy system, the FOV is moved by physically repositioning the imaging system in the longitudinal direction and the patient table in the lateral direction (figure 3). When the inch-up function is used in such a system, the radiographic image is displayed by magnifying the central area of FPD. In Zexira i9, although the method is basically the same in principle, the difference is that the inch-up function allows the FOV to be moved anywhere within the fully open field size of the FPD (43 cm × 43 cm), eliminating the need to reposition the imaging system or the patient table (figure 4). For this reason, the conventional limitation of "the center of the FPD" no longer applies to the magnified area displayed as an inch-up image.

When i-fluoro is used, the four blades of the collimator (upper, lower, left, and right blades) are adjusted by operating the i-fluoro lever to freely move the FOV (figure 5). The target is tracked while the FPD shows a fluoroscopic image of only the area in which X-rays are projected. In addition, inch-up fluoroscopic images are continuously displayed on the fluoroscopy monitor. Although the X-ray beam used in i-fluoro is the same size as the fully open FPD and does not match the actual FOV, good image quality is maintained.

Greater safety with i-fluoro

In fluoroscopic examinations or therapeutic procedures (and especially in invasive procedures), the operator is instructed to always watch the surgeon's hands and to notify the surgeon before moving the field of view or to ask the surgeon to temporarily move their hands away. A common, but very dangerous, concern is that inexperienced operators tend to rush to move the FOV in order to track the target while looking only at the fluoroscopy monitor.

When i-fluoro is used, because there is no need to physically reposition the system, the FOV can be moved safely without interrupting the surgeon's work. In addition, during invasive procedures, patients are unable to see what is happening, so they tend to focus on what they hear and feel.[2] With i-fluoro, patient anxiety is reduced because there is no disturbing sound or vibration due to mechanical movement of the system. Nevertheless, even when i-fluoro is used, it is essential for the operator to always observe the surgeon's hands and pay close attention to ensure safety.

Clinical application of i-fluoro

This section describes retrograde cystography (RCG) in detail as an example of the clinical application of i-fluoro.

(1) Place the patient on the table. Turn on the X-ray field indication lamp. Position the imaging system and the tabletop at a position where the target is included in the FOV and set the position in advance (figure 6a).
(2) Perform fluoroscopy for a short time to obtain a last image hold (LIH).
(3) Activate i-fluoro. Select the field size to be used for examination. Set the position precisely based on the LIH without additional fluoroscopy (figure 6b). Start the contrast enhancement procedure (figure 6c).
(4) During the procedure, adjust the field size or move the FOV as required.

When the above steps are followed, there is no need to perform additional fluoroscopy during position setting, which minimizes radiation exposure. Because the imaging system and the patient table do not need to be physically repositioned, procedures can be performed with greater safety and less patient anxiety.

Zexira i9 has a number of additional useful features. The imaging system has an extremely long movement range of 162 cm in the body-axis direction and the FPD can be moved up to a position 9 cm from the end of the table. This means that field enlargement up to this position is possible (figure 7), which is extremely helpful when performing procedures such as hysterosalpingography (HSG), ureteral catheter placement/replacement, and central venous catheter insertion via a puncture site in the neck.

Low dose while ensuring high image quality

Figure 8 shows two images of the same patient: a lateral view of the lumbar spine obtained by general radiography (figure 8a) and a contrast-enhanced image of the spinal canal obtained by Zexira i9 (figure 8b). Although the exposure dose is much lower for the image in figure 8b, low-contrast regions near bone are clearly visualized and excellent contrast enhancement is seen in the spinal canal, which was the primary diagnostic objective of this study. By introducing the FPD and , resolution in low-contrast areas is markedly improved even at lower doses. In addition, processing can be performed with different parameters to optimize image quality in both low-absorption areas and high-absorption

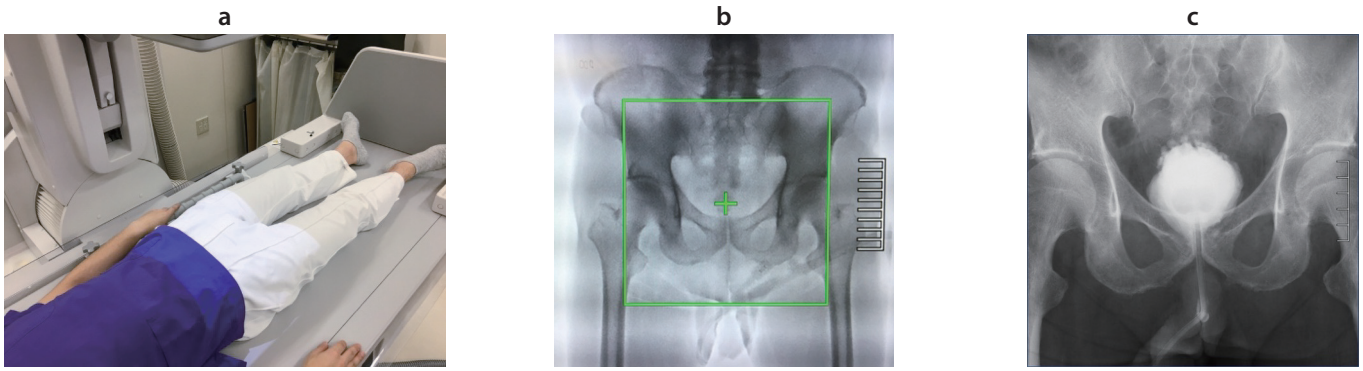

Figure 6: Clinical application of i-fluoro in RCG

a: Position setting using the X-ray field indication lamp
b: Precise position setting using i-fluoro (□) after obtaining an LIH at a fully open field size (figure shows the image displayed on the monitor)
c: Radiographic image acquired using i-fluoro

