Pictorial essay

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Subpleural lung tumors ultrasonography

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Abstract

The assessment of patients with pulmonary focal abnormalities continues to represent an important problem in pulmonary diagnosis. A large number of lung nodules remains undetermined after bronchoscopy, radiological and CT imaging analysis. Ultrasound can contribute to the determination of the nature of peripheral lung tumors, serving as an important aid in decision-making. It helps the investigator to decide the appropriate subsequent step in order to establish the etiologic diagnosis: another imagistic investigation, ultrasonographic guided transthoracic needle biopsy or surgery. This pictorial essay summarizes the main sonographic signs of subpleural lung tumors and the differentiation of benign and malignant lesions.

Keywords: chest ultrasonography, subpleural lung tumors, ultrasound diagnosis

Rezumat

Evaluarea pacienţilor cu leziuni focale pulmonare continuă să reprezinte o importantă problemă de diagnostic. După explorarea radiologică, computer-tomografică şi bronhoscopică, un număr mare de noduli pulmonari rămân nedeterminaţi. Ecografia poate contribui la determinarea naturii maselor pulmonare subpleurale, oferind un important sprijin diagnostic. Ecografia poate stabili următoarea procedură diagnostică: o metodă imagistică complementară, biopsia transtoracică sau explorarea chirurgicală. Acest pictorial rezumă principalele semne ecografice ale tumorilor pulmonare periferice şi posibilităţile de diferenţiere benign – malign.

Cuvinte cheie: ecografie toracică, tumori pulmonare periferice, diagnostic ecografic

Lung cancer is still a major diagnostic problem, this localisation being one of the leading cause of cancer-related deaths all over the world [1]. The increasingly wide use of CT scan has led to an explosion in the detection of pulmonary formations, many of which remain undetermined after CT analysis. Ultrasound may contribute to the characterization of undetermined subpleural pulmonary nodules, being an important help in diagnostic and therapeutic decisions.

Lung ultrasound is performed using convex probes with a frequency of 3.5-5-7.5 MHz. Linear probes are more difficult to adapt to intercostal spaces in thin persons, in longitudinal sections, but they can provide better images, particularly of the pleural space. Intercostal, supraclavicular and subcostal transdiaphragmatic incidences are used.

The lung with air is an interface that strongly reflects ultrasounds, stopping their transmission to the depth. Thus, the ultrasound image of the normal lung is a highly echogenic line that moves with inspiration and expiration. Reverberation artifacts are also recorded as echogenic lines parallel to the surface of the pleura, whose intensity diminishes with the increase in distance to the transducer. The irregularities of the lung surface may determine „comet tail" artifacts. Peripheral lung tumors appear as well-defined masses with variable echogenicity, most frequently hypoechogenic, surrounded by the aerated lung with high reflectivity (fig 1) [2].

Generally, the ultrasound of lung is performed after radiological and CT examination, but sometimes it can

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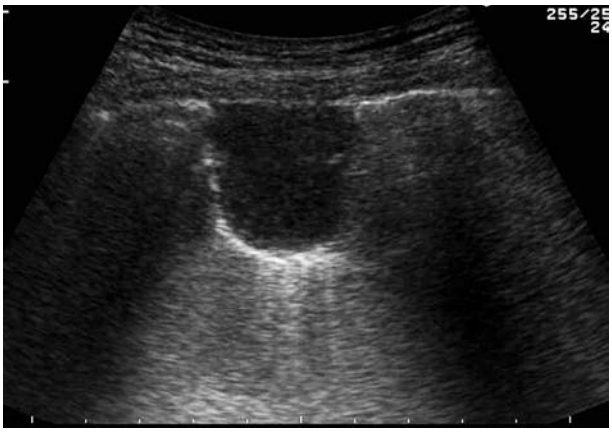


Fig 1. Subpleural lung mass, sharply demarcated from ventilated lung tissue.

be the first used imaging method, guided by local signs (thoracic pain or palpable mass). It is estimated that 40% of lung cancers appear as peripheral lung masses, consequently they are potentially accessible to ultrasound [3]. Lung tumors that reach the pleura most frequently appear as hypoechogenic masses with a clear-cut deep margin, compared to inflammatory pulmonary condensations. The echogenic line of the visceral pleura is absent where the tumor abuts the pleura. There is posterior echo enhancement, tumors transmitting ultrasounds better than the surrounding aerated lung. Lung carcinomas are variable in shape. They are most frequently round, polypoid or triangular, with clear-cut margins, more rarely with ramifications in the surrounding normal tissue (fig2) [2,4]. Unlike inflammatory condensations, the shape and the size of malignant lesions do not change in a short time period.

