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Review Article

Chest Ultrasonography

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ABSTRACT

Chest ultrasonography is a useful tool for assessing disease activity in the peripheral lung parenchyma, pleura, chest wall, diaphragm, and mediastinum. Ultrasound imaging also provides highly useful guidance in invasive diagnostic and therapeutic procedures. The main advantages of this imaging technology are the absence of ionizing radiation and the possibility of real-time bedside applications. The chief indications and limitations of chest ultrasonography and the principal sonographic signs are reviewed

Ecografía torácica

Palabras clave:
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Derrame pleural
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RESUMEN

La ecografía torácica es útil en la valoración de enfermedades del parénquima pulmonar periférico, pleura, pared torácica, diafragma y mediastino, y también es de gran utilidad como guía en procedimientos intervencionistas diagnósticos y terapéuticos. Sus principales ventajas radican en la ausencia de radiaciones ionizantes, la capacidad de explorar en tiempo real y la posibilidad de realizar la exploración en la cabecera del paciente. En este artículo se revisan sus principales indicaciones y limitaciones, así como su semiología básica.

Introduction

The usefulness of ultrasonography has now been demonstrated in many diseases and areas of the body because it offers a number of advantages over other radiologic imaging technologies,[1] including the absence of ionizing radiation, the accessibility of the necessary equipment, and the possibility of real-time bedside applications and image assessment.[2] These characteristics are especially useful in patients who are particularly susceptible to the adverse effects of radiation, such as children[3,4] and pregnant women, and in patients who can only be moved with difficulty, such as those in intensive care units.[5-7] Because ultrasound scanners are portable, they can also be used by emergency response teams to evaluate patients outside of the hospital setting.[8]

The latest technical advances, such as tissue harmonics,[9] improvements in Doppler ultrasonography, and the use of new ultrasound contrast agents,[10] have helped establish important roles for this imaging modality in the diagnosis and management of disease in several subspecialties, including abdominal, breast, and locomotor apparatus radiology. In diseases of the chest, however, ultrasonography has played practically no role or only a secondary one. The reason for this is that 99% of the ultrasound waves emitted by the transducer are reflected at the interface between the pleural membrane and the lung because of the large difference in acoustic impedance between the soft tissues and the aerated lung[11] and the attenuation of ultrasound waves when propagated through aerated structures. Nevertheless, many studies have demonstrated the utility of ultrasound imaging in noncardiac chest disease. Since the object

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of this review is to highlight the diseases in which ultrasonography can be useful, we have organized the article according to the thoracic structures: the pleura, lung, chest wall, mediastinum, and diaphragm.

Pleura

The main application of chest ultrasonography has traditionally been in pleural disease,[12] especially in the diagnosis and sampling of pleural effusions, although in many centers its use has been restricted to the guidance of thoracentesis.

As the normal pleura is only 0.2 to 0.4 mm thick, and this measurement is below the resolution limits of ultrasound systems, the pleural membranes appear as a single highly echogenic line that moves as the patient breathes (lung sliding).

Pleural Effusion

With a sensitivity of 100% and a specificity of 99.7%, sonography is more accurate than conventional radiography in the detection of pleural effusion because as little as 5 mL of fluid can be visualized.[13] By contrast, the minimum volume detectable in a posteroanterior radiograph is 150 mL and in anteroposterior projections with the patient in a supine position the minimum can be as much as 525 mL.[14]

In a study by Lichtenstein et al[15] comparing several diagnostic procedures with computed tomography (CT) in patients with acute respiratory distress syndrome, ultrasonography demonstrated greater diagnostic accuracy (93%) for pleural effusion than either auscultation (63%) or supine anteroposterior radiography (47%).

