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Review Article

Thoracic application of multi-detector CT: A pictorial essay

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ABSTRACT

Multi-detector CT (MDCT) has considerable advantage over single-detector helical CT in the form of the shorter acquisition time, greater coverage and superior image resolution. It can be used to systematically evaluate the cardiovascular anatomy, morphologic features of thoracic vessels such as aorta, systemic veins and pulmonary vessels and relationship between the upper lobe bronchi and pulmonary arteries, coronary artery, valves, systemic veins. In diffuse lung diseases, this technique can increase nodule detection and help differentiate between small nodules and vessels.

MDCT with three-dimensional (3D) volume rendering provides a unique perspective on thoracic anatomy and disease. MDCT allows shorter acquisition times, greater coverage and superior image resolution. In vascular imaging, this technique provides image quality that equals or surpasses that of conventional angiography. Its use has expanded to aid in diagnosis and surgical planning.

In this article we present a pictorial review of the current applications of MDCT in diseases of the thorax.

Keywords: bronchus, multi-detector CT, thorax, vascular pathology

CLINICAL APPLICATIONS

Vascular Applications

In cases of thoracic aortic aneurysms or dissection, imaging from the arch to the bifurcation is possible with MDCT or contrast enhanced MRA. The extent of an intimal flep and its relationship to arch vessels as well as the patency of both the true and the false lumen are clearly defined with these techniques (Figure 1) (1-3). Also, MDCT reveals pulmonary arteries well, especially at MIP images (Figure 2).

Pulmonary embolism

Multi-detector CT pulmonary angiography (CTPA) has now been established on a quick, reliable, safe, cost-effective and accurate technique in the evaluation of pulmonary embolism (PE) (Figure 3 a,b,c). With advances in MDCT technology evaluation of PE can now be performed with combined CTPA and venography as a one-stop-shopping test with delayed images of the pelvis and lower limbs being acquired in the same setting to exclude deep venous thrombosis (1, 2, 4).

Coronary arteries

Cardiac- gated MDCT in providing a worthy competitor to electron–beam CT in the assessment of coronary artery calcium scoring. The reported sensitivity and specificity is 86% and 98% (16-detector MDCT) and 99% and 96% (64-detector MDCT) respectively in the evaluation of coronary artery stenosis as compared to conventional catheter angiography.

Venous anatomy

Superior vena cava obstruction (Figure 4) and the extent of collateral vessel formation are well demonstrated with 3D volume rendering. Similarly, other causes of venous obstruction such as thoracic outlet syndrome and subclavian vein thrombosis can be evaluated (1, 2, 6).

Airways

The MDCT is useful for the evaluation of congenital bronchial anomalies, extent of tracheal stenosis or stricture, stent extent of tumor and bronchiectasis. Multiplanar reconstruction is as accurate as axial CT images in the detection of obstructive airway lesions detected using fiberoptic bronchoscopy (FOB) and is more accurate than shaded surface display and minIP (Figure 5) (1, 2, 7).

Virtual bronchoscopy

At the level of the central airways, external volume rendered (VR) allows creation of virtual bronchoscopy images that are very similar to conventional bronchograms. It is unable to identify the causes of bronchial obstruction and does not provide biopsy or bacteriological samples. Some of the potential clinical applications of virtual bronchoscopy (VB) include screening airways for endobronchial tumors, characterizing endobronchial abnormalities and guiding interventional bronchoscopy (Figure 6) (1, 2, 7).

PULMONARY APPLICATIONS

Diffuse Interstitial Lung Diseases

The chest radiograph is the first modality in the evaluation of diffuse interstitial lung diseases (DILD). Multiplanar reconstruction imaging provides a panaromic view which appears similar to chest radiograph that can be visualised in multiple planes. Maximum intensity projection (MIP) imaging is also useful in both detecting disease and assess DILD. The MDCT has also been found to be useful in the follow up of cases such as cystic fybrosis (CF) and langerhans cell histiocytosis (Figure 7) (1, 2, 8, 9).

