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A Study of Non-Coplanar Imaging Technique in INER Prototype Tomosynthesis System

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Abstract : Tomosynthesis is an imaging system that generates a 3D image by scanning in a limited angular range. It could provide more depth information than traditional 2D X-ray single projection. Radiation dose in tomosynthesis is less than computed tomography (CT). Because of limited angular range scanning, there are many properties depending on scanning direction. Therefore, non-coplanar imaging technique was developed to improve image quality in traditional tomosynthesis. The purpose of this study was to establish the non-coplanar imaging technique of tomosynthesis system and evaluate this technique by the reconstructed image. INER prototype tomosynthesis system contains an X-ray tube, a flat panel detector, and a motion machine. This system could move X-ray tube in multiple directions during the acquisition. In this study, we investigated three different imaging techniques that were 2D X-ray single projection, traditional tomosynthesis, and non-coplanar tomosynthesis. An anthropopathic chest phantom was used to evaluate the image quality. It contained three different size lesions (3 mm, 5 mm and, 8 mm diameter). The traditional tomosynthesis acquired 61 projections over a 30 degrees angular range in one scanning direction. The non-coplanar tomosynthesis acquired 62 projections over 30 degrees angular range in two scanning directions. A 3D image was reconstructed by iterative image reconstruction algorithm (ML-EM). Our qualitative method was to evaluate artifacts in tomosynthesis reconstructed image. The quantitative method was used to calculate a peak-to-valley ratio (PVR) that means the intensity ratio of the lesion to the background. We used PVRs to evaluate the contrast of lesions. The qualitative results showed that in the reconstructed image of non-coplanar scanning, anatomic structures of chest and lesions could be identified clearly and no significant artifacts of scanning direction dependent could be discovered. In 2D X-ray single projection, anatomic structures overlapped and lesions could not be discovered. In traditional tomosynthesis image, anatomic structures and lesions could be identified clearly, but there were many artifacts of scanning direction dependent. The quantitative results of PVRs show that there were no significant differences between non-coplanar tomosynthesis and traditional tomosynthesis. The PVRs of the non-coplanar technique were slightly higher than traditional technique in 5 mm and 8 mm lesions. In non-coplanar tomosynthesis, artifacts of scanning direction dependent could be reduced and PVRs of lesions were not decreased. The reconstructed image was more isotropic uniformity in non-coplanar tomosynthesis than in traditional tomosynthesis. In the future, scan strategy and scan time will be the challenges of non-coplanar imaging technique.

Keywords : image reconstruction, non-coplanar imaging technique, tomosynthesis, X-ray imaging
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