

Experience Using the SONIALVISION G4



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1. Introduction to Our Hospital

When Nihon Koukan Hospital (**Fig. 1**) was founded in 1937, it was the first general hospital in Kawasaki City, Kanagawa Prefecture. The Koukan Clinic (**Fig. 2**) was established in October 2003 as part of the Nihon Koukan Hospital. The hospital is visited by around 1,100 outpatients every day and has 395 beds (45 for convalescent care). It plays the role of a central, community-based hospital, working in cooperation with local hospitals and clinics, and acting on the fundamental principles of the Koukan Association: "medical care that is holistic and patient-centered," "medical care delivered with sincerity," and "medical care firmly rooted in the local community."



Fig. 1 External View of Nihon Koukan Hospital



Fig. 2 External View of Koukan Clinic

2. Our Needs for Introducing a Fluoroscopy System

An R/F system is one of systems for which many demands are made due to the variety of intended uses. Reasons that high fluoroscopic image quality is demanded include our strong need for clear image rendering for the visibility of guide wire and

the visibility of subtle, pale contrast of contrast media as well as the increasing employment of endoscopy for various purposes and increasing use of fluoroscopic recording for swallowing imaging. High-definition fluoroscopic images have also become an effective tool for recognizing subtle lesion changes during stomach radiography examinations and enema examinations. Improvements in fluoroscopic image quality, as well as shortened examination times, have been essential in improving the quality of medical care at this hospital. Nevertheless, it would be short-sighted to focus only on image quality and result in increasing exposure dose. Having given both these requirements equal concern in choosing the model of system, because of the substantial noise reduction achieved during fluoroscopy and radiography examinations resulting in lowered exposure dose and improved image quality and because of the safety of use, we chose the Shimadzu SONIALVISION G4 (**Fig. 3**).



Fig. 3 SONIALVISION G4

3. Merits of the New System

The merits of the SONIALVISION G4 (hereafter G4) are shown below.

- (1) Fluoroscopic/radiographic image quality is improved.
- (2) System operability is improved substantially.
- (3) Features that enable a reduction in exposure dose
- (4) System safety is improved.
- (5) Supporting functions of benefit to each hospital department are included.

3.1. Improvements in Fluoroscopic/Radiographic Image Quality

• SUREngine-Advance

The exposure dose given during a single X-ray examination is greatly influenced by the fluoroscopy time. However, reducing the exposure dose by decreasing the fluoroscopy dose can result in inadequate irradiation and a substantial increase in image noise, which can become a potential impediment to the examination itself. Furthermore, reducing the fluoroscopy frame rate in an effort to reduce the fluoroscopy dose can result in insufficient continuity between fluoroscopic images and reduced image quality as a result. The frame rate must be selected very carefully and according to the objectives of the examination itself. Another factor to consider is that increasing the strength of the recursive filter, which is used to control noise, will increase the number of afterimages. While this technique can be used during examinations with little movement of the target, during examinations such as stomach X-ray examination that include rapid movement and flow, and with examinations that include delicate manipulation of guide wires and the like, use of the recursive filter is limited by the objectives of the examination and it cannot be used to reduce noise completely. Therefore, the reduced visibility of subtle findings and guide wires may cause increased examination times.

The SUREngine-Advance used in the G4 is a further evolution of the SUREngine included in the SONIALVISION safire, currently in use at our hospital, and allows effects of noise reduction improvements to be visually confirmed. The addition to the G4 of a frequency-separating recursive filter efficiently reduces noise components at separate frequencies, minimizing the effect of noise on the image in all frequency bands and improving fluoroscopic image quality. The noise reduction effect can also minimize use of the recursive filter, thereby reducing the number of afterimages in

fluoroscopic images. This feature improves visibility during the delicate manipulation of guide wires and during the observation of barium flow in stomach fluoroscopy, and has received high praise from the physicians using it at this hospital.

Furthermore, for improvements of fluoroscopy image contrast, dynamic range compression technology is used to reduce the halation that occurs in areas where there is substantial variation in fluoroscopy dose or direct X-rays incident on the FPD during fluoroscopy, resulting in a dramatic improvement in visibility in low-dose regions.

