Early Clinical Experience on Cone-Beam CT

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AN X-RAY ROTATIONAL projection system (SF-VA100, Hitachi Medical Co., Tokyo, Japan) provides three dimensional reconstructed images with minimal 0.8 millimeter spatial resolution in each direction. In this system, a cone-beam X-ray unit with an image intensifier, which is placed 180 degree opposite to X-ray tube, rotates around the patient at a speed of 4.8 seconds per one rotation. The advantage of this system is higher spatial resolution in the direction of the body axis comparing with the helical CT scan. Instant volume scan at one rotation, with twenty centimeter field of view, could reduce both total scanning time and X-ray exposure. On the other hand, slow rotation time as compared with the conventional CT scan may be one of the causes of motion artifacts, and inferior image quality in radiographic contrast limits its use to structures with high radiographic contrast, such as angiography, lung fields, or bony structures. As far as we know, there is no report of applications of this system to the lung fields and bony structures, although almost all previous studies reported the 3-D angiography by using this system.^{1,2} We evaluated the feasibility of this system for the clinical use.

MATERIALS AND METHODS

We evaluated this system on three different clinical fields as follows. First, demonstration of the pulmonary lesions for the surgical or interventional approach and evaluation of radiotherapeutic effect. Second, demonstration of bony structures with skull base or sellar lesions for the neurosurgical approach. Third, demonstration of vertebral structures comparing with conventional X-ray tomography.

RESULTS

In the pulmonary lesions, the multiplanar reconstruction (MPR) method made it possible to choose any view directions, such as a plane along the vessels from the pulmonary hilum to the lesion. In primary lung cancers, the involved vessels were easily identified by confirming the continuity from the hilum, which is occasionally difficult on axial CT images. In an arteriovenous malformation, a

feeding artery and a draining vein were clearly demonstrated and gave great information for pre-embolization planning (Fig 1). Comparing of the pre- and post-radiation images of lung cancer was useful for the evaluation of therapeutic effect because exact measurement of the tumor size in any direction, especially in the direction of body axis, was possible. Peripheral pulmonary lesions were demonstrated clearly with breath holding, but central lesions were tend to be suboptimal in appearance due to motion artifacts caused by the cardiac cycle.

In the skull base and sellar lesions, the reconstructed images corresponding to the magnetic resonance images were useful for the evaluation of tumor extension. Intracranial invasion of the head and neck tumors through the skull base with bone destruction were demonstrated in any direction. Sagittal images were excellent for the demonstration of pterygopalatine fossa and communicating pathways such as Vidian canal, foramen rotundum, superior orbital fissure and so on (Fig 2) and useful for the evaluation of tumor involvement of such structures in the patients with some neurological symptoms. In the pituitary adenomas, sagittal images had advantages for the evaluation of sellar erosion or destruction. In a pituitary adenoma with typical double floor sign on plain X-ray, reconstructed sagittal images made it possible to separate those "floors" and indicated correct location of tumor extension to the sphenoid sinus. Sagittal images were also useful to certify the location of the implanted bone tip after the Hardy's surgery.

In the vertebral spondylosis, sagittal images were useful for the diagnosis of protruded structures from intervertebral spaces observed in the

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Fig 1. Pulmonary arteriovenous malformation (arrowheads) with a feeding artery (solid arrows) and draining vein (open arrows).

corresponding magnetic resonance images. Spur formations were clearly identified and differentiated with herniated discs. In addition, oblique sagittal images demonstrated correct width of inter-

Fig 2. Pterygopalatine fossa (small arrowheads) and communicating pathways: Foramen rotundum (open arrow) and superior orbital fissure (solid arrow).

vertebral foramen. In the cases of ossification of posterior longitudinal and/or yellow ligaments, sagittal images could demonstrate the forms and extension of the ligamentous ossifications. In a spondylolysis, MPR images were useful for the demonstration of segmental fractures in pars inter-

Fig 3. Spondylolysis with segmental fractures (solid arrows) in pars interarticularis on sagittal (A) and coronal (B) images.

articularis (Fig 3). In the vertebral lesions, reduction of X-ray exposure comparing with conventional X-ray tomography was possible.

CONCLUSION

This system is really non-invasive, relatively low in X-ray exposure, and is able to obtain fruitful informations from many directions. Therefore cone-beam CT is considered as a suitable modality for the demonstration of high contrasted structures and subsequently provides the beneficial informations

to the therapeutic approaches. This system may take place of conventional X-ray tomography if the cost-down becomes feasible.

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