The echogenicity of lung tumors is variable. Lesions smaller than 5 cm are generally hypoechogenic, while lesions larger than 5 cm have a higher echogenicity and are frequently inhomogeneous, due to hemorrhage and necrosis (fig 3). Echogenicity does not allow the differentiation between malignant and benign tumors. Sometimes the echostructure of lung tumors is complex and may include aerated lung tissue areas. Such air bubbles are found in primary lung cancer, but not in metastases [4,5].

Adenocarcinoma most frequently involves the upper lobes and occurs as subpleural nodules with the retraction of the pleura. Squamous-cell carcinoma is frequently a central tumor that can only be visualized in the presence of obstructive atelectasis, atelectatic lung being a good ultrasound window. The ultrasonographic evaluation of bronchioloalveolar carcinoma is difficult, because of its various modes of presentation, from minimal irregulari-

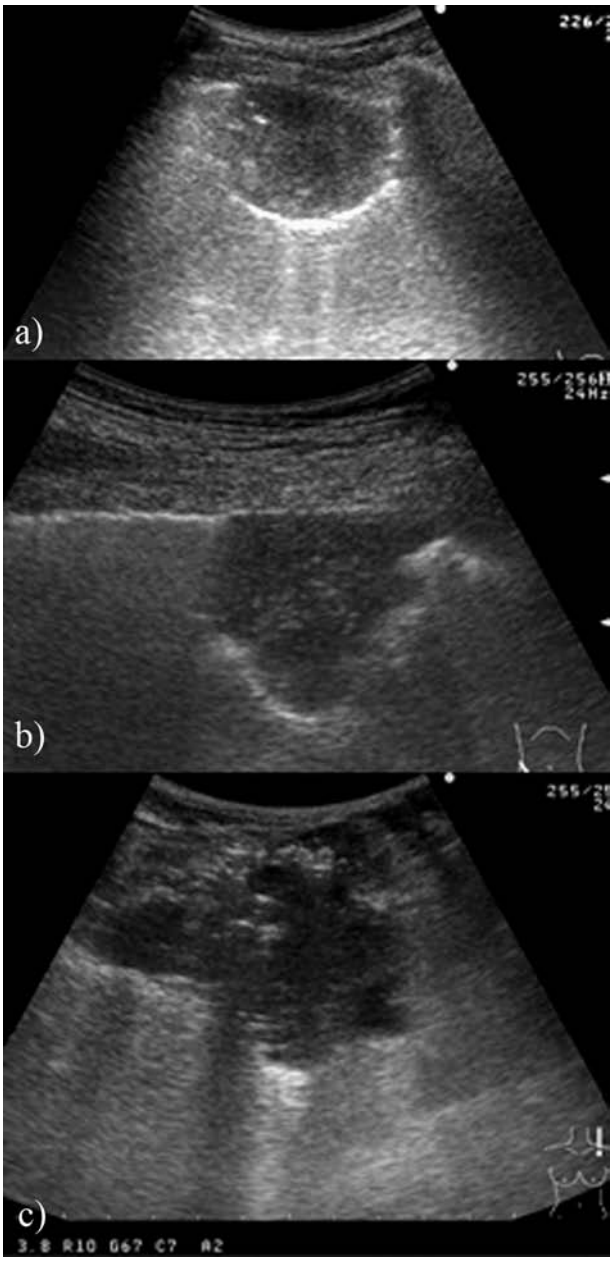


Fig 2. The shape of the lung carcinomas is variable: a. Well delinated round tumor presenting posterior amplification b. Triangular tumor; the echogenic line of the visceral pleura is absent where the tumor abuts the pleura c. Irregular shaped tumor in the upper lobe of the right lung, presenting air bubbles trapped within. Biopsy indicated large cell neuroendocrine carcinoma.