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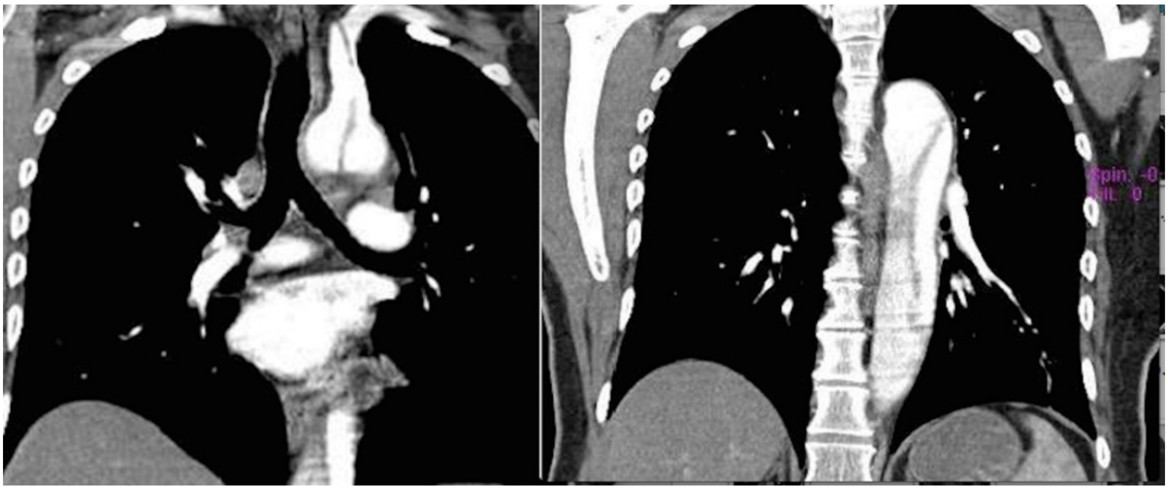

Figure 1: *Type III aortic dissection. On CTA images, there is dissection extends from subclavian artery to diaphragm*

Figure 2: *Multi-detector CT, MIP images show pulmonary arteries in detail*

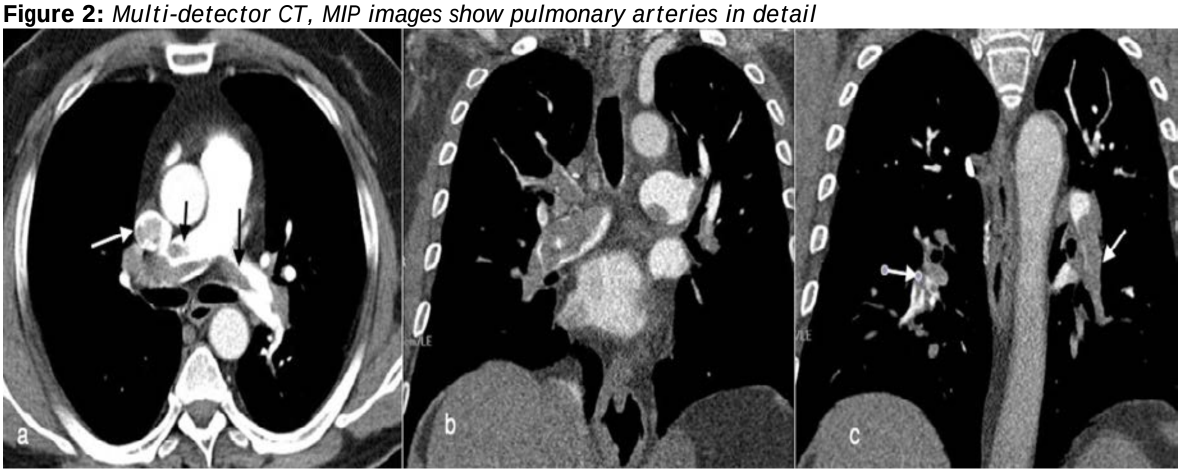

Figure 3: ***Acute massive pulmonary embolism on multi-detector CTA****. a. There is filling defect due to thrombus in right and left pulmonary artery (black arrows) and v.cava superior on axial slice (white arrow); b. On coronal reformatted images, in right and left pulmonary artery; c. Filling defects due to thrombus in segmental and subsegmental branches of pulmonary artery (arrows)*

