R/F

Using the SONIALVSION safire Series Tomosynthesis Application

Mr. Yoshihiro Uchida

Department of Radiological Technology, Mitsubishi Kyoto Hospital
Yoshihiro Uchida

1. Introduction

The Mitsubishi Kyoto Hospital was established in 1946 as a company hospital for employees of the Kyoto Works of Mitsubishi Heavy Industries Limited. However, currently the hospital is affiliated with the Mitsubishi Motors Corporation, which was spun off as a separate company in 1970. Located in the southwest part of Kyoto city, the Mitsubishi Kyoto Hospital has 188 beds (174 beds in the general ward, 8 in the ICU/CCU, and 6 in the NICU). Ever since it was originally established, it has treated not only Mitsubishi employees and their families, but also the general public living in the greater area, serving a vital role as a central hospital contributing to the region.
Immediately after the hospital was established, the hospital mainly treated tuberculosis and other contagious diseases. However, due to subsequent changes in disease trends, the treatment facilities have been expanded and updated many times. Then in 2007, we were reborn as a hospital designed to withstand earthquakes and other disaster events, and the only hospital in Japan with all buildings designed to be earthquake-proof, with only electric equipment, stocked with an emergency underground supply of water, and equipped with a heliport. All our employees are dedicated to providing healthcare based on our fundamental philosophy of supplying sophisticated and friendly healthcare **(Fig. 1)**.

Fig. 1 Mitsubishi Kyoto Hospital

2. Current Status

Our hospital has one fluoroscopy system. Due to diminishing image brightness and passage of the equipment life, the previous II-DR system was replaced in December 2012 with a SONIALVISION safire series FPD-DR system. It is used for a wide variety of examination and treatment procedures, such as upper GI studies for screenings in the morning and ERCP for gastrointestinal medicine, pre- and post-operative contrast radiography for gastrointestinal surgery, bronchoscopy for respiratory medicine, HSG for gynecology, myelography and arthrography for orthopedics, and VF(video fluoroscopy) for oral surgery **(Fig. 2)**.

Fig. 2 SONIALVISION safire Series

When the SONIALVISION safire system was introduced, we had not planned to use tomosynthesis. Therefore, the doctors did not show much interest during the manufacturer's presentation. Therefore, we studied all about tomosynthesis to determine how it might be used at our hospital and what medical cases would benefit most from its functionality.
Furthermore, we had the technologists engage in activities to promote having the doctors actively use tomosynthesis. As a result, the orthopedic department started submitting examination orders. Then the examination reservation log, which had always been relatively sparse, started filling up. In addition, we readily accepted even unscheduled

orders as much as possible, which resulted in an average of 17 examinations per month and a total of about 200 examinations in 2013 **(Fig. 3)**.

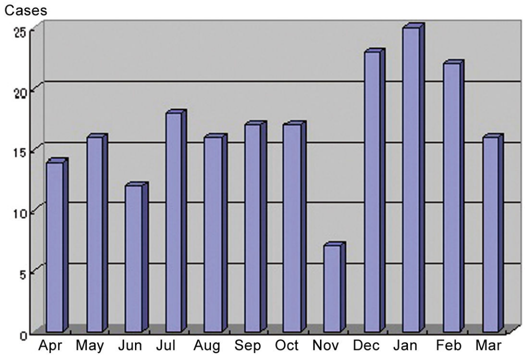

Fig. 3 Number of Cases Using Tomosynthesis in FY 2013

3. T-smart

When the system was introduced, it already included the optional T-smart function capability. (T-smart isolates the metal areas from surrounding areas of tomosynthesis images and then reconstructs an image for each area by successive approximation so that all images are eventually combined.) This process of successive approximation, called iterative reconstruction (IR), reduces metal artifacts better than previous filtered back projection (FBP) methods and allows obtaining thinner cross sectional image slices. Consequently, there was an active shift to using tomosynthesis, such as for arthrography and inserting metal implants after surgery. The IR method reduces metal artifacts and also renders detailed structures, such as bone fracture lines and trabecula, in more detail, which has been a tradeoff when using the FBP method **(Fig. 4)**. However, there are issues with the IR process, such as a long reconstruction time, difficult metal filter selection process, and insufficient contrast in images. Initially we used the IR method to process images from orthopedics, but for diagnostic purposes orthopedic surgeons also wanted FBP images that provided contrast levels that resembled plain radiography. Therefore, currently our hospital provides two types of images, processed using either IR or FBP methods.

4. Displaying and Saving Oblique Tomographic images

Previously tomosynthesis images were coronal slice images obtained with the target area positioned parallel to the table. However, the oblique slice display and saving functions on the new side station allow displaying oblique slices tilted left-right or backward-forward at angles up to ±20 degrees. This allows correcting slight misalignments in cross sections in follow-up observations or displaying a wider range in each cross sectional image for bone fracture lines, metal implants, and so on. This feature is thus helpful for achieving more accurate diagnoses **(Fig. 5)**.