Figure 7: The FOV can be enlarged up to a position 9 cm from the end of the table

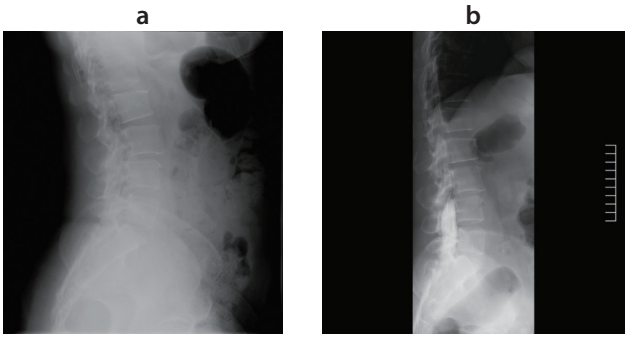

Figure 8: Comparison of images of the same patient obtained by general radiography and by Zexira i9

a: Lateral view of the lumbar spine obtained by general radiography (scan conditions: 88 kV, 60 mAs)
b: Contrast-enhanced image of the spinal canal obtained by Zexira i9 (scan conditions: 91 kV, 6.4 mAs)

areas, providing extremely clear images with outstanding gradation which was previously very difficult to achieve in a single image. Various functions are also provided to reduce radiation exposure. For angiography, a retrospective fluoroscopic storage function has been added, which is now a common feature for use in combination with radiography. Image brightness was previously controlled using a function known as "automatic brightness control" (ABC), in which the brightness is controlled by reducing or increasing X-ray output, but it is now controlled by digitally adjusting the brightness using a new function known as "digital brightness adjustment" without the need to change the fluoroscopy dose rate. In addition, three fluoroscopy dose modes are available, allowing the fluoroscopy dose rate and digital brightness correction to be adjusted with no loss of image brightness. The grid-controlled X-ray tube supports pulsed fluoroscopy with a short wave head and tail at nine selectable frame rates: 1, 2, 3, 5, 7.5, 10, 15, 20, and 30 fps. These features allow us to strategically employ the most suitable frame rates. For example, 15 fps can be selected for clearer visualization of movement, 3 fps can be selected for VCUG in pediatric patients, and so on.

Finally, X-ray exposure dose report functions are available in Zexira i9 (figure 9). These functions can also be used for dose management in order to satisfy the dose optimization and evaluation requirements specified in the Japanese Diagnostic Reference Levels (2020 version).

Although it has been only 2 months since the installation of our Zexira i9 system, we are happy to share our initial clinical experience with the features and functions of the system up to the present time. In order to fully utilize the latest functions of Zexira i9, users must gain a thorough understanding of the system. Our goal is to develop examination protocols that ensure an optimal balance between image quality and exposure dose by making the best possible use of the many advanced functions provided in the system. Zexira i9 is a system that fully meets the needs of fluoroscopy in modern clinical practice.

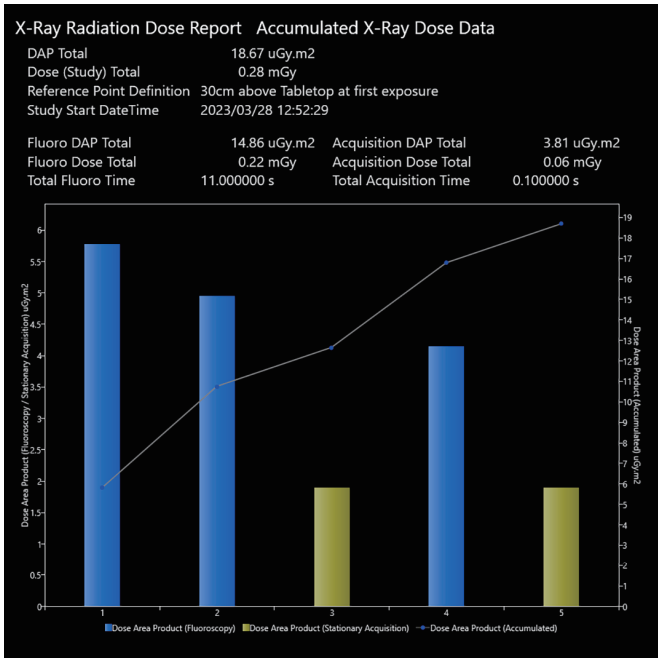

Figure 9: X-ray exposure dose report

Dose datasets for fluoroscopy and radiography are displayed in graphical form for each event. This allows dose management from an additional perspective that differs from the conventional method.

References

1. Yuko Kobashi. Points to be noted when performing examination (Fluoroscopy): *Clinical Image*, 36(14):30-37, 2020. (in Japanese)
2. Japanese Association for Operative Medicine: Practice Guidelines for Surgical Medicine (revised edition). 2013. (in Japanese)

The contents of this report include the personal opinions of the author based on his clinical experience and knowledge.

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