The volume of a pleural effusion can be estimated using a number of different equations employing the width of the column of fluid, the height of the subpulmonary effusion, or the thickness of the mantle surrounding the lungs.[16,17] The simplest method is to multiply the width of the lateral fluid lamella (in millimeters) by an empirical factor of 90 to obtain the volume of pleural effusion in milliliters (r=0.68). Ultrasonography provides a more accurate estimation of the volume of pleural effusions than radiography.[17]

The sonographic appearance of a pleural effusion depends on its nature, cause, and chronicity. Pleural effusions can be classified on the basis of their sonographic characteristics according to whether they are echoic or totally anechoic, and whether they have septa (thick or thin and mobile) and/or pleural nodules. Ultrasonography has been shown to be more sensitive than CT for demonstrating the presence of septa (Figure 1) inside a pleural effusion.[4,18] An effusion can be classified as an exudate when echoes, septa, or nodules are detected on ultrasound.[19] In the absence of such findings, that is, when the effusion is anechoic, it is not possible to determine whether it is a transudate or an exudate because the latter can also be anechoic.[19]

Ultrasonography is useful for distinguishing small pleural effusions from solid pleural lesions[20] and atelectases.

It can also differentiate between a small pleural effusion and pleural thickening.[20] The fluid color sign[21] provides useful evidence in this respect as it appears in effusions but never in pleural thickening. This sign is the result of the transmission of respiratory and cardiac movements that give rise to a Doppler color signal within the effusion.

The 2 findings most suggestive of malignancy are the presence of pleural nodules—the only sign specific to malignancy—and the swirling pattern.[22] This pattern, which reflects the spiral movement of the internal echoes, is not pathognomonic for malignancy but is often found in patients with malignant effusions.[22] Pleural nodules are more often found in the outer and diaphragmatic pleura.

Figure 1. Pleural effusion with marked pleural thickening and thick septa within the effusion. Biochemistry confirmed the suspected exudative nature of the effusion.

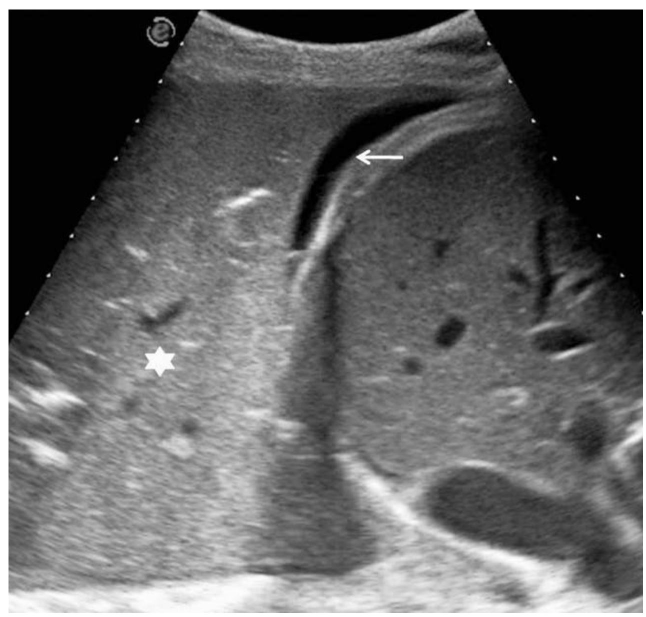

Figure 2. Ultrasound scan of a patient admitted to an intensive care unit with a hard-to-interpret chest radiograph. It shows a large pulmonary consolidation (asterisk) and a very small subpulmonary pleural effusion (arrow).

In patients who can only be moved with difficulty, such as those in intensive care units, ultrasound imaging is also useful for determining whether abnormalities visible on anteroposterior supine radiographs correspond to pleural effusion or lung consolidation (Figure 2). Furthermore, as mentioned below, this technique also facilitates safe and rapid sampling of pleural fluid.

