Experience Using the FLEXAVISION F4 Package R/F System Suitable for Hospital Scale Operations

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1. Introduction to the Hospital

Higashimatsuyama City is located almost in the center of Saitama Prefecture and celebrated its 70th anniversary as a city on July 1st of this year (2024). Surrounded by lush, natural hills, it is a pleasant place to live, with convenient access to central Tokyo, approximately one hour by away train. Our hospital has a history of 60 years since its establishment. With a total of 150 beds (146 general beds and 4 infectious disease beds), it serves as a core hospital for secondary emergency medical care in the Hiki district (including Higashimatsuyama and six other towns and one village). In recent years, we have strengthened our emergency and advanced specialty medical systems by adding physicians with high levels of specialization, including specialists in neurology and stroke treatment, as well as gastroenterology. To reassure the local community, our hospital's philosophy states "Our hearts are always for our patients." We continue to improve our capabilities as a core hospital, primarily focusing on acute care **(Fig. 1)**.

Two R/F rooms are available in medical departments and one room in the health check-up center. In 2023, we simultaneously introduced a FLEXAVISION F4 package system and a SONIALVISION G4 LX edition (hereinafter referred to as the G4) system, both manufactured by Shimadzu Corporation, in the two medical department examination rooms. The G4 is equipped with optional features such as SmartBMD, SLOT Advance, and Tomosynthesis. We currently have 11 radiological technologists (8 in the radiology department and 3 in the health check-up center).

This report focuses on our experience with the FLEXAVISION F4 package R/F system (hereinafter referred to as the F4).

Fig.1 Higashimatsuyama Municipal Hospital

2. Background of Equipment Introduction

The two R/F systems in the medical department reached their replacement period at the same time as with the breakdown of the bone density measurement device, which was deemed irreparable. One of the old R/F systems was a SONIALVISION safire 17 system from Shimadzu Corporation. In updating the equipment, we aimed to maintain SLOT Advance and Tomosynthesis functionalities, while also addressing strong requests from orthopedic physicians for a system capable of measuring bone density. As a result, we decided on the G4 **(Fig. 2)**. Because the previous bone density measurement device was operated in a different examination room, the new system also provided significant benefits in terms of more effective space utilization. For the other system, we selected the F4, which is capable of performing fluoroscopy examinations requested by all medical departments (including endoscopic retrograde cholangiopancreatography: ERCP) and offers excellent performance for the cost, allowing efficient use of the examination room without placing a strain on hospital operations. Notably, the maximum anode heat capacity of the installed X-ray tube system is 400 kHU.

Fig.2 Appearance of SONIALVISION G4

By introducing both systems simultaneously, we achieved cost reductions and established a comprehensive maintenance agreement that included four Shimadzu RADIOTEX CM general radiography systems, which helped control long-term running costs. Furthermore, the old bone density measurement device measured forearm bones and had a medical reimbursement of 140 points, while the G4 SmartBMD system measures the lumbar spine and proximal femur, allowing for a reimbursement of 450 points, thus providing a significant advantage in profitability. These factors are critically important in terms of hospital management, which helped smoothly gain the understanding of the hospital executive board regarding the simultaneous introduction of both systems.

3. Features of the Equipment

The examination room where the F4 operates is the largest room within the radiology department. However, the previous equipment made the space cramped during procedures such as ERCP due to the presence of endoscopes and other medical devices. The compact, space-saving design of the F4, which features a one-cabinet configuration, has resulted in a more spacious area around the support columns, improving nurse workflow and enhancing patient monitoring. Additionally, ample workspace around the table allows for the placement of medical equipment and facilitates moving patients in a hospital bed into the room. The control room is equipped with a single remote console that controls the R/F table emission and digital image processing, making it simple and user-friendly. The absence of a separate image processing control cabinet and presence of only one PC operating the console, keep the area tidy and utilize the limited space in the control room effectively.

