TECHNICAL NOTE / Thoracic imaging

Tomosynthesis: A new chest imaging technique

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Tomosynthesis; Spatial resolution; CT scan; Tomography; Irradiation

Tomosynthesis is a new medical imaging technique, a real digital revival of ‘‘conventional’’ tomography that became obsolete a long time ago. The rapid growth of digital radiology and plane sensors has contributed to the reappearance of this imaging procedure.

Technique

Tomosynthesis acquisition can be easily undertaken following a simple chest X-ray, without changing the patient’s position, regardless of whether he is standing or lying on a conventional remote-controlled radiology table. With this imaging technique, a very large number of slices can be reconstructed after rapid acquisition (2 to 6 seconds) with a low radiation dose.

The patient is on the table, in the desired position (decubitus or procubitus if frontal views are required, lateral decubitus if sagittal views are needed). Several parameters can be modified: kV, mA, the number of pulses per second (X-ray emission is discontinuous or ‘‘pulsed’’), the duration, centre and total thickness of the acquisition. Slice thickness is not precisely quantifiable but can be roughly modified (\(+\), \(+\), \(\pm\), \(-\), \(\ldots\)); at its thinnest, it is about one centimetre. The spatial resolution in the cross-sectional plane \((x, y)\) is particularly high (200 \(\mu\)m). During acquisition, as during conventional tomography, the X-ray tube describes a 40-degree arc around the patient (from \(-20\) to \(+20\) degrees). At the same time, the plane sensor moves synchronously inside the table. Finally, specific algorithms permit reconstruction of the slices in the volume desired \([1,2]\). A posteriori (post-processing) reconstructions can then be produced with different slices and at different places in the acquisition volume.

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Advantages

The large number of slices avoids superposition of anatomical structures and, compared with a conventional chest X-ray, thus improves detection of small lesions. In addition, tomosynthesis has very high spatial resolution (200 μM with the Shimadzu Safire technology) in the acquisition plane (x, y), much higher than that of the CT scanner. Resolution in the Z-axis is still however insufficient and does not allow you to produce multiplanar reconstructions. Tomosynthesis could therefore be particularly useful in specific indications requiring high spatial resolution. Visualisation may be improved, for example, of fine intralobular reticulations with honeycomb features (Fig. 1). Detecting pulmonary foci may also be facilitated (Fig. 2). In addition, the radiologist would probably be able to see fine detail of areas of ground glass attenuation: fibrous ground glass attenuation secondary to a micro-honeycomb structure or ground glass attenuation consecutive to a small degree of alveolar filling, for example. However, very few articles have been published in the literature up to the present time concerning the application of tomosynthesis to chest imaging, mainly to

Figure 1. Patient with pulmonary fibrosis. The CT scan (frontal plane) (a) shows small peripheral intralobular reticulations. Tomosynthesis (frontal plane) (b) improves visualisation of these reticulations because of its very high spatial resolution (200 microns).

Figure 2. Patient with acute infectious pneumonia of the upper right lobe. Standard X-ray (a) shows increased opacity projecting out from the right hilum. Tomosynthesis (frontal slice) (b) permits precise image characterisation, showing ground glass attenuation (wide arrow) and condensation with air bronchogram (head of arrow).
detection of pulmonary nodules [3] and study of infectious mycobacterial lesions [4].

Another notable advantage of tomosynthesis is the low exposure to radiation [4,5], equivalent to two or three standard X-ray procedures, and up to 70 times lower than a CT scan [4]. Data in the literature usually state an effective dose in the order of 0.12 mSv [3,4], which can be reduced to around 0.05 mSv by optimising the acquisition protocol (low-dose tomosynthesis) [4]. In addition, producing numerous slices avoids the superposition of anatomical structures, and can mean that there is no point in producing a lateral X-ray image, reducing the dose of radiation even more. Finally, tomosynthesis can facilitate application of the ALARA principle (reduction in exposure/improvement in diagnostic performance).

Limitations

Resolution in density of tomosynthesis is still low compared with the CT scan. For example, the fat lobules of hamartochondroma can only be visualised with a CT scan. Although tomosynthesis allows a lot of slices to be produced with high spatial resolution, it is only a technical improvement, important though it is, of the conventional chest X-ray. Another major limitation of tomosynthesis is that it is impossible to produce multiplanar reconstructions.

Cost

There is no agreed reimbursement fee in France at the present time for tomosynthesis. In the future, if the national health insurance system takes this new technique into account it could result in a benefit to public health and therefore, indirectly, to its cost. Tomosynthesis could possibly replace the CT scan in certain specific indications yet to be determined, and thus bring about savings to the health system.

Conclusion

To sum up, the diagnostic performance of tomosynthesis may be better than that of the standard X-ray. The dose of radiation is lower than that of a CT scan. The place of tomosynthesis among other imaging techniques is still to be determined by future scientific studies.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References