Pleural Thickening

Pleural thickening may be caused by pleuritis or correspond to pleural plaques. Pleuritis is seen as a break in the pleural line with irregular broadening of the visceral pleura. This anomaly is almost imperceptible on radiographs but easy to identify on ultrasound.[23] Asbestos-related pleural plaques appear as hypoechogenic bulges with marked posterior acoustic shadowing when the plaques are calcified.[20]

Pleural Masses

Benign pleural neoplasms (lipoma, schwannoma, chondroma, and benign localized fibrous tumors) are uncommon, only accounting for 5% of pleural tumors.[24,25] They appear on ultrasound as well defined moderately echogenic masses and are sometimes accompanied by small pleural effusions. Ultrasound findings do not permit differentiation of benign neoplasms, but do distinguish them from malignant lesions.

Malignant masses found in the pleura include mesothelioma, lymphoma, and metastases. On ultrasound, mesothelioma appears as an irregular thickening, sometimes nodular, in association with a large pleural effusion.[26] However, CT remains the imaging modality of choice in the staging of pleural mesothelioma,[26] notwithstanding the fact that some authors have reported correct results with ultrasonography.[27]

Metastases, primarily of adenocarcinoma, are the malignant tumors most often found in the pleura.[20] They are generally accompanied by pleural effusion which, because it acts as an acoustic window, facilitates enhanced sonographic assessment of the solid component. The most characteristic ultrasound findings are nodules greater than 5 mm in diameter in the parietal pleura, although these are sometimes found in the visceral pleura.[7] The most commonly affected area is the diaphragmatic pleura (Figure 3),[20] and sonography may also show chest wall involvement.

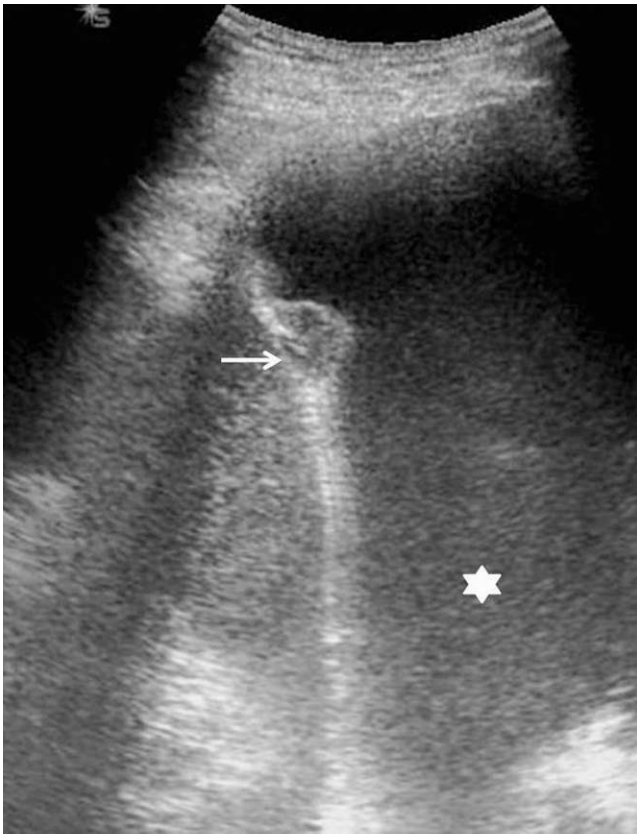

Figure 3. A pleural effusion with multiple internal echoes (asterisk) and a solid nodule in the diaphragmatic pleura (arrow). Metastasis was diagnosed on cytology of the pleural fluid.

Pneumothorax

CT is the gold standard technique for diagnosing pneumothorax,[28] but it is not the procedure of choice because of its high cost, limited availability and, above all, the fact that it involves exposure to ionizing radiation. In routine clinical practice, when pneumothorax is suspected a posteroanterior radiograph taken during inspiration is used for diagnosis. Traditionally, a radiograph during expiration was also obtained although several authors have now shown that the use of this projection does not affect management or improve diagnostic yield in these cases.[29-31] Pneumothorax can be rapidly detected on ultrasound, and this technique is particularly indicated in pregnant women and children (who are particularly vulnerable to radiation) as well as in patients with traumatic injuries and patients in intensive care departments (who cannot easily be moved); ultrasound imaging also provides quantitative data that can inform the subsequent management of the condition.[32]