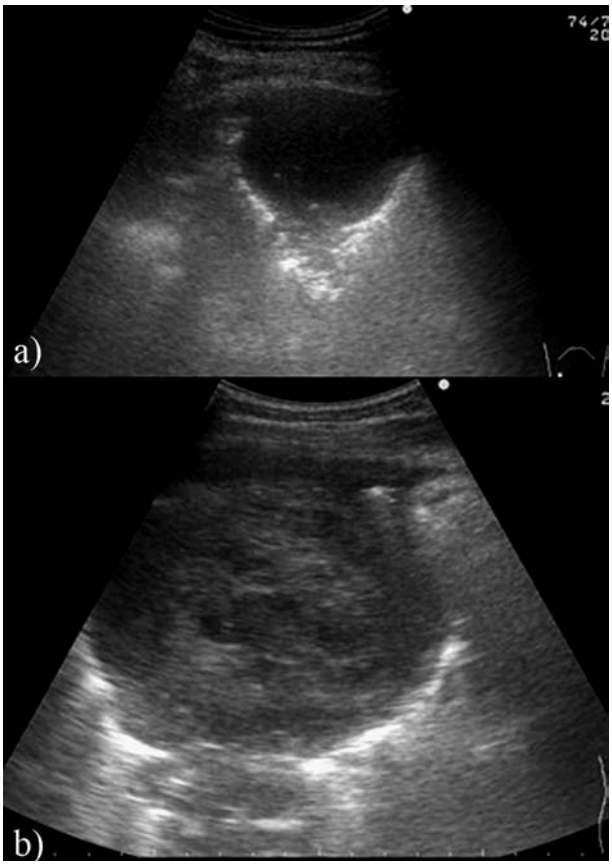


Fig 3. Two lung adenocarcinomas showing different echotexture: a. The small tumor is hypoechoic and homogeneous b. The large tumor has incresed echogenity and it is inhomogeneously structured due to internal hemorrhages and necrosis.

ties of the lung surface to multiple triangular consolidations mimicking multifocal pneumonia (fig 4).

For the differentiation of the benign or malignant nature of lung formations, the outline of the lung, the outline of the lesion, the changes in the normal pathways of the bronchi and the vessels, as well as the presence or the absence of invasion in the adjacent structures are analyzed.

The irregular outline of the lung surface at the level of a large consolidation suggests its malignant nature, while a regular surface and sharp margins are suggestive of its inflammatory nature (fig 5). Malignant lesions are frequently very clear cut, while the margins of inflammatory consolidations are irregular, saw-tooth like. However, sometimes malignant tumors may have finger-shaped extensions in the normal aerated parenchyma, a sign of local invasion (fig 6) .

Malignant invasion destroys the normal lung structure, bronchial branches being displaced, amputated or completely destroyed (fig 7). Another sign of malignancy is the change in vascular pathways. In pneumonia, vessels