• Density Standardization Processing

The originally obtained image data will not always produce an image of optimal quality. This is because an original image includes uncertainties due to the inclusion of direct X-rays and body positioning, so applying the same image processing to the original image may not produce identical quality images, which are not always optimal for a region of interest either. Therefore, the G4 includes a density standardization processing function. Density standardization processing perceives a region of interest in the original image from a histogram, and applying optimization processing to the histogram makes it possible to produce a consistent image quality. By using this function, at our hospital we have been able to send approximately 80–90 % of images to PACS without post-imaging modification after a single examination in cases of stomach radiography examination (**Fig. 4 and Fig. 5**) and enema examination (**Fig. 6**). Because the minimum necessary number of images is taken for a stomach radiography examination, the images including many areas with blocked up shadows or insufficient density can lead to overlook lesions. The greatly increased rendering range provided by the optimization processing is of substantial assistance during diagnosis in these cases.



Fig. 4



Fig. 5

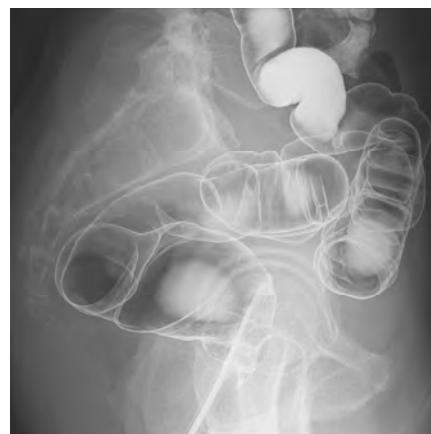


Fig. 6

- High-Definition (HD) Fluoroscopy Mode

HD fluoroscopy mode (6-inch only) permits display of fluoroscopic images at 1 x 1 binning mode with a pixel pitch of 139 μm (Fig. 7). At our hospital, we switch to HD fluoroscopy mode to evaluate the articular surface when repositioning fractures in fingers and wrists with a fracture that reaches an articular surface, or when observing for small common bile duct stones during ERCP.



Normal Fluoroscopy



High-Definition Fluoroscopy

Fig. 7 Normal Fluoroscopy and High-Definition Fluoroscopy

3.2. Substantial Improvements in System Operability

- Improved Overall System Response

The system is ready to perform imaging about two minutes after turning on, making it suitable for quick examinations in an emergency. In addition, operability has been improved greatly for all operations, providing a substantial improvement in examination efficiency and making the conduct of multiple examinations a stress-free process.

- Complete Control over Imaging Conditions Through the Touchscreen Panel

With the G4, all adjustments can be made through a touchscreen panel located in the middle of the remote console (Fig. 8). This permits the stress-free change of conditions to perform plain radiography.

- Customizable Buttons for Hospital-Preset Use

The remote console has 10 customizable buttons and the local console has 8 or 10 customizable buttons that can be configured according to the uses of the hospital, with a resulting substantial increase in examination efficiency. The presence of customizable buttons on an R/F system that is used in a variety of situations is testament to the thoughtfulness of Shimadzu. Since we perform a large number of stomach fluoroscopy examinations and enema examinations at this hospital, many of the buttons have been allocated to inch switching.



Fig. 8 Remote Console

- Widened Potential Range of Fluoroscopy

Improvements to the table have removed the appearance of metal parts at the edges of the fluoroscopy field of view. The effectiveness of this improvement is demonstrated in enema examinations, arthrography, myelography, extremity repositioning, shunt PTA, and other examinations. Furthermore, using an asymmetric collimator that accepts one-sided collimation, and virtual collimation that adds collimation to a LIH (light-image-hold) fluoroscopic image without fluoroscopy avoids unnecessary exposure in patients and operators and utilizes the fluoroscopic field of view to its maximum effectiveness.

