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Intrathoracic tumors in contact with the chest wall – ultrasonographic and computed tomography comparative evaluation

Romeo Chira, Alexandra Chira, Petru Adrian Mircea

I[st] Medical Clinic, "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca, Romania

Abstract

Aim: a comparative evaluation of lung lesions in contact with the thoracic wall by transthoracic ultrasonography (US) and computed tomography (CT). **Material and method:** A retrospective analysis of the US and CT results was performed in 131 patients with thoracic masses. In all of these cases the histological diagnosis was established after a US guided transthoracic biopsy. A comparative analysis of the two methods was realized regarding the following items: lesion dimensions, presence of tumoral wall invasion, peritumoral atelectasis, presence of pleural effusion and incidence of post-biopsy complications. **Results:** A number of 17 patients from the study group were diagnosed with benign lesions and 114 (87%) with malignancies. US showed signs of wall invasion in 78 patients (68.42%), whereas CT revealed it in 83 of the patients (72.8%) from the malignancies group. Intratumoral necrosis was diagnosed by US in 100 patients (87.71%) and by CT in 83 patients (72,8%), also from the 114 patients with malignant lesions. US found peritumoral atelectasis in 33 cases and CT in 38 cases. All parameters had good and very good correlation indexes between the methods (kappa =0,8; 0,6; 0,72; $p < 0,001$ in all cases). **Conclusions:** In patients with thoracic masses in contact with the thoracic wall there is an overlap in the diagnosis performances of US and CT. The sensitivity and specificity of US in diagnosing wall invasion of malignant lesions is superior to that of CT.

Keywords:

Introduction

Thoracic masses with wall contact represent a frequent pathology that requires complex imaging studies, and often interventional procedures, in order to reach the complete diagnosis. In most cases, after a thoracic lesion is found on a thoracic X Ray, the next step is to perform a bronchoscopy and/or a CT exam. But mediastinal and pulmonary lesions often call for additional investigations. Therefore, transthoracic ultrasonography (US) permits visualization of these lesions, their structural characterization, while offering suggestive elements for their malignant nature and for the differential diagnosis [1-3]. Furthermore US allows percutaneous guided biopsies with lower risks compared with the radiological guiding methods (fluoroscopy and CT) [4-6]. US advantages are numerous – accesibility (including bedside exams), lower costs, no radiation exposure, and shorter biopsy time.

Regardless of these advantages, the use of US in malignant lesions of the thorax is still low, in many centers the CT guided biopsy being preferred.

The purpose of this study was to realize a comparative analysis of US and CT in diagnosing thoracic lesions with parietal contact. In order to do this the following parameters were considered: lesions size, presence of tumoral wall invasion, intratumoral necrosis, peritumoral atelectasis, and presence of pleural effusion, in a group of patients that benefited from histopathological diagnosis after US guided transthoracic biopsy.

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Corresponding author: Romeo Ioan Chira
I[st] Medical Clinic
3-5 Clinicilor str
Cluj-Napoca 400006, Romania
Phone: 0040742025557
Fax: 0040264590899
Email: romeochira@yahoo.com

Material and method

A retrospective analysis of the files of 131 patients (35 females and 96 males, ages between 20 and 82 years

old) with thoraco-pulmonary peripheral lesions, demonstrated by CT, was performed. The patients were hospitalized in 'Leon Daniello' Pneumophtisiology Hospital or in the Ist Medical Clinic, Cluj-Napoca between 2004 and 2010. Some of the patients underwent bronchoscopy with or without biopsy, depending on the direct and indirect signs of the tumors. Subsequently the patients were examined through transthoracic US and US guided biopsy of the lesions. Before biopsy all patients signed an informed consent form.