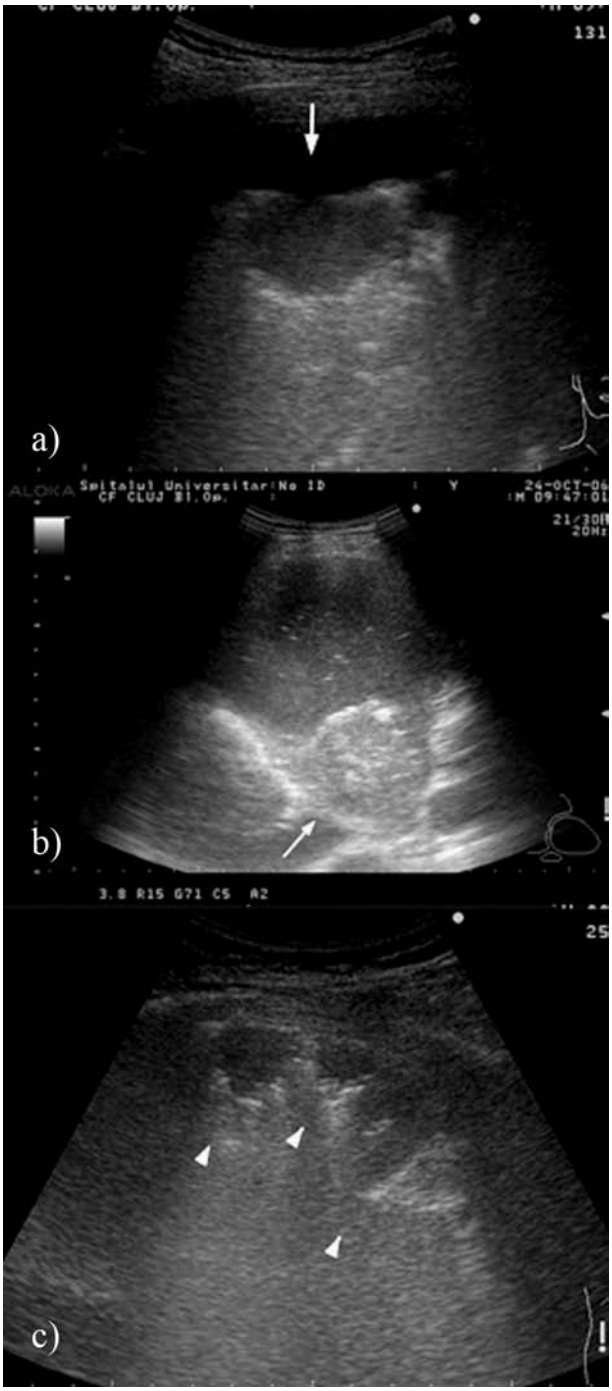


Fig 4. Differentiation of primary lung cancers is rarely sonographicaly possible: a. Adenocarinomas often present as a subpleural mass with retraction of the pleura (arrow) b. A central round squamos-cell carcinoma (arrow) in the tip of a triangular atelectatic consolidation c. Bronchioloalveolar carcinoma presented as multiple triangular serrated consolidations (arrow heads) mimicking multifocal pneumonia.

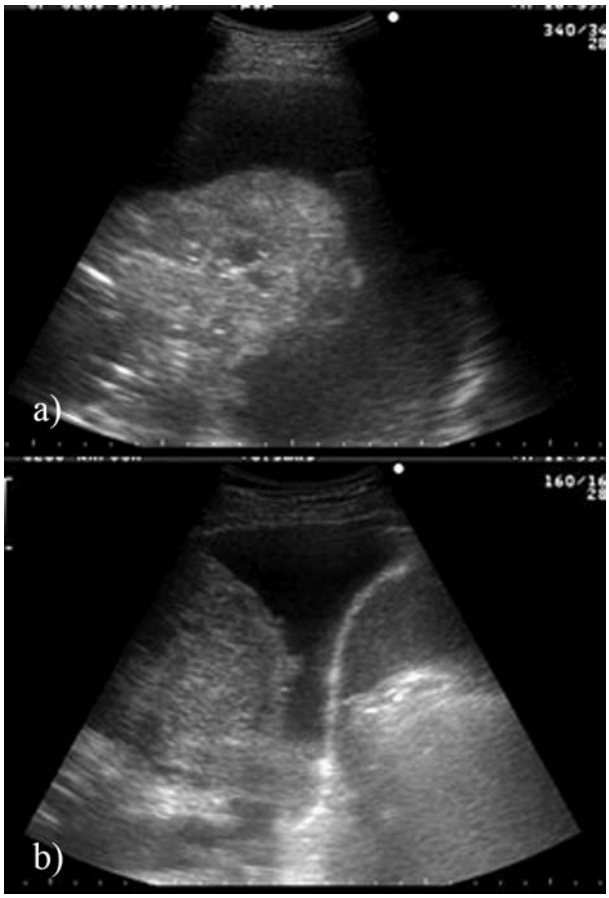


Fig 5. The outline of the lung surface differentiates the malignant or benign etiology of large lobar consolidations: a. Small-cell carcinoma invading the entire left lower lobe surrounded by pleural effusion. The lung contour is irregular b. Round well delineated consolidation of the left lower lobe. Histology of the sonographic-assisted biopsies indicated organizing pneumonia.

maintain their normal fan-like arrangement, perpendicular to the line of the pleura. In malignant tumors, vessels are displaced, being frequently detected at the margin of the tumor, having a spiral shape and variable diameters. Anarchic vascularization can also be present (fig 8) [6,7].