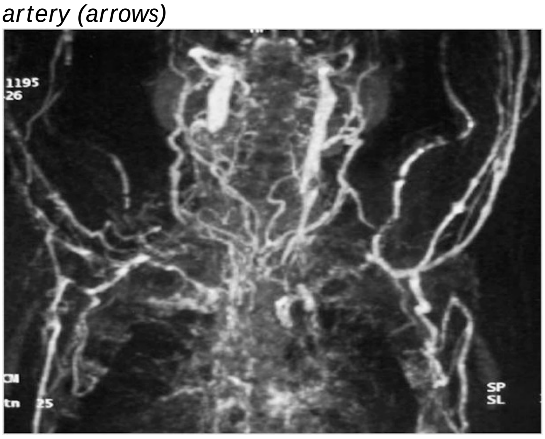

Figure 4: *65-year-old patient with Behcet syndrome, occlusion in superior vena cava on MR venography*

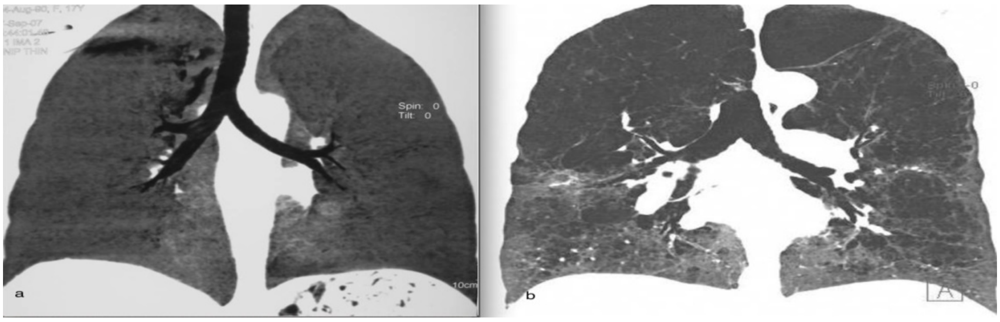

Figure 5: *a. Multi-detector CT. Normal appearance of airways and lungs on MinIP. b Bullae and bilateral emphysema on minIP*