The ultrasonographic exam and the biopsy were performed using one of the following equipments – Toshiba SSH 140 or General Electric LOGIQ S6 – by the same examiner (RC). The intrathoracic lesions were initially evaluated with a 3.5 MHz convex transducer or with a variable frequency transducer (4-5.5 MHz). In case of thoracic wall invasion the examination was completed with a 7.5 MHz or a 10-13 MHz linear transducer. For the biopsies a Bard Biopsy-Gun system was used, with Tru-cut needles, with diameters between 16 and 18 G. The needle was chosen depending of the charactersitics of the lesion: for lesions with signs of wall invasion or larger than 4 cm higher caliber needles were usually used. In 127 patients a single passage was performed and in 4 patients two passages were needed. The length of the obtained fragments was measured and the histopatological examination was performed in the Pathology Lab of the Emergency County Hospital, Cluj-Napoca. After the biopsy the patients were monitored for at least 24 hours and in cases where complications were suspected the US was repeated or a thoracic x-ray was done.

The initial US assessment consisted of measurements of the largest diameters of the lesions, evaluation for intratumoral necrosis, peritumoral atelectasis, wall invasion and presence of pleural effusions and mediastinal lymphadenopathies. All this parameters were analyzed on the CT examination as well.

The invading character of the tumoral masses in the thoracic wall was established by US, based on the following signs: absence of lesion mobility with respiratory cycles (absence of the lung sliding sign), an obtuse angle between a subpleural lesion and the parietal pleura (fig 1), and evidence of tumor invasion within the muscle layers, bone or hypoderm [1,2,6-8]. Intratumoral necrosis was diagnosed based on the presence of transonic or hypoechoic fluid areas within the lesion, with no evidence of vascular signal on the Doppler examination (fig 2) or based on the presence of cavities with or mixed content (fig 3). The corresponding aspect of the intratumoral necrosis as it seen on CT is presented in fig 4.

Peritumoral atelectasis was demonstrated in two ways: as areas of parenchyma consolidation, with trian-

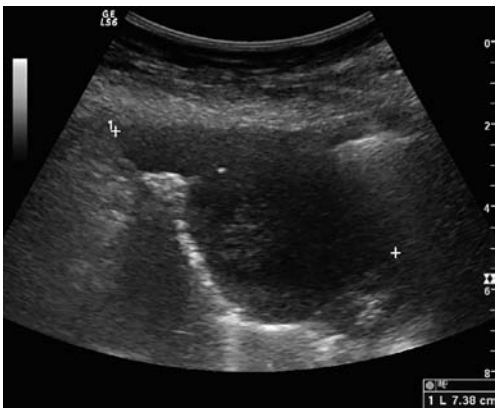


Fig 1. Hypoechoic, homogeneous, ill circumscribed lung mass with wall invasion and obtuse angle with the parietal pleura – non-small cell carcinoma.



Fig 2. Pulmonary mass with unhomogeneous structure and ill circumscribed hypoechoic areas inside – adenocarcinoma.

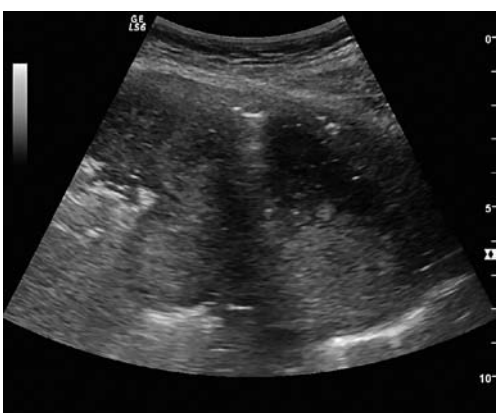


Fig 3. Left upper lobe central pulmonary mass with necrosis and mixed content, fluid and gas (hyperechoic images with posterior shadowing in the upper zone).

gular shape and the apex towards the hilum, where an obstructive tumoral nodule was visualized or as areas of consolidation adjacent to a tumoral mass in contact with the wall, usually also of triangular shape. Fluid bronchograms and pulmonary vessels with perpendicular distribution towards the thoracic wall and radiating towards the atelectasis area were observed in both situations (fig 5) [1-3].

In many cases several types of alterations were associated: intratumoral necrosis and peritumoral atelectasis (fig 6), necrosis and wall invasion.

The data obtained by US were compared with those from the CT exam, which was considered the reference method, using the following statistics tools: Chi square test, T test, and Cohen test (for the evaluation of parameters correlation between the two techniques).

