Clinical Experiences with Tomosynthesis in Orthopaedic Surgery at the Dokkyo Medical University Koshigaya Hospital

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Introduction

We used a conventional tomography system at this hospital until June 2007. As most requests for radiography were for patients with bone fractures due to trauma, many of the cases were difficult to observe by plain radiography due to obstructive shadows from the external fixation device or metal implants. We introduced tomosynthesis when the conventional tomography system failed in October 2007. This report presents our clinical experiences with tomosynthesis for orthopedics at this hospital. It introduces the differences in tomosynthesis image quality due to different image reconstruction filters and shows comparisons with CT images.

Clinical Cases

Plain radiography is used for follow-up observations of bone formation after posterior lumbar fixation or external fixation of limb fractures. However, tomosynthesis provides simpler observations **(Fig. 1)**. It also permits confirmation of bone union after femoral bone grafts.

It can be difficult to check bone union at the fracture site after cast immobilization using plain radiography, due to obstructive shadows from the cast. In such cases, too, tomosynthesis eliminates the obstructive shadows and facilitates observations **(Fig. 2)**.

Tomosynthesis imaging during myelography for spinal canal stenosis allows easy observations of the cauda equine at the site of stenosis **(Fig. 3)**.

Differences in Reconstruction Filters

Metal implants are inserted to treat fracture cases. Normal tomosynthesis results in undershooting artifacts during reconstruction that can hinder observations of the site. Metal artifact reduction reconstruction (metal reconstruction) applies direct-current (DC) components to reconstruction filters to reduce the artifacts. We compared images using metal reconstruction with images reconstructed by conventional filtered back projection (FBP) and shift-and-add reconstruction **(Fig. 4)**. Metal reconstruction could reduce undershooting artifacts to provide easier-to-view images.

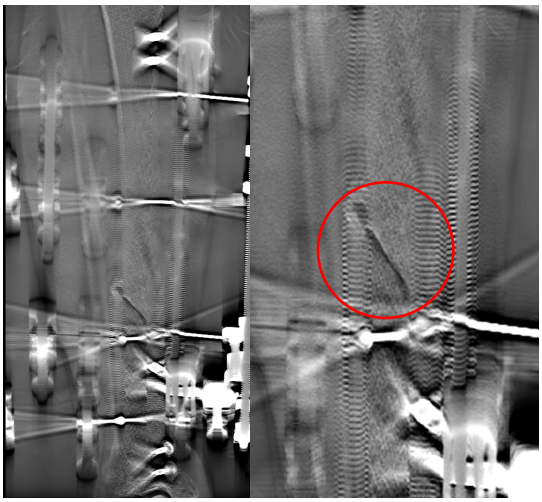

Fig. 1 After Tibial External Fixation (Right: magnified image)

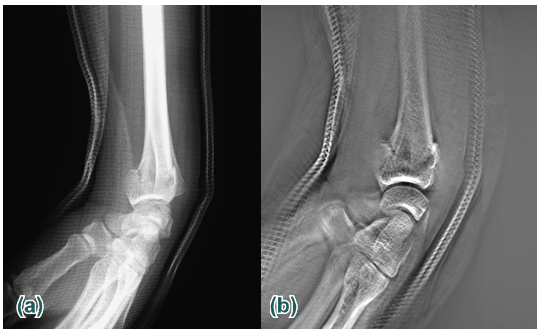

Fig. 2 Cast Immobilization
(a) Plain Radiograph, **(b)** Tomosynthesis Image

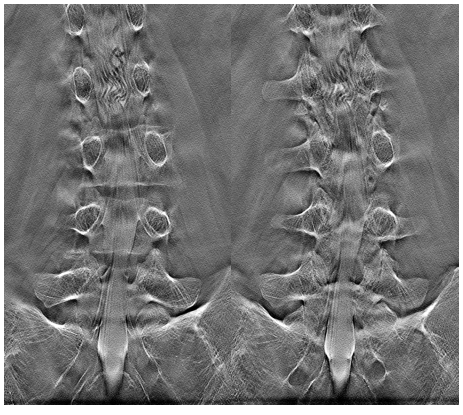

Fig. 3 Myelography (Tomosynthesis Image)