The F4 is equipped with a new type of flat panel detector (FPD) that features a large field of view (17×17 inches) and five selectable views, which enables viewing a broad area at the same time. This capability enables comprehensive imaging of areas ranging from the kidneys to the bladder for urological examinations, the entire digestive tract for lower gastrointestinal tract examinations, and showing the entire lung field in one image for chest imaging. For instance, in the case of dislocation fractures, the F4 enables fluoroscopy for the confirmation of fracture conditions, followed by radiography for fracture reduction, imaging, and chest X-rays upon admission, all without having to move the patient, thus streamlining the examination process. Furthermore, the F4 now offers a high-definition fluoroscopy mode with a 6-inch field of view, allowing for an expanded area of interest in endoscopic procedures and, thereby aiding in the success of those techniques.

Two table-side monitors are provided in the examination room. In terms of image quality, the F4 provides clear fluoroscopic images with reduced noise, even for patients with high body thickness. The F4 is equipped with an image processing engine that includes multi-frequency processing, which enables the reduction of halation in direct line areas and enhances the contrast and edge definition of devices. This improves examination efficiency and reduces the burden on both patients and operators. Additionally, the F4 is fitted with a scattering protection drape specifically designed for compact R/F systems (manufactured by Hoshina Seisakusho), which further contributes to the reduction of radiation exposure. The table has a practical load capacity that allows both the patient and the physician to be on the table during procedures, such as for fracture reduction during fluoroscopy, and it also features oblique incidence X-ray tube function. As a result, it enables all fluoroscopic examinations requested by our medical departments **(Fig. 3)**.

Fig.3 Appearance of the FLEXAVISION F4

4. Case Examples

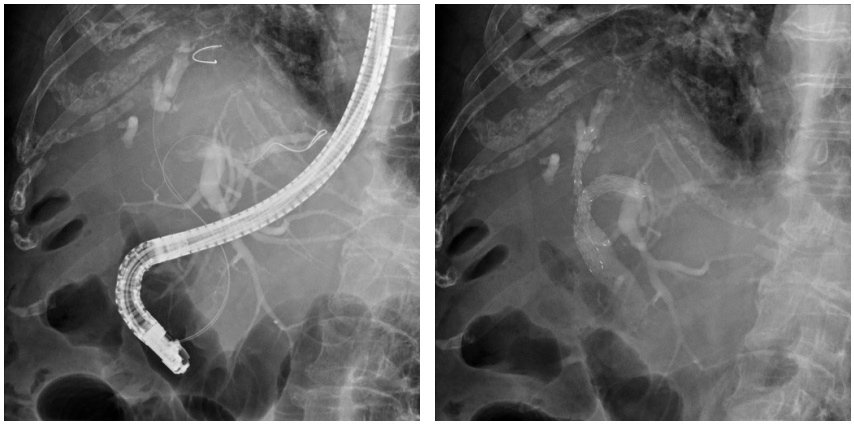

Fig.4 Endoscopic Biliary Stenting

Fig.5 Urological Examination

5. Effectiveness of the Scattering Protection Drape

We evaluated the effectiveness of the protection drape. The fluoroscopy conditions were set at 89 kV, 2.3 mA, and 15 fps, using a 20 cm thick phantom (10 cm acrylic and 10 cm Mix-DP) for scattering measurements with a Cobia Flex (RTI Corporation) high-sensitivity semiconductor probe. The measurement height was set at 150 cm above the floor. For creating the scattering distribution map, we utilized ScRaX (SS Giken Co., Ltd.) software **(Fig. 6)**.

In the absence of protection, the maximum radiation dose was measured at 144.57 μSv/min, while with protection, it was reduced to a maximum of 4.13 μSv/min. At the operator's position, the values were 73.76 μSv/min without protection and 2.27 μSv/min with protection, resulting in a reduction rate of approximately 97%.

These results demonstrate that the scattering protection drape is effective in reducing radiation exposure during ERCP and other examinations, contributing to the safety of medical personnel within the examination room. The importance of protection is particularly heightened given the recent reductions in dose limits for the lens of the eye. Our measurements confirm the effectiveness of the protection drape as part of radiation protection measures. Additionally, we have displayed the scattering maps within the examination room as visual reminders of radiation dose levels and they have been well received by both physicians and nurses.

