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Can dynamic contrast enhanced multidetector CT differentiate the nature of different pulmonary nodules?

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1. Introduction

In recent years, the development of lung cancer screening programs and computed tomography with higher spatial resolution has increased the number of diagnosed pulmonary nodules [1]. The probability of malignancy in patients with pulmonary nodules on computed tomography ranges from 1.1% to 12% depending on the morphological features of the nodules and the population at risk [2].

Newly developed pulmonary nodules in an oncology patient should be considered metastatic nodules unless proven otherwise. However, the possibility of an inflammatory nodule should be considered [3]. So determination the probability of malignancy for pulmonary nodules is essential to the subsequent management and treatment [4].

On conventional CT, differentiating malignant from benign pulmonary nodules is usually a challenge for the radiologists because of the great overlap in morphological features between malignancy and benignity [5] and unfortunately CT-guided fine-needle aspiration biopsy is used only for pulmonary nodules located close to the chest wall [6].

In addition to evaluation of the morphological features of pulmonary nodules, there has been increasing in study of nodule perfusion with contrast-enhanced imaging studies and metabolism with FDG-PET [7].

Although FDG-PET/CT is imaging technique of choice (most sensitive and specific) for differentiating between malignant and benign pulmonary nodules, it has low diagnostic accuracy in small nodules < 10 mm, high costs and limited availability [7]. PET/CT may provide a false negative and false positive finding in patients who have an inflammatory process (sarcoidosis or rheumatoid nodules) or in a case of infection (fungal or mycobacterial infections) [8].

With increasing the spatial and contrast resolution of multi detector computed tomography and development of its perfusion technique tumor, hemodynamic derived from perfusion measurement is used to improves sensitivity and specificity of detection and characterization of different pulmonary nodules [9]. Pulmonary nodule enhancement can be quantitatively assessed in dynamic contrast-enhanced MDCT to differentiate malignant and benign lesions. It was useful in determining the possibility of malignancy in nodules as small as 8 mm. The degree of nodule enhancement correlates with the degree of vascularity, which increases in malignant lesions [10].

The aim of this study is to evaluate the value of dynamic contrast enhanced computed tomography for differentiation of primary malignant pulmonary nodules from secondary malignant and benign nodules by measuring mean maximum enhancement Hounsfield unit (net enhancement value) of these nodules.

2. Material and methods

2.1. Patients

Eighty patients were included in our retrospective study between march 2015 to June 2017 at Mansoura university hospital. They were 45 men and 35 women (mean age, 55.5 year, range, 20–70 years). On routine CT chest, fifty patients had solitary pulmonary nodule and thirty patients had multiple nodules. All these patients were pathologically confirmed by tissue biopsy. Twenty patients had primary carcinoma and presented as solitary pulmonary nodule. Forty patients had metastases (from them 18 patients had solitary nodule) and twenty patients had benign inflammatory nodules (from them12 patients had solitary nodule). Value of the study was explained to the patients. They agreed to participate in the study and informed written consents were taken from them and the medical research ethics committee of Mansoura University approved the current study.

Prior to performing DCE-MDCT and on routine CT, the suitability of pulmonary nodules for DCE-MDCT were assessed and the nodules that measures or more than 8 mm and less than 3 cm and had soft tissue attenuation (at WW 400 HU, WL 40 HU) were included. The nodules that met the following criteria were excluded (a) nodules that measures less than 8 mm (b) polygonal shaped nodules with no central spherical components (c) flat nodules that measures 8 mm in the axial and 3–4 mm in the craniocaudally direction (d) calcified nodules and (e) cystic nodules.

2.2. Dce-mdct

Multidetector CT examination were performed using 128-detector-row scanner (phillips Medical System). Images were obtained in