The lack of comet-tail artifacts[33] and lung sliding[34,35] (the latter in both grayscale and Doppler color images), the presence of posterior linear reverberations,[33] and the lung point sign[36] are all findings diagnostic of pneumothorax. The lung point sign also predicts the need for chest drainage; 90% of patients with lateral pneumothorax will require drainage, as compared to only 8% of those with anterior pneumothorax.[32] The earliest published studies were carried out in patients who had traumatic injuries[37,38] or were on mechanical ventilation,[32] although the best results have been obtained in series of patients assessed for pneumothorax after transthoracic needle aspiration in which ultrasound demonstrated greater sensitivity than conventional radiography and was almost as sensitive as CT.[39,40] However, there have been reports of false positives, for example in patients with chronic obstructive pulmonary disease (COPD) in whom ultrasound may identify reduced lung movement probably caused by lung hyperexpansion, although this hypothesis has not yet been confirmed.[41] Lung sliding may also be absent in patients without pneumothorax who have a history of pleurodesis, asbestos-related pleural disease, or acute respiratory distress syndrome.[33] Ultrasound imaging is also of limited utility in injured patients with subcutaneous emphysema, because, as mentioned above, the propagation of ultrasonic waves is greatly attenuated in air.

Hydropneumothorax can also be diagnosed with chest ultrasonography. The typical finding in this case is the curtain sign, a product of reverberation artifacts inside the effusion that indicate the presence of pleural air.[34]

Lung

Ultrasonography can be used to study diseases affecting the periphery of the lung parenchyma.[42] Diseases that do not affect peripheral lung cannot be assessed using this technology because almost all of the ultrasound waves are reflected back at the pleural-lung interface owing to the great difference in acoustic impedance at that point.

Pneumonia

In the initial stages of pneumonia, the lung appears diffusely echogenic with irregular margins and a sonographic appearance similar to that of the liver.[43,44] Highly echogenic branching linear structures representing air bronchograms are often observed (Figure 4).[45,46] In the more advanced stages of the disease and following antibiotic treatment, areas of pneumonic consolidation contain multiple air-filled spaces that correspond to portions of the lung parenchyma where infection has been resolved.

Another sign sometimes found within pneumonic consolidations and also visible on CT is the fluid bronchogram,[46] which consists of anechoic linear structures within the parenchyma. This sign, while not pathognomonic, should raise the suspicion of a central obstruction as the cause of the consolidation.[47] Ultrasound may also be useful in such cases, since it can sometimes distinguish between the central tumor and consolidated peripheral lung.

Ultrasonography is more sensitive than conventional radiography,[12,43] and even than CT,[48] in the assessment of pulmonary necrosis and abscesses. When color Doppler ultrasound is used, highly echogenic areas indicate hypoperfusion.[49] The abscesses appear as nodular or oval structures that may or may not be well defined and their contents may be fully anechoic or internally echogenic and possibly septated.[43,50,51]

Ultrasonography is important in the assessment of pneumonia because it can detect parapneumonic pleural effusion and intrapulmonary abscesses and can guide the aspiration of consolidations to obtain specimens for culture. In addition it provides an alternative method for the assessment of patients who are particularly vulnerable to radiation, such as children[49] and pregnant women.

Neoplastic Disease

Only neoplasms in contact with the pleura can be assessed with ultrasound. The echogenicity of peripheral pulmonary lesions does not differentiate between benign and malignant lesions, although lung tumors demonstrate as predominantly hypoechoic masses.[47] However, differentiation can be facilitated by attending to the following ultrasound criteria: the contours of the lung surface, the limits with the ventilated lung, the destruction of normal pulmonary architecture, vascular displacement, neovascularization, invasion of adjacent structures, and differentiation between a central lesion and subsequent obstructive atelectasis.[47]

Tumors sometimes present a pleuropulmonary surface with an irregular outline—a pattern not seen in inflammatory processes and one that can be easily identified when there is pleural effusion.