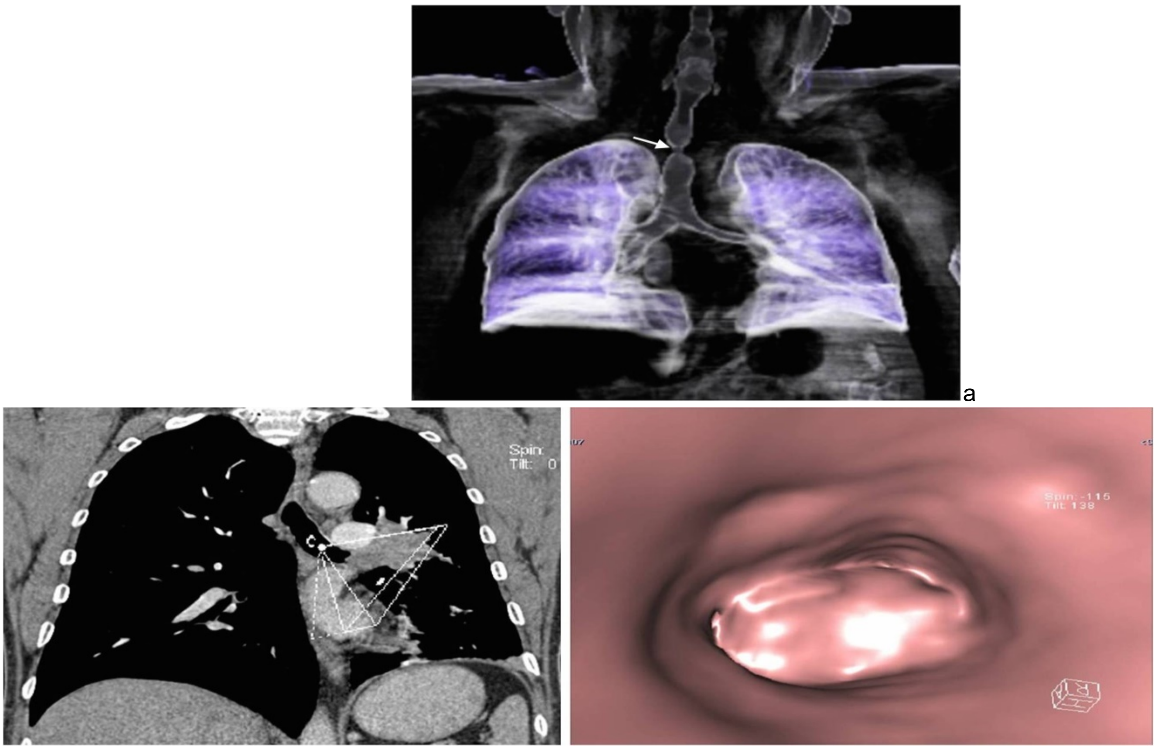

Figure 6: *a.Tracheal stenosis (arrow) on virtual bronhoscopy frontal projection; b. On coronal reformatted image, left upper bronchus mass (epidermoid cancer) (right), virtual broncoscopy shows the upper lobe bronch mass (left)*

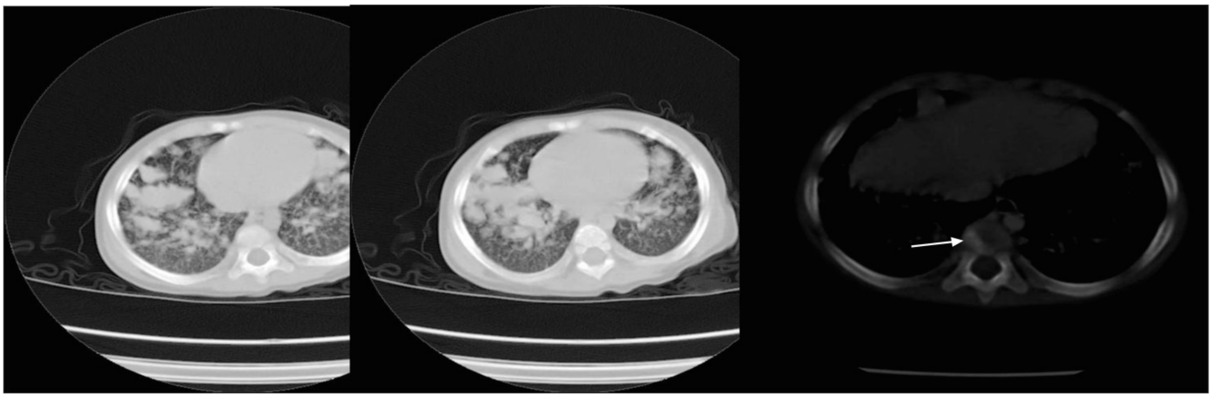

Figure 7: *LCH. Bilateral extensive parenchymal irregular contoured infiltrations, vertebral body lytic lesion (arrow)*

Solitary Pulmonary Nodule

The primary role of radiologic evaluation is to differentiate benign from malignant pulmonary nodules. Volumetric growth estimation based on reported 3D volumetric measurements of small pulmonary nodules is more accurate than estimation of growth rate on axial CT images. The 3D analysis of small pulmonary nodules may be one of the key tools for non-invasive assessment of growth rate and morphology of small pulmonary nodules (1, 2, 10).

Lung Cancer

Low-dose MDCT has recently been proposed as a technique for screening patients with high risk of developing lung cancer. Besides screening for lung cancer, MDCT also finds application in staging the tumors. MDCT is also superior to conventional CT for demonstration chest wall involvement, extent of airway involvement, mediastinal invasion and small pulmonary metastasis (11).