Evaluation of the extent of tumor invasion to the pleura, chest wall and mediastinum is an important objective of ultrasound examination, the presence of invasion being a definite sign of malignancy. The presence of invasion may influence the subsequent treatment of patients with lung cancer. High-resolution ultrasound proved superior to CT examination for the assessment of chest wall invasion [8,9].

In the case of small tumors, invasion is suspected when the contact with the pleura exceeds 3 cm, if the angle between the tumor and the lung surface is obtuse and if the adjacent pleura is thickened. Also, in the case

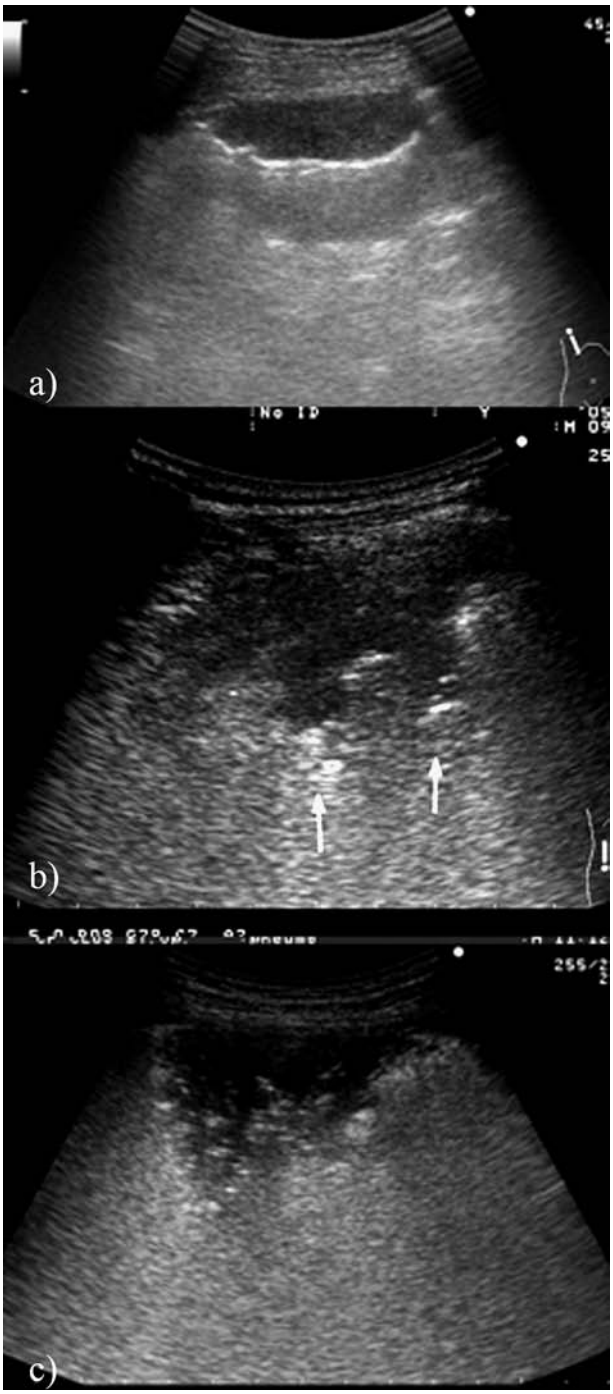


Fig 6. The mass margins: a. Lung metastasis of breast cancer with clear cut deep margin b. Lung adenocarcinoma with finger-shaped ramifications (arrows) into the normally aerated parenchyma c. Pneumonia with unclear serrated margins.

Fig 7. Malignant invasion destroying the normal lung texture: a. Bronchial branche (arrow) cut off by a round tumor that protudes into the pleural space b. Bronchial branche (arrow) displaced, in abnormal position, almost parallel to the visceral pleura.