The margins of tumors are normally well circumscribed and there may sometimes be finger-like projections invading adjacent lung tissue.

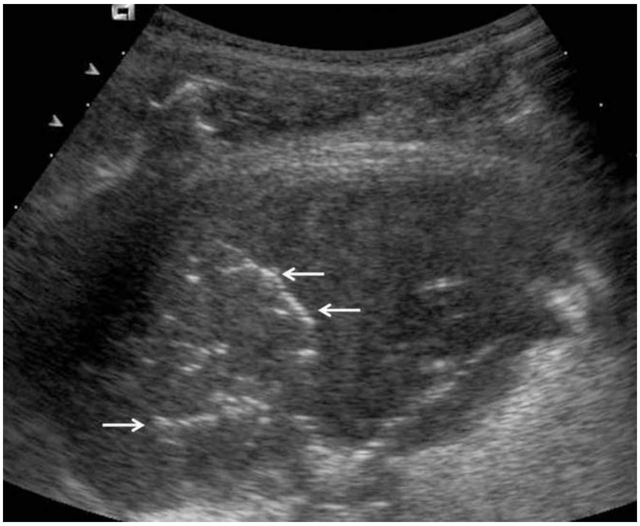

Figure 4. Echogenic consolidation of air space with a highly echogenic branching linear pattern (arrows) corresponding to air bronchogram in a patient with bacterial pneumonia.

Ultrasound imaging is more sensitive (76.9%-100%) than CT (68%-69.2%) in the assessment of chest wall invasion.[52,53] Recent studies comparing sonography with spiral CT and 1.5 tesla magnetic resonance imaging have shown it to be more sensitive than either in the detection of pleural and chest wall invasion.[11,54] When tumors invade the chest wall and parietal pleura, a loss of normal lung sliding is evident during respiration.[20]

Tumors destroy the lung's normal architecture, displacing bronchi and vessels, which may become twisted or change in size.[47]

Color Doppler ultrasound is a useful tool for determining the benign or malignant nature of peripheral pulmonary lesions and for demonstrating the presence of neovascularization on the basis of resistive indices. [23] A mean (SD) resistive index of 0.52 (0.13) (sensitivity, 100%; specificity, 95%) and a pulsatility index of 1.43 (0.13) (sensitivity, 97%; specificity, 95%) have been reported to be useful in differentiating malignant and benign pulmonary masses.

Hematogenous metastasis in the form of subpleural echogenic nodules can also be visualized on ultrasound because of its normally peripheral distribution. Sonography is of limited use in the study of pulmonary metastasis because it cannot detect lesions that are not in contact with the outer pleura.

Pulmonary Embolism and Infarction

Areas of pulmonary infarction can be detected on ultrasound as hypoechoic wedge-shaped lesions with a peripheral base[55,56] that may bulge outward from the pleural surface (Figure 5). In initial phases, the lesions are poorly circumscribed, but with time they become more clearly demarcated and a linear hyperechoic structure corresponding to the bronchiole can also be seen in the center of the lesion.[55-58] The congestive afferent vessel may also be visible. Fresh infarcts can be distinguished from infectious consolidations at sonography because the latter normally present an air bronchogram sign, which is absent in infarction.[59]

While some studies have demonstrated good results with ultrasound in the detection of pulmonary embolism, multidetector CT —with a sensitivity of 74% to 98% and a specificity of 60% to 95%[55-59]— not only visualizes the infarcts but can also assess the presence of repletion defects in the pulmonary arteries through to the subsegmental level. Sensitivity is 85% to 90%[60] and the negative predictive value is 96% to 99%.[61] Consequently, the current potential of ultrasonography in pulmonary embolism is limited to patients who are not candidates for multidetector row CT because they cannot easily be moved.[62,63]

Atelectasis

A crucial problem in radiology is distinguishing between obstructive atelectasis and passive atelectasis caused by pleural effusion. Certain radiographic signs, such as the Golden S sign, facilitate the diagnosis of obstructive atelectasis caused by a central mass, but this finding is not common. However, certain ultrasound findings can help differentiate between these two types of atelectasis.