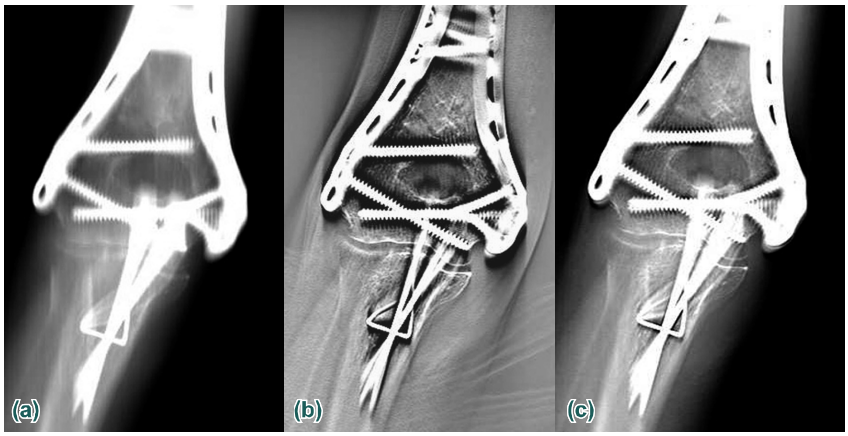

Fig. 4 Reconstructed Images by **(a)** Add-and-Shift, **(b)** Filtered Back Projection (FBP), **(c)** Metal Artifact Reduction

Comparison of CT and Tomosynthesis Images

In cases with metal implants inserted, the direction where metal artifacts occur is different in CT and tomosynthesis images due to the direction of projected data acquisition. Tomosynthesis is thought to be more suitable for follow-up observations after artificial femoral head replacement, due to the different direction in which the artifacts appear at the observation site **(Fig. 5)**. For fine fractures, tomosynthesis images are easier to observe than CT images due to the difference in resolution. Also, thanks to its resolution, the tomosynthesis image is superior for evaluation between a bone spur and a bone fragment from a fracture **(Fig. 6)**. For the reasons above, it is important to use CT scanning or tomosynthesis in examination, depending on the state of the fracture site, by understanding the features of CT scans and tomosynthesis in order to make effective diagnosis.

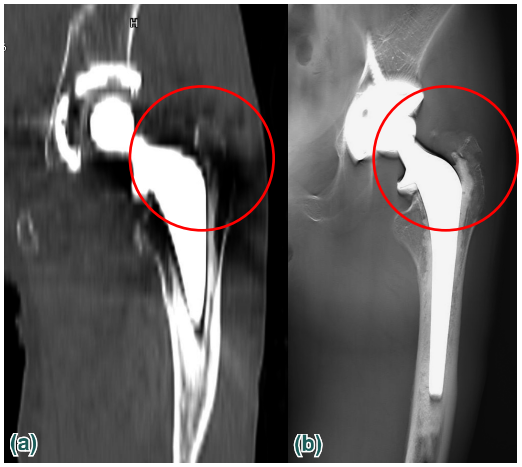

Fig. 5 Femoral Prosthesis
(a) CT Image (MPR), **(b)** Tomosynthesis Image

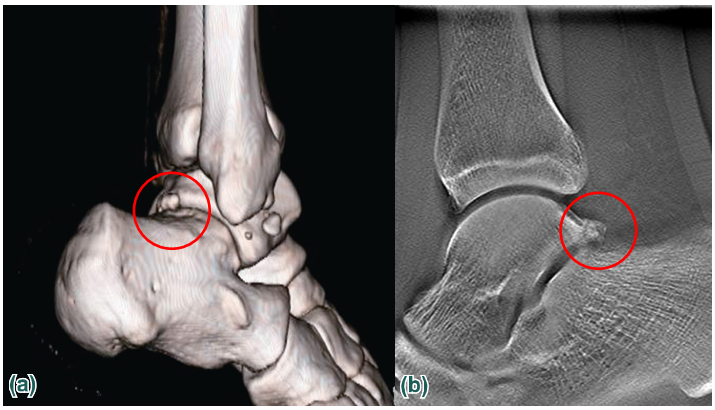

Fig. 6 Ankle
(a) 3-D CT Image, **(b)** Tomosynthesis Image

Summary

This hospital uses tomosynthesis in the field of orthopaedics for observations of bone formation after posterior lumbar fixation and for follow-up observations of external fixation in trauma patients. For cast radiography, the area imaged by plain radiography is immobilized by a cast, such that the range of motion is restricted and adequate patient positioning is not possible. Therefore, this radiography is difficult and the images can be adversely affected by the cast. Tomosynthesis can resolve such problems and the use of different reconstruction filters can reduce the metal artifacts. Tomosynthesis can be used when tomographic images are required in the standing posture, when the direction of the artifacts overlaps the observation site in the CT image, or in cases where plain radiography is inadequate for diagnosis but tomosynthesis can offer satisfactory diagnosis without performing a CT scan. There is little awareness of tomosynthesis by orthopaedic surgeons at this hospital. They do not know that tomosynthesis imaging is adequate for the diagnosis of some diseases, without resorting to CT scans.

To remedy this situation, it is an urgent duty of the X-ray technologists to impart knowledge about tomosynthesis to orthopaedic surgeons and other doctors.