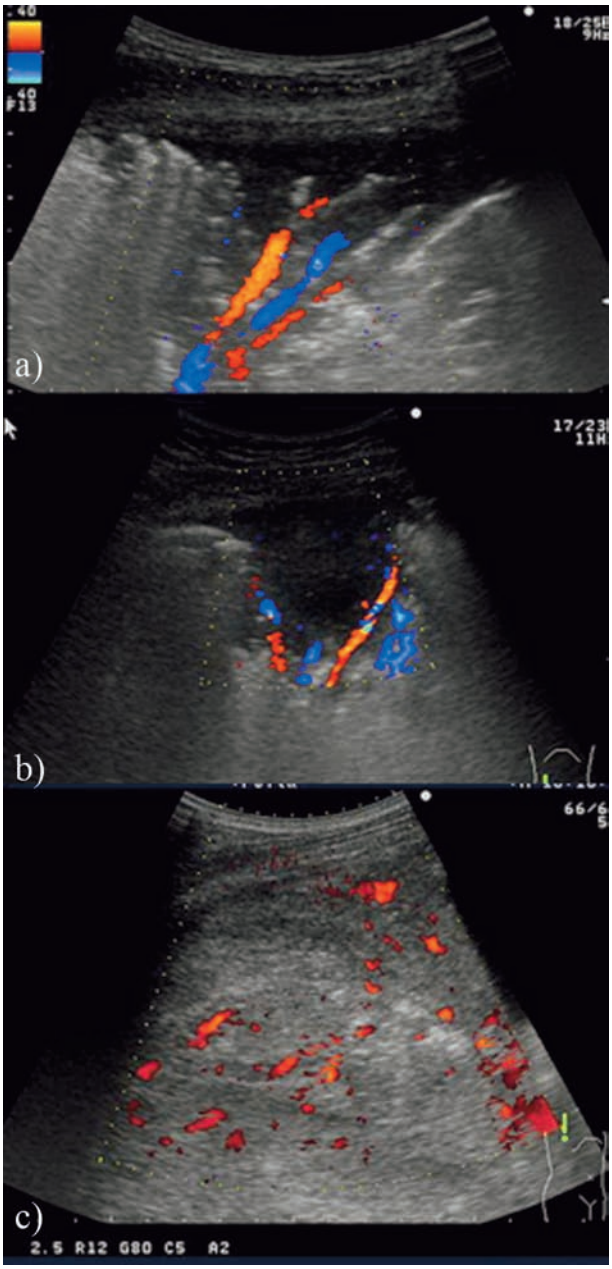
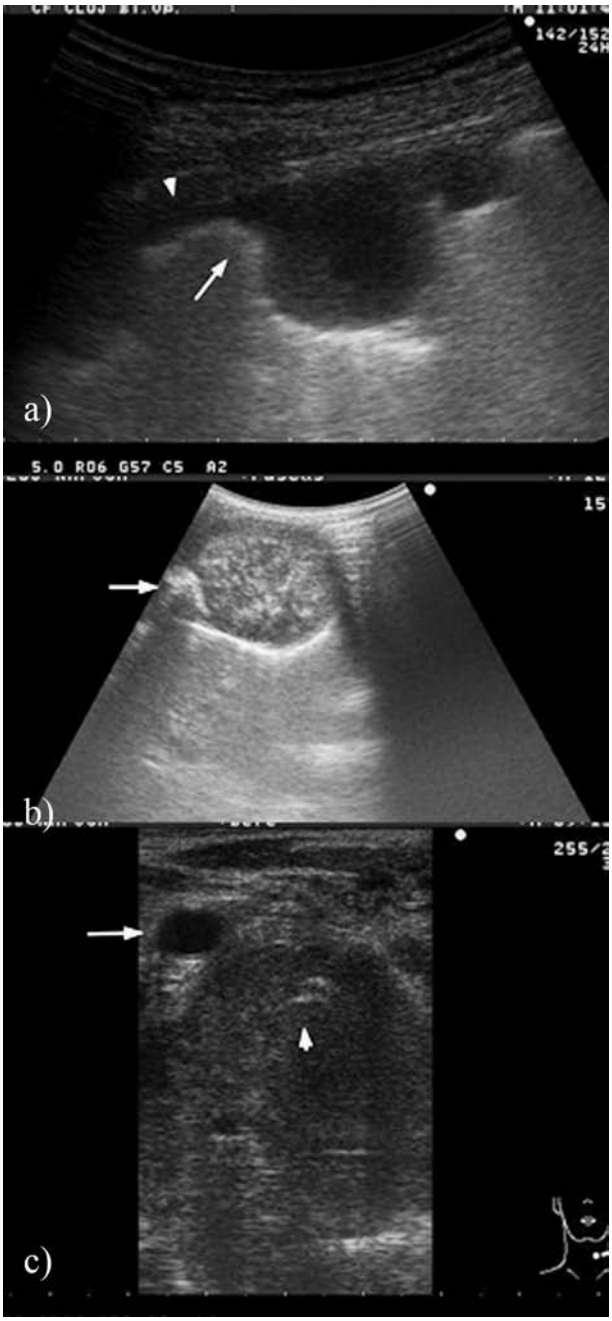