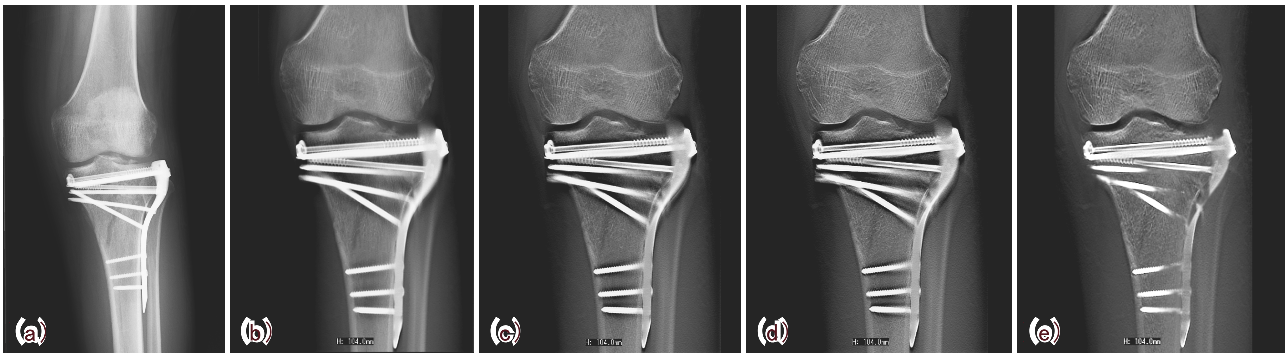

Fig. 4 Differences Between Images Using FBP and IR Methods
(a) Plain radiography **(b)** FBP method (Thickness ++ and Metal 4) **(c)** FBP method (Thickness +- and DC 2)
(d) FBP method (Thickness -- and Contrast 2) **(e)** IR method (Metal M)

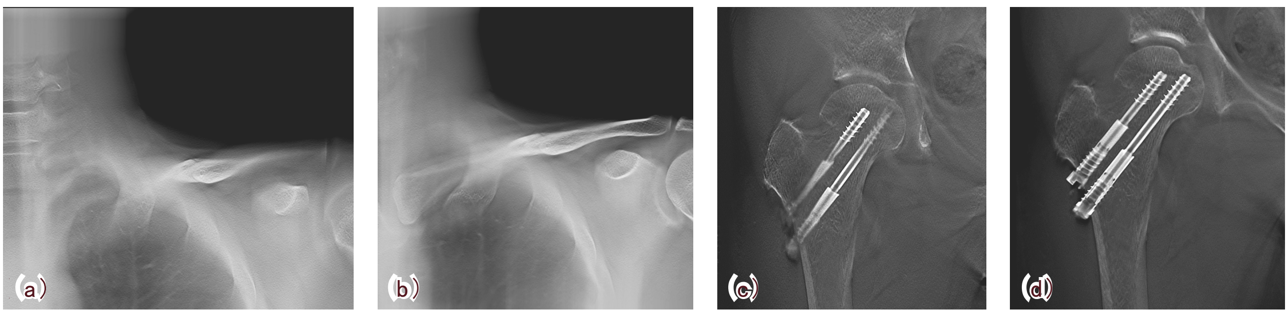

Fig. 5 Oblique Tomography Display Functions
(a) Original image displayed (oblique angle X: 0 deg. and Y: 0 deg.) **(b)** Oblique slice image displayed (oblique angle X: 20 deg. and Y: 5 deg.)
(c) Original image displayed (oblique angle X: 0 deg. and Y: 0 deg.) **(d)** Oblique slice image displayed (oblique angle X: -19.2 deg. and Y: -2.3 deg.)

If the patient condition does not permit positioning the target area parallel to the table or positioning causes suffering, we adjust the position by processing images after exposure, rather than forcing the patient into the ideal posture desired for examination. This can prevent motion artifacts caused by uncomfortable body positions or having to repeat exposures when the desired cross section was not obtained. Therefore, it is also more patient-friendly.

5. Shortened Processing Time

In addition to our experience using tomosynthesis for orthopedic surgery, tomosynthesis has also become very popular for bronchoscopy examinations by the respiratory medicine department. Previously, when acquiring tissue samples, whether or not the brush or biopsy forceps were touching the lesion was confirmed by having the patient raise both their arms so that cross sections could be observed from the side, in the anteroposterior direction. However, with increasing subject thickness as well, it was difficult to confirm smaller lesions using fluoroscopy. In such a case, using tomosynthesis makes it easy to understand the positional relationships in the anteroposterior direction. At our hospital, we generally approach from the patient's head end, with a 20-degree angle, at a high speed (2.5 s breath-holding time), and using FBP (Thickness--) **(Fig. 6)**. Given the above conditions, but depending on the center height of the cross section, images can be obtained with the center of the exposure area about 60 cm or more from the top end of the table. In the case of lesions in apex of the lungs, we have patient move slightly toward their feet, but lesions in the mid to lower areas of the lung field can be captured without a problem.