In passive atelectasis, sonography demonstrates moderate pleural effusion, wedge-shaped consolidation of the lung parenchyma, irregular borders when the lung is aerated, and partial reventilation during inspiration or after thoracentesis.

In obstructive atelectasis, the ultrasound imaging demonstrates scant pleural effusion, hypoechoic lung consolidation, focal lesions (caused by liquefaction, the formation of abscesses, or metastasis), fluid bronchogram, a central obstructive mass, and a lack of reventilation during inspiration.

Ultrasonography can distinguish between atelectasis and a central mass in 50% of cases.[64]

Figure 5. Peripheral pulmonary lesion indicative of pulmonary infarct with a linear pattern in the apex (arrow) corresponding to the thrombosed afferent vessel.

Diseases Involving the Interlobular Septa

The interlobular septa, seen on ultrasound as comet tail artifacts, are affected by many diseases, and their peripheral location makes it easy to assess these processes sonographically.[12,65] Comet tail artifacts are visible under normal conditions,[66] but in certain diseases of the interlobular septa the number of tails seen on the pleural surface increases (Figure 6).[67] In patients with COPD, by contrast, it has been reported that fewer of these artifacts are observed.

In the intensive care unit, this finding is useful for distinguishing patients with COPD from those with heart failure,[5,68-70] with a sensitivity of 100% and a specificity of 92% for the detection of pulmonary edema.[68] A relationship has even been reported between the number of comet-tail artifacts and the severity of heart failure,[71,72] which facilitates follow-up of these patients.[73]

Chest Wall

Masses

Sonography is a sensitive, albeit not at all specific, tool for the detection of masses arising from the chest wall.[4] Its role in the study of such masses is therefore limited to detection[49] and other more specific tools, such as magnetic resonance imaging, must be used to provide a more precise diagnosis.

Lymph Nodes

Ultrasonography is very useful in the detection and characterization of lymphadenopathies particularly in the axilla and supraclavicular fossa.[11] Moreover, it can distinguish reactive lymph nodes from those with malignant infiltration.[74] Reactive lymph nodes are oval or triangular in shape and retain the fatty hilum, which may even become enlarged.[7] By contrast, malignant lymph nodes appear rounded, are hypoechoic, and have no fatty hilum.[7] Extracapsular spread should be suspected when malignant nodes have irregular borders. Nodes that have been infiltrated by lymphoma are rounded and hypoechoic, but well demarcated.

Ribs and Sternum

Ultrasonography is useful in the detection of rib and sternum fractures and is more sensitive than conventional radiography for this purpose.[7,75] The “chimney phenomenon,” which reflects the presence of posterior reverberation artifacts at the traumatized point, facilitates the diagnosis of fractures even when there is no displacement. Ultrasonography also permits the diagnosis of associated complications, whether mild (for example, hematomas or displacement of fragments)[76] or complex (hemothorax or pneumothorax).

Ultrasound imaging can also detect costal metastasis by demonstrating the presence of hypoechoic lesions as compared to the normal hyperechogenicity of cortical bone.[76] It is not, however, useful for ruling out costal metastasis because this would require a very lengthy and expensive scan.[77] Consequently, the role of ultrasound imaging in this context is to guide invasive interventions.[78]

Diaphragm

Ultrasound examination of the diaphragm is difficult and, under normal circumstances, an abdominal approach is used.[79] Consequently, the left hemidiaphragm is more difficult to examine because the air in the stomach blocks transmission of the ultrasound beam.[4]

Diaphragmatic defects, whether congenital, traumatic, or the result of a hernia, are difficult to assess with ultrasonography. They are more easily visualized in the presence of pleural effusion because the fluid serves as an acoustic window.