Fig 8. Malignancies displace or destroy normal vessels: a. Pneumonia with regular vascular architecture b. Lung metastasis of prostate carcinoma with marginal, convulted vessels of changing diameter c. Large small-cell lung carcinoma with anarchic vascularization of blood pools apppearance.



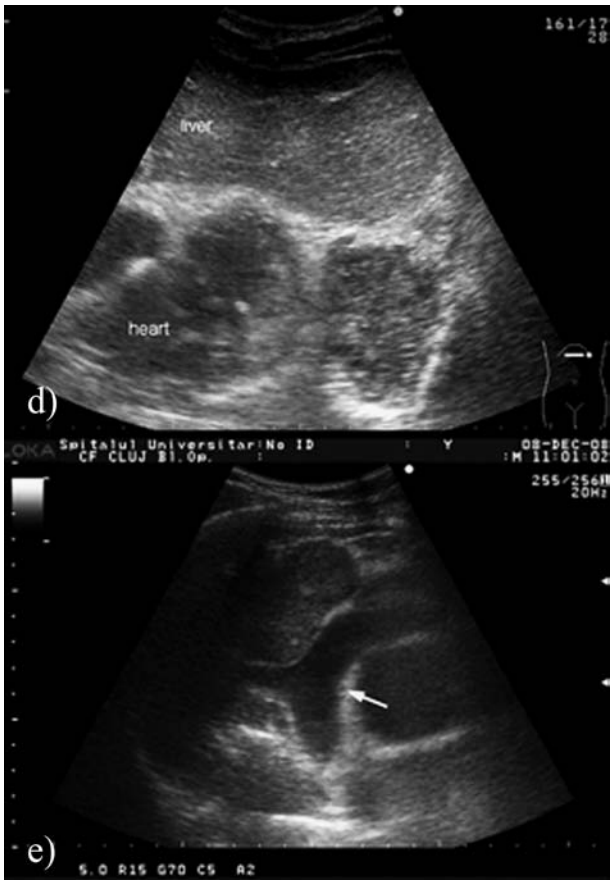


Fig 9. Invasion into adjacent structures is a very reliable sign of malignant growth: a. Small tumor showing pleural invasion: the angle between tumor and lung surface is obtuse (arrow) and accompanied pleural thikening is detected (arrow head) b. Small-cell lung carcinoma extending to the intercostal region. The rib (arrow) is invaded c. Pancoast tumor penetrating the pleural dome. The subclavian artery (arrow) is slightly displaced anteriorly by the tumor. Biopsy (arrow head: needle tip) indicated poorly differentiated adenocarcinoma d. Tumor in the lingula invading the parietal pericardium. Transdiaphragmatic incidence e. Lung adenocarcinoma extending into the anterior mediastinum (arrow: pulmonary artery bifurcation).

of parietal pleural invasion, the sliding sign is absent. However, the absence of the sliding sign is not sufficient to demonstrate malignant invasion, because this sign can also be caused by inflammatory changes. The invasion of muscles, ribs or supraclavicular tissues can be ultrasonographically evidenced under excellent conditions (fig 9).

Metastases can be differentiated from primary lung cancers by their ovoid or round rather than triangular or irregular shape, the absence of aerial inclusions and the marginal vascularization. Malignant pleural mesothelioma appears as a regular or nodular pleural thickening of more than 1 cm. Benign pleural tumors are round or lobulated, frequently encapsulated, echogenic, pedunculated, with central vessels (fig 10) [10].