Results

Seventeen (13%) patients from the study group were diagnosed with benign lesions and 114 (87%) with cancers. The mean age of the patients with benign lesions was 54.53+/-13.6 years old and that of the patients with malignant lesions was 62.08+/- 10.13 years old.

The mean value of the maximum length of the lesions as measured by US was 7.38 cm, with limits of 2.8 cm and 11.5 cm. These findings were similar to those determined by CT – mean value 7.53 cm with limits of 3 cm and 12 cm – the resulted correlation kappa index was 0.888.

The sites of the lesions were: pulmonary – 106 cases (80.9%), mediastinal – 14 cases (10.7%) and pleuro-parietal – 11 cases (8.4%) (table I).

Thoracic biopsy was followed by a reduced number of complications. Thus, there where 3 patients (2.29%) who required analgesics for pain management, one patient (0.76%) presented hemoptysis, and one patient (0.76%) developed hemothorax that necessitated drainage tube placement. There were no cases of pneumothorax clinically manifested or confirmed by CT or US. The overall percentage of complications was 3.81 % (5 cases).

The histological diagnosis established after percutaneous biopsy revealed the histopathological types presented in table II. In the 'other types of cancers' category are included lymphomas, pleural mesotheliomas and mediastinal tumors (thymomas, lymphomas).

The mean size of the benign lesions was 5.11 +/- 1.71 cm, and that of the malignant lesions was 7.71 +/- 1.85 cm.

The US evaluation revealed signs of wall invasion in 78 (68.42 %) of the 114 patients from the malignant

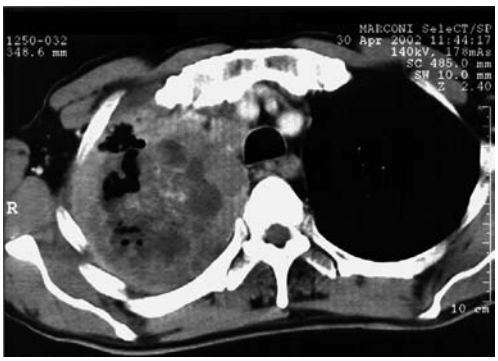


Fig 4. Right upper lobe pulmonary mass with central necrosis – CT aspect – non-small cell carcinoma.



Fig 5. Peritumoral atelectasis with radiating, normal vascularity distribution, adjacent to a hypoechoic, unhomogeneous tumor that is hypovascular when compared with the surrounding parenchyma.

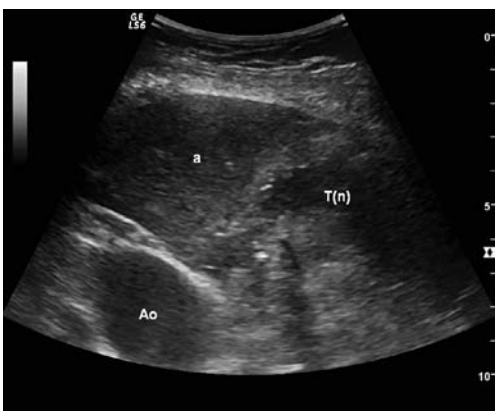


Fig 6. Tumoral mass with central necrosis (T) and peritumoral atelectasis (a) – triangular shape, well-circumscribed; Ao – thoracic aorta.

Table I. Topographic distribution of thoracic lesions in contact with the thoracic wall

Lesion localisation	Patients
Right upper lobe	29 (22.1%)
Right lower lobe	24 (18.3%)
Left upper lobe	28 (21.4%)
Left lower lobe	25 (19.1%)
Mediastinum	14 (10.7%)
Other localisations	11 (8.4%)
Total	131 (100%)

Table II. Histopathological types of thoracic lesions in contact with the thoracic wall (US guided biopsy).

Types of lesions	Patients (number)
Benign	17 (13%)
Non small cell carcinoma	75 (57.3%)
Small cell carcinoma	5 (3.8%)
Other types of cancer	26 (19.8%)
Metastasis	8 (6.1%)
Total	131 (100%)

lesions group. The CT exam found this feature in 83 patients (72.8%). The information obtained through the two techniques had a kappa correlation index of 0.8; $p<0.001$.