The movement of the diaphragm can be visualized and measured using real time ultrasound imaging. Phrenic nerve paralysis and

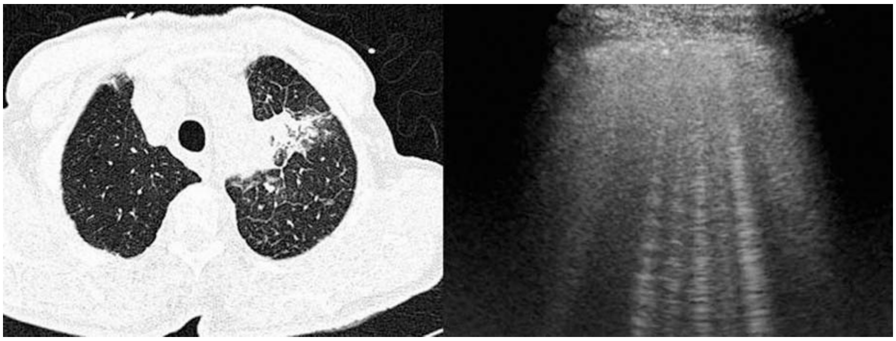

Figure 6. Chest computed tomography scan *(left)*: lung cancer in the upper left lobe with thickening of the interlobular septa indicative of lymphangitic carcinomatosis. Chest ultrasound *(right)*: multiple comet-tail artifacts corresponding to the thickening of the interlobular septa.

paradoxical diaphragmatic motion can easily be studied sonographically,[4,80] and this method has the added advantage that it does not involve the use of ionizing radiation essential to other imaging techniques, such as fluoroscopy.

Mediastinum

Cardiology is the area in which ultrasonography has undergone the greatest development, but such use falls outside the scope of this article. It is possible, however, using suprasternal[81] and parasternal[82] approaches, to visualize certain areas of the mediastinum, particularly the anterior compartment and the aortopulmonary window.[47,83]

Approximately 75% of mediastinal masses are found in the middle and anterior compartments. Since these regions can be visualized sonographically, ultrasound can be used to study these mediastinal masses and to assess vessel infiltration and the cystic nature of the lesions.[84]

Ultrasound imaging has yielded better results than conventional radiography in the assessment of mediastinal lymphadenopathies.[85] The overall sensitivity of ultrasound imaging in the study of abnormal mediastinal lymph nodes is 62%, rising to 72% when only the accessible regions are considered.[86]

Mediastinal sonography has certain disadvantages compared to CT and magnetic resonance imaging, such as its inability to visualize the entire mediastinum and its low specificity in the study of noncystic mediastinal masses.

Pericardial abnormalities, such as effusions, tumoral infiltration, and hemopericardium, are easily assessed by ultrasonography.[87]

Contrast-Enhanced Ultrasonography

Owing to its dual arterial supply, the lung can be assessed using contrast-enhanced ultrasound.[88] The use of ultrasound contrast media enhances the specificity of the technique on the basis of 2 parameters: time to uptake, and extent of uptake. This method can be used to confirm a diagnosis of pleuritis or peripheral pulmonary embolism, to characterize consolidations caused by atelectasis, pneumonia, or tumors, and to guide invasive procedures.[88]

Ultrasound-Guided Thoracic Interventions

Thoracentesis

Ultrasound provides safe, rapid, and effective guidance for obtaining pleural fluid samples,[89-91] and the outcomes are better than those achieved by expert clinicians using other methods.[92] In experienced hands, the complication rate of ultrasound-guided puncture is 2% to 3%, a rate very similar to that associated with CT-guided puncture.[26] Ultrasound-guided thoracentesis is therefore safe and can be performed on patients on mechanical ventilation.[93,94]

In the study of metastatic pleural effusion, the possibility of guiding the puncture towards solid pleural components, which are sometimes very small, gives a better diagnostic yield that the aspiration of fluid alone.[95]