In all cases of undetermined subpleural lung tumors, ultrasound guided biopsy provides important diagnostic information (fig 11).

Ultrasonography is an important aid in subpleural lung tumors diagnosis. It characterizes radiologicaly undetermined nodules, guides biopsy and provides informations for surgical plans.

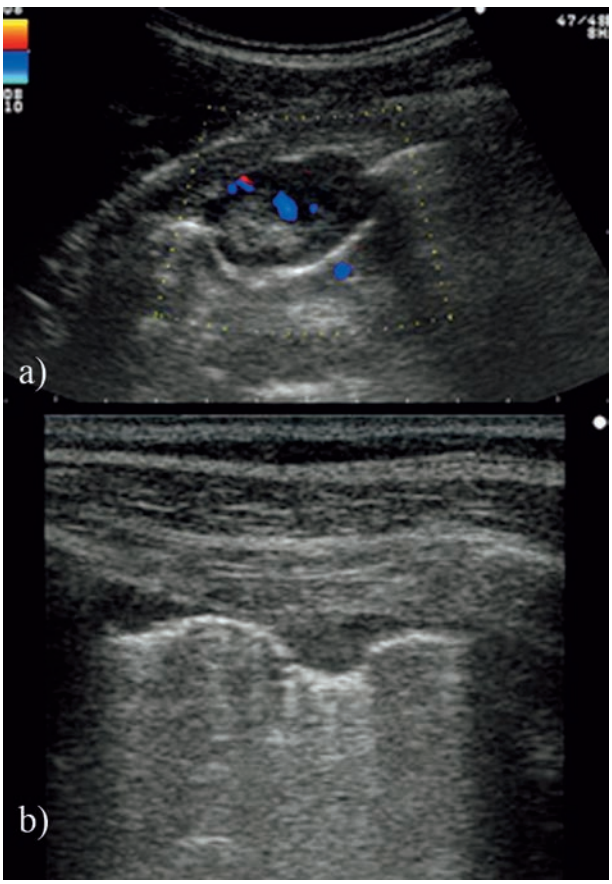


Fig 10. Pleural tumors: a. Well-defined, central feeding vessel, benign pleural tumor (histology from sonographic-assisted biopsy indicated schwannoma) b. Nodular mesothelioma.

Fig 11. Ultrasound guided lung tumor biopsy. The needle passes over the pleural effusion penetrating the tumor.

References

1. US Cancer Statistic Working Group. United States Cancer Statistics: 2003 incidence and mortality (preliminary Data). Centers For Disease Control and Prevention. Washington DC: Department of Health and Human Services, Centers for Disease Control and Prevention, and National Cancer Institute, 2006
2. Rumack MC, Wilson RS, Charboneau JW (eds). Diagnostic Ultrasound, Third Edition. Mosby Inc, 2005
3. Naidich PD, Vlahos *I*, Muller LN, Webb WR, Krinsky AG (eds) Computed Tomography and Magnetic Resonance of the Thorax, 4th Edition. Lippincott Williams & Wilkins, 2007
4. Gebhard M (ed). Chest Sonography. Springer-Verlag Berlin Heidelberg, 2008
5. Mathis G. Thoraxsonography-part II: peripheral pulmonary consolidation. Ultrasound Med Biol 1997; 23: 1141-1153
6. Yang PC. Review paper: color Doppler ultrasound of pulmonary consolidation. Eur J Ultrasound 1996; 3:169-178
7. Yuan A, Chang DB, Yu CJ, Kuo SH, Luh KT, Yang PC. Color Doppler sonography of benign and malignant pulmonary masses. AJR Am J Roentgenol 1994, 163: 545–549
8. Suzuki N, Saitoh T, Kitamura S. Tumor invasion of the chest wall in lung cancer: diagnosis with US. Radiology 1993; 187: 39-42
9. Bandi V, Lunn W, Ernst A, Eberhardt R, Hoffmann H, Herth FJ. Ultrasound vs CT in detecting chest wall invasion by tumor. Chest 2008; 133: 881-886
10. Wernecke K. Ultrasound study of the pleura. Eur Radiol 2000; 10: 1515-1523