Tumoral necrosis was diagnosed by US in 100 patients (87.71%) out of the 114 patients with malignant lesions. On the CT exam, necrosis was evident in 95 patients (83.33%), the correlation index for this parameter being kappa=0.6; $p<0.001$.

US found peritumoral atelectasis in 33 patients, while CT showed it in 38 cases. There was a good correlation of the data given by the two methods – kappa = 0.672; $p<0.001$.

Pleural effusions were diagnosed by US in 10 cases and by CT in 8 cases, out of the 131 patients from the study group. The correlation index between the two imaging methods in this case is also very good ($p<0.001$).

Discussions

The sizes of the thoracic lesion as they were measured by US are overlapping those obtained by CT. Our data revealed a very good correlation (kappa=0.888; $p<0.001$) between the two imaging techniques. It is well known that just considering the intra and interobserver variations, in evaluating diameters and volumes, these can reach significant differences as up to 7% interobserver and up to 4.8% intraobserver [9].

Between the patients with benign lesions and those with malignant lesions there are differences regarding the size of the masses, malignant lesions being significantly larger in size ($p<0.001$).

A particular aspect is that of the wall invasion determined by the tumoral masses. The performance of US in diagnosing wall invasion is recognized (89-100%), being at least equal with that of CT (42-68%) [7,8,10,11]. In the present study the percentage of cases with wall invasion suggested by CT was higher than the one diagnosed by US, but on the US exam some of these tumors presented clear respiratory mobility, a sign that excludes invasion of the parietal pleura (7 cases). Therefore, the sensitivity and specificity of US remain superior to those of CT, which may give a percentage of false positive results.

In our study group intratumoral necrosis was very frequently detected by both imaging techniques (over 80%). This high percentage is probably due to the large size of the tumoral masses that were examined (the mean size higher than 7 cm).

The sensitivity of US in diagnosing small amounts of fluid within the pleural space is excellent. In the study group US found a higher number of cases with pleural effusion than CT. The presence of pleural effusion in a patient with lung cancer is equivalent with pleural invasion and corresponds to a T4 mass [11]. Rarely pleural effusions may be of paraneoplastic nature, caused by obstruction of the lymphatic drainage, atelectasis or hypoproteinemia [12].

Within the study group, the complication rate after biopsy was low, especially that of pneumothorax, because of the wall contact of the tumoral masses and also probably because of the large sizes of the lesions, which were over 2.8 cm. Literature data report higher percentages of pneumotorax occurence, especially in patients who underwent CT guided biopsies [4,6]. A higher rate of pneumothorax may also be caused by the higher number of passages, a higher distance for the needle to go through lung parenchyma to reach the lesion (especially over 40 mm) and a value of FEV1 < 70% in patients with chronic obstructive pulmonary disease.

As a result of evaluating US and CT it was concluded that there is an agreement between the two imaging methods regarding tumor invasion, intratumoral necrosis and peritumoral atelectatsis in patients with thoracic lesions in contact with the thoracic wall. In this category of patients the US visualisation of the lesions is very accurate providing structural details, bringing important elements for tumor staging, allowing a quick differential diagnosis with other types of lesions (pneumonia, atel-

ectasis, pulmonary embolism, cystic lesions) [1-3]. The sensitivity and specificity of US in detecting lung cancer wall invasion is superior to that of CT, a finding that is in agreement with literature data [7,8].

The limits of the US examination are determined by the impossibility to visualize the pleura entirely, due to the presence of the skeletal components of the thorax, and the necessity to have a rather large wall contact in order to completely analyze a lesion or to perform a US guided biopsy. The limits of our study are the small numbers of tumors (especially cancer) and the retrospective design.

Overall, US and CT offer comparable information, US keeping its well known advantages (lower cost, no radiation exposure, bed side examination possible). Additionally, US guided biopsies of lesions in contact with the thoracic wall are followed by a lower number of adverse reactions, with lower costs and a shorter execution time.

Conflict of interest: none

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