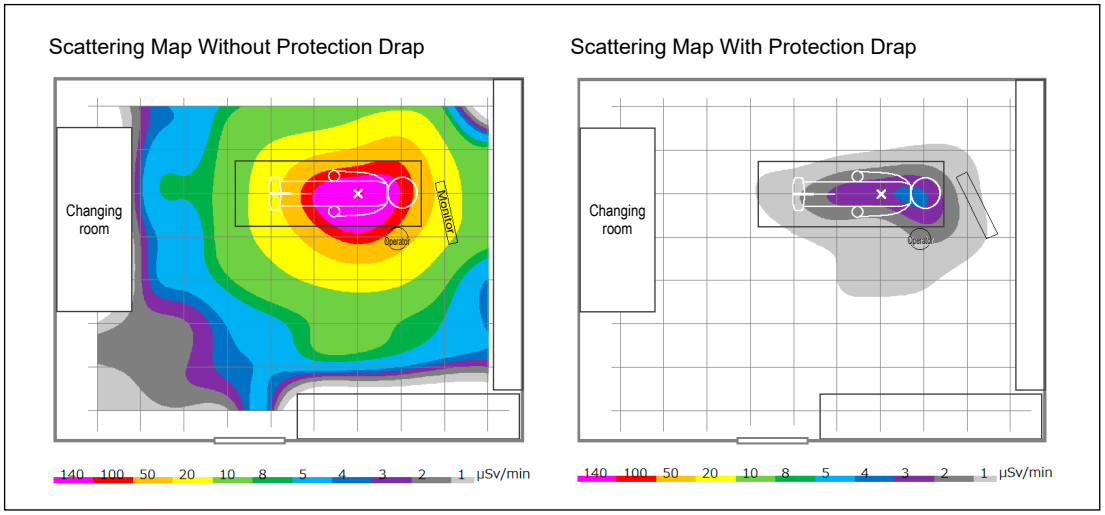

Fig.6 Scattering Maps With and Without Protection Drape

6. Conclusion

Due to our characteristics of our region, there are numerous requests for imaging, including bone density measurements, particularly from orthopedic departments, which has resulted in using the G4 primarily for orthopedic purposes, including using features such as SLOT Advance and Tomosynthesis functionality. Requests for fluoroscopic examinations like ERCP are not as common, allowing us to conduct such examinations using the F4. The operation of both R/F systems enables us to conduct examinations for orthopedic patients without any waiting time, even during prolonged fluoroscopic procedures.

Since its introduction, over 1,000 bone density measurements have been performed with the SONIALVISION G4 SmartBMD system within approximately one year. While requests for bone density measurements primarily come from the orthopedics department, requests from internal medicine and urology departments have been increasing since the introduction of the system. The entire examination process, from the patient entering the room to imaging, analysis, and generating a report, takes about five minutes. The burden on patients during positioning is minimal and the G4 system simplifies the analysis process (with AI assistance), which has improved examination efficiency.

The FLEXAVISION F4 package sufficiently meets our department's requirements for introducing the equipment, including cost effectiveness, comfort, low radiation exposure, and high image quality. Consequently, it has received high praise from physicians across all departments, including gastroenterologists who handle procedures such as ERCP. Moreover, the administrative departments appreciate that maximum clinical effectiveness is achieved with only essential functionality (investment). From the perspective of examinations performed at our hospital, it serves as a dependable device for critical situations. In terms of future equipment improvements, it would be beneficial if the minimum position of the table could be lowered by an additional 10 cm to facilitate easier patient accessibility getting on and off the table.

The F4 and G4 systems introduced during this equipment update are consistent with the scale of our hospital and the characteristics of the region, and they support the diagnostic imaging operations of our departments for providing ongoing high-quality and appropriate medical services and providing a sense of security to the local residents.