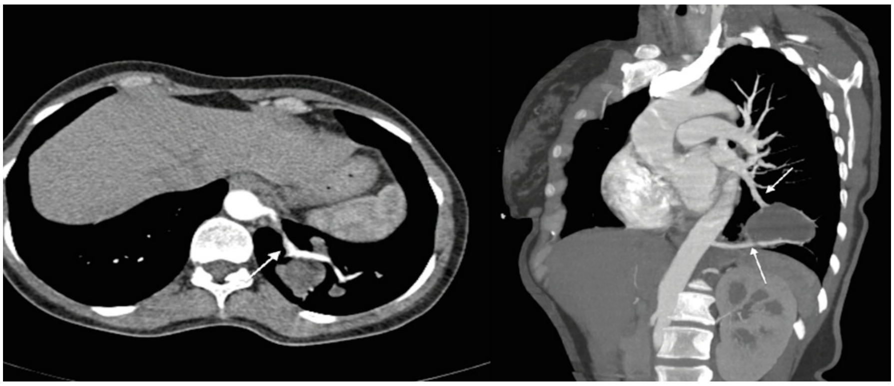

Figure 8: *MDCT angiography with MPR image showed pulmonary sequestration of lung segment and the aberrant vessel (arrows) originating from abdominal aorta*

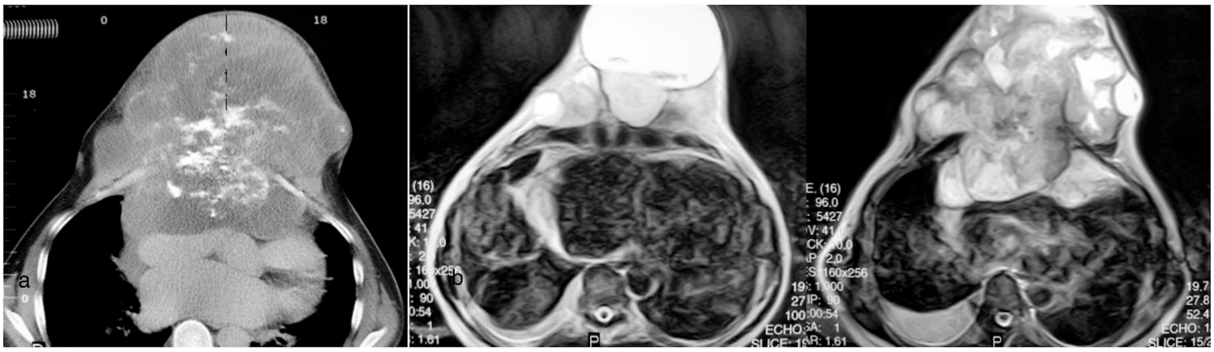

Figure 9: *Low grade chondrosarcoma at sternum, a. Sternal mass lesion with destructive pattern and punctate calcification; b-c. On T2 weighted images, mucinous substance and heterogenity of the hyperintense mass lesion*

Pulmonary Sequestration

MDCT has become the primary screening tool for sequestration, as it provides optimal evaluation of the thoracic and abdominal aorta in the same study with a single bolus of contrast injection. Sequestration of lung segment can be elegantly depicted by demonstrating the sequestrated segment and the aberrant vessel originating from abdominal aorta by MDCT angiography with MPR or MIP images (Figure 8) (12).

Broncho pulmonary Sequestration

MDCT angiography has emerged as the imaging technique of choice for preoperative evaluation of pulmonary sequestration, both in the pediatric and in the adult population. Computed tomography has an advantage over MR angiography, as CT scan times are significantly shorter, which makes it especially easier to evaluate children. CT also has a better spatial resolution for evaluation of small vessels and lung parenchyma. The main disadvantage of CT remains the radiation dose involved (13, 14).

CHEST WALL

Spectacular 3D SSD or VR images of the thoracic wall can be generated due to the natural high contrast of bony structures. VR images are useful in pre-operative and post-operative evaluation of the orientation of ribs and costal cartilages and their relationship to the sternum (Figure 9) (15).

CONCLUSION

MDCT is a useful imaging modality for the morphologic evaluation of the thorax, as it provides isotropic imaging. Since this introduction, MDCT has nearly replaced or complemented more invasive radiological procedures such as aortography, pulmonary angiography and bronchography.

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