3.3. Features That Can Reduce the Exposure Dose

- Grid Detachment

Being able to perform fluoroscopy and radiography with the grid detached has increased the compatibility of the G4 for pediatric examinations that employ low levels of exposure, and since radiography can be performed in the low-kV region, the G4 can also now be used for examination of areas where it was difficult to obtain image contrast, such as extremity peripheries, with radiation quality proper to each region. Images obtained by low-kV radiography using a G4 without the grid attached (Fig. 9, Fig. 10, and Fig. 11) provide the same level of quality as that of images obtained using a general radiography system. As well as broadening the scope of use of the G4 to plain radiography, this improvement can also be expected to lower the exposure dose during fluoroscopic examinations in the future.



Fig. 9



Fig. 10



Fig. 11

- **Autofilter (Soft X-Ray Removal Filter) Function**

The autofilter function, which consists of three soft X-ray removal filters that can be set automatically depending on the type of examination, removes soft X-rays that do not contribute to the image and can reduce the patient exposure dose by 40 % (compared to imaging without a filter). By choosing a filter that is highly effective at soft X-ray removal, low-exposure examinations can be performed, such as for pediatric examinations and the gynecologic HSG (hysterosalpingogram).

3.4. Equipment Safety Improvements

- **Safety Sensors**

To facilitate an environment where assistance can be safely provided to patients, gaps have been removed from the G4 unit to prevent the insertion of fingers and other small objects and safety sensors have been installed in multiple hazardous locations that are at risk of contact such as on supports.

- **Table Elevation When in Standing Position**

The step up to the table during radiography in standing position was previously relatively high, and mounting and alighting from the step was not easy for elderly and postoperative patients. Mounting and alighting from the G4 is safer due to a table that can be lowered nearer to the floor when at a tilt angle of between 80° and 90°.

3.5. Features of Benefit to Each Hospital Department

- **Urology Mode**

Widening the potential range of fluoroscopy with the G4 has made observation possible at distance of 9.5 cm from the tabletop. In urology mode, there is a "uro-tracking" mode where X-rays are collimated based on the tabletop edge to allow the conduct of procedures while reducing exposure. In addition, the table can now be tilted without an operator needing to change the height

of their hands, facilitating efficient examination and treatment without causing stress to them.

- **Fluoroscopic Recording Function**

The fluoroscopic recording function is used to check the passage of the contrast media during VF (videofluorography) and gastrointestinal examinations. Dynamic range compression has made movement of the lips and tongue easier to observe, fluoroscopic recording of high-quality images is possible at a resolution of 1024 × 1024 pixels, and a maximum of 1000 frames can be saved.

- **Compatible with PinP**

By preparing a dedicated PC with external HD and a network connection, digitalized and stored fluoroscopic images can be linked with even virtual endoscopy to enable PinP (Picture in Picture) display with endoscopic images, which can be helpful in assisting manipulation during endoscopic examinations.

4. Summary

The greatest strength of the SONIALVISION G4 is a substantial improvement in its fluoroscopic performance. R/F systems are gradually moving away from using an I.I. (image intensifier) to using an FPD. A previous FPD system managed to deliver satisfactory, high-quality radiographic images with a wide dynamic range, no warping at the image margins and little noise compared to using an I.I. For fluoroscopic images, however, the FPD system posed a number of issues including increased noise and afterimages relative to using an I.I. Therefore, it was far from satisfactory in an everyday clinical site. However, the G4 improves greatly on noise and afterimages

caused by insufficient exposure, which are the main shortcomings of using an FPD to obtain fluoroscopic images. The G4 demonstrates a real advancement in the fluoroscopic images obtained using an FPD, and we urge you to view these images for yourself even just the once. Other positive attributes of the G4 are a low dose mode that uses noise reduction processing to reduce the exposure dose and other features that support the use of this mode (grid detachment and autofilter features).

Our future tasks include an improvement in image quality by the previous R/F system and combining the main unit with PinP features to be used in the future to support examinations and procedures in many scenarios. Although improving functionality, adding new features and increasing ease of use in a fluoroscopy system to be used for a variety of examinations is no easy proposition, we look forward to Shimadzu delivering further such systems able to provide safer and higher quality medical care.