Since real time images are required, before starting examinations, we input the height of the lesion position, range, and pitch settings referring to CT images, so that images can be processed automatically. Ideally, thinner image slices with metal artifacts minimized using T-smart are preferred, but our hospital uses the FBP method due to the faster processing speed. Due to the faster side station function, images can be displayed in about 10 seconds after exposures are finished **(Fig. 7)**. Currently, we check side station cross section images in the control room, but we would prefer being able to check them in the examination room as well.

Fig. 6 Using Tomosynthesis for Bronchoscopy

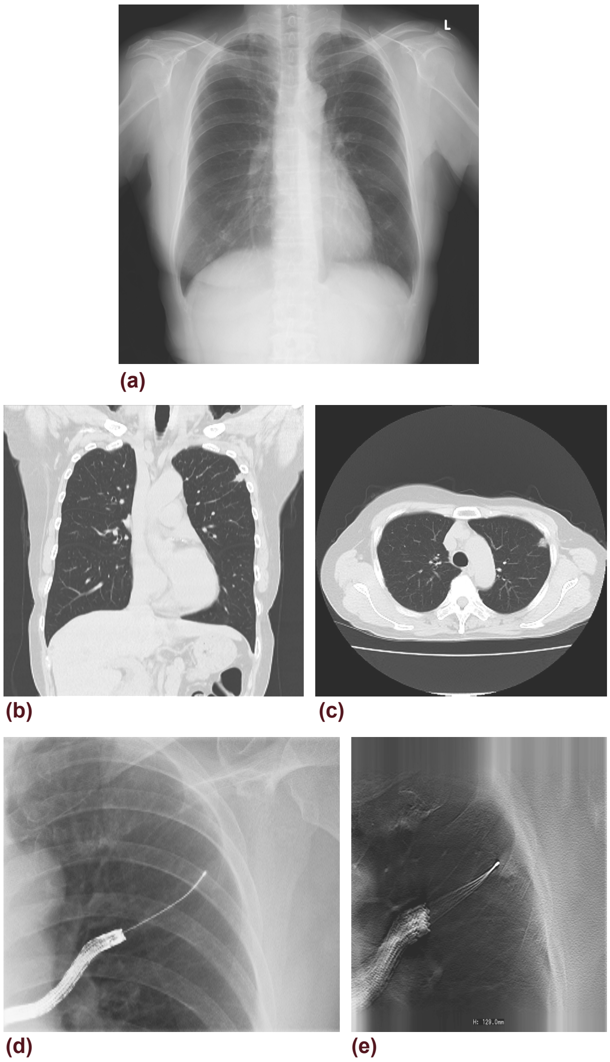

Fig. 7 Bronchoscopy Using Tomosynthesis Guide for Node on Left Upper Lobe
(a) Plain chest radiography
(b) CT image of chest (transversal image)
(c) CT image of chest (coronal image)
(d) Fluoroscopy image **(e)** Tomosynthesis

6. Summary

Introducing tomosynthesis functionality increased the frequency with which our fluoroscopy system has been used for orthopedics. In our daily striving to provide better healthcare, we continue to cooperate with the orthopedic department to search for exposure positions and tomosynthesis applications that have more diagnostic utility, such as for obtaining images with a load applied after arthrography or myelography.

However, even with the remarkable functionality of tomosynthesis, it will not be utilized unless the environment for using this technology is provided and information is provided to the doctors that order examinations. To utilize the functionality of tomosynthesis effectively, close communication between doctors and technologists is more important than anything. First, we technologists must take the first step by becoming familiar with the characteristics of the equipment and preparing an environment where examinations can be performed.

Due to T-smart, oblique tomography display and save functions, and the faster processing speed of the new side station, tomosynthesis is steadily increasing its presence as a useful tool for clinical use. In the future, we intend to continue expanding the applications for tomosynthesis beyond the orthopedics and respiratory applications by further educating others throughout the hospital about this technology.

References

Kazuhiro Mori: A New Side Station for T-smart, MEDICAL NOW, No. 73, 20-23, 2013

Takeshi Kuzuwa: Experience Using Tomosynthesis (T-smart) at Nara City Hospital, MEDICAL NOW, No. 74, 12-17, 2013

Shingo Baba: Tomosynthesis and T-smart Technology Using a SONIALVISION safire Series Fluoroscopy System, INNERVISION (28/12), 2013

Takehiro Izumo: Tomosynthesis in Respiratory Medicine, MEDICAL NOW, No. 75, 11-18, 2014