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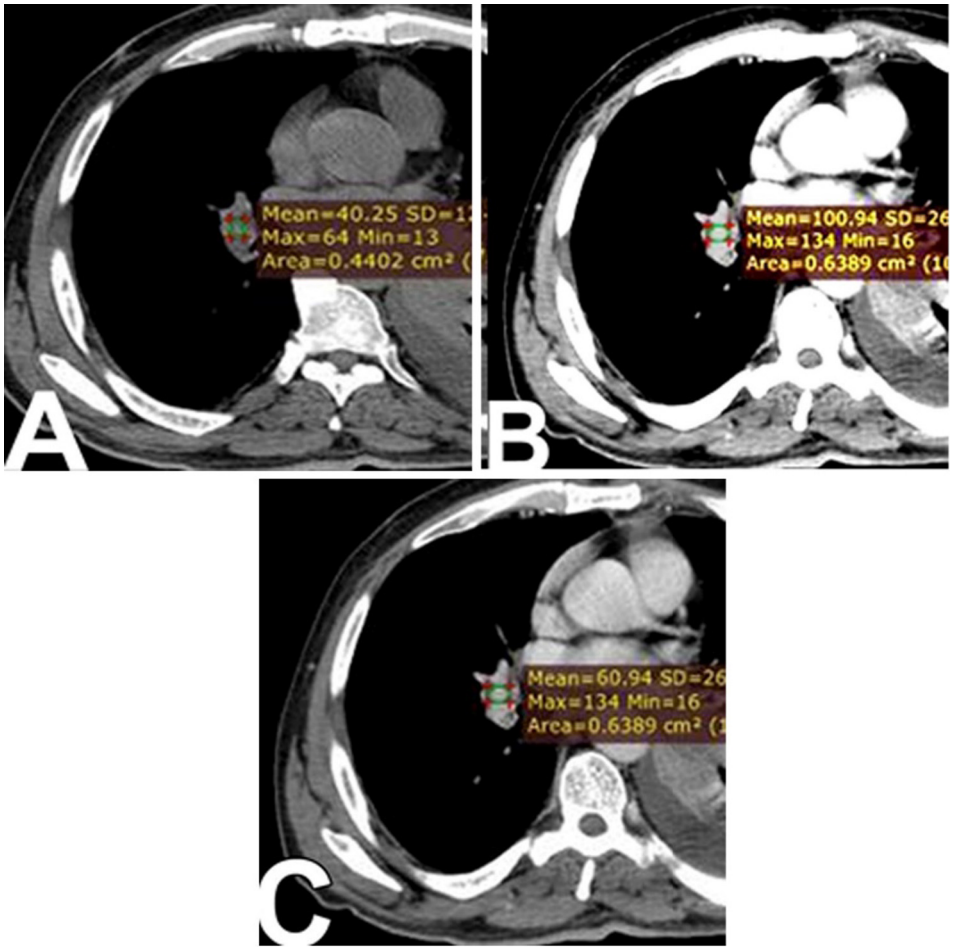

Fig. 1. DCE-MDCT of 55-year-old male patient with histopathologically proven Small cell carcinoma: (A) Pre contrast scan demonstrates pulmonary nodule (1.7 cm) with irregular outlines and demonstrate mean pre contrast attenuation = 40 HU. (B) 120 s post contrast scan. The nodule shows maximal attenuation (peak enhancement) = 100 HU. (C) 180 s post contrast scan. Its density is 60 HU. So net enhancement = 60 HU.

craniocaudally direction before and after contrast injection. Contrast-enhanced images were obtained at 60, 120, 180 s after onset of injection of 100 ml nonionic contrast media (350 mg/ml) at 4 ml/s using power injector. The CT parameters used were as follow: peak tube voltage 120 kvp, tube current determined by patient's weight: < 70 kg, 300 mAs and > 70 kg, 350 mAs, rotation time 0.5 s, slice thickness 3 mm, field of view (20 cm), reconstruction interval 2 mm, 128- row-detector configuration, and pitch 1.3. MDCT scan were obtained from lung apices to the middle parts of both kidneys.

2.3. Image interpretation

The nodule analyzed on mediastinal windows (Width 400 HU, Level 40 HU) and on the axial plane starting with unenhanced scan then post contrast 60, 120 and 180 sec. scans (Fig. 1). We identified the slice on which the nodule is of maximum size and on the magnified image we manually draw a circular ROI that encompasses at least 60% of the nodule diameter (Fig. 2). The software tool automatically calculates the mean, minimum and maximum HU number for the drawn ROI as well as the ROI size in mm^2. The pre enhancement value is density (in HU) of the nodule in pre contrast scan and peak enhancement value is its maximum density (in HU) in post contrast scans. Measurement of the mean maximum enhancement HU (net enhancement value) was performed by subtracting pre enhancement value from peak enhancement value. The measurement was performed by two radiologists, one unware of the final diagnosis of the nodule. The pulmonary nodule that measures net enhancement value > 30 HU was defined as primary malignant (Figs. 1 and 2), between 15 and 30 HU as secondary malignant nodule (Figs. 3 and 4) and < 15 HU as benign nodule (Figs. 5 and 6).

2.4. Data analysis

Data were fed to the computer and analyzed. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-parametric variables and mean, standard deviation for parametric variables. The used tests were: 1 - Chi-square test for categorical variables, to compare between different groups. 2. ROC curve: for detection of validity and cutoff point in comparison to sure diagnostic test.

3. Results

This retrospective study conducted on 80 adult patients and all pathologically proved; 16 cases (20%) were under the age of 40 years, 40 cases (50%) were from 40 to 60 years and 24 cases (30%) were older than 60 years. 56 cases (70%) out of the patients were males while the remaining 24 cases (30%) were females. The histopathological analysis revealed primary malignant nodules in 20 patients, secondary malignant nodules in 40 patients and benign nodules in 20 patients. In 62.5%