Pleural Drainage

Ultrasound can also be used to guide the placement of pleural drains and facilitate more precise placement of small-bore catheters. These procedures have been shown to be useful in parapneumonic effusions,[96,97] empyema, malignant pleural effusion, and pneumothorax. The use of small-bore catheters is associated with a lower complication rate compared to that of wide-bore chest tubes.[23] The success rate of pleural drains in parapneumonic effusion ranges from 72% to 88%.[23]

Pleural Biopsy

With a success rate of 80%, ultrasound guidance is also useful for obtaining histology samples from pleural lesions.[98] In a study comparing ultrasound-guided biopsy and traditional unguided biopsy with an Abram's needle, the image-guided method was shown to have higher sensitivity (70%-86%) and specificity (100%) in the diagnosis of malignancy and tuberculosis than the unguided technique.[23,99] Good results have been obtained with ultrasound-guided biopsy in the diagnosis of malignant mesothelioma. With a sensitivity of 61.5%, a specificity of 100%, and a precision of 82.8%,[100] the results are similar to those obtained using thoracoscopy.[101]

Lung Cancer

Tumors that are located in the peripheral lung and in contact with the pleura can be biopsied using ultrasound-guided needle aspiration,[44] a technique reported to have a sensitivity of 97% and accuracy of 98%. Nodules as small as 1 cm in diameter can be sampled[102,103] because ultrasound provides real time monitoring and can confirm when the needle point is correctly located inside the lesion.

Ultrasonography is also useful in the biopsy of tumors exhibiting central necrosis because it can be used to guide the needle into the solid portions of the lesion, thereby increasing the sensitivity of the test.

CT-guided percutaneous biopsy of Pancoast tumors is limited by the location of the lesions. In such cases, real time ultrasound facilitates complex approaches (for example, a supraclavicular route), and color Doppler can be used to evaluate the area prior to biopsy in order to prevent accidental puncture of subclavian vessels; a success rate of 83% has been achieved with this method.[23]

In general, ultrasound-guided percutaneous biopsy of peripheral pulmonary lesions is a safe technique, with a complication rate of between 1% and 2%. Most complications—pneumothorax and hemoptysis are the most common—are usually self-limiting. Like other diagnostic imaging modalities, ultrasound can detect a pneumothorax that develops during the procedure. If pneumothorax occurs before the biopsy has been obtained, the attenuation of ultrasound waves caused by the entry of air into the pleural space will prevent correct visualization of the lesion[104] and an alternative imaging technique will have to be used.

Pneumonia and Pulmonary Abscesses

In immunocompromised patients with pneumonia it may be useful to establish etiology. In such cases, ultrasound-guided percutaneous needle aspiration is a useful technique because the addition of color Doppler makes it possible to avoid injury to large intrapulmonary vessels.[44]

Ultrasound can also be used to guide the sampling of lung abscesses to obtain specimens for microbiological diagnosis and to drain the abscess cavity,[105] although some authors prefer to use CT guidance for drainage.[23]

Mediastinum

Ultrasound can also be used to guide fine needle aspiration to obtain cytologic and histologic specimens of enlarged lymph nodes[106] or masses located in the anterior and superior mediastinum.[107] A suprasternal[108] or parasternal[109] approach can be used, and the use of color Doppler makes it possible to avoid the puncture of mediastinal vessels.

Conclusions

Ultrasonography is useful in the diagnosis and management of many chest diseases. It is a quick and economical technique that poses no danger to the patient (since no ionizing radiation is used) and it does not require the patient to be moved. In certain diseases, it yields better results than other imaging modalities (such as radiography and CT) and in other situations it can contribute additional information.

Although ultrasound imaging may appear to be a complex technique, for the trained clinician who has learned the different ultrasound patterns it is a valuable tool in the study of thoracic disease. It is up to pulmonologists and radiologists to move forward together in the understanding of sonography and to integrate it progressively into routine clinical practice.

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