Arch Bronconeumol. (2021);57(6):385–386

Sociedad Española de Neumología y Cirugía Torácica SEPAR

ARCHIVOS DE Bronconeumología

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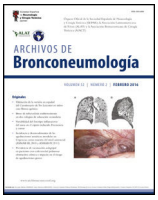

Editorial

Contrast-Enhanced Lung Ultrasound: A New Horizon☆

Ecografía pulmonar con contraste: un nuevo horizonte

Lung ultrasound has succeeded in occupying an important place in the management of lung diseases, given its low cost, widespread availability, and rapid learning curve.[1,2] The different imaging techniques (CT, MRI, PET/CT) used have changed radically in recent years due to both the development of new systems and the appearance of new contrast agents and radiopharmaceuticals. The use of contrast agents has revolutionized the field of ultrasound imaging by combining perfusion imaging methods with conventional B-mode imaging.[3,4] This editorial does not aim to give a detailed description of how to perform contrast-enhanced ultrasound,[5] but it is interesting to note that contrast agents, which are administered intravenously, are composed of gas microbubbles stabilized with other substances. One such agent is SonoVue (Bracco), which is composed of sulfur hexafluoride microbubbles stabilized with a phospholipid shell. Contrast-enhanced ultrasound is performed using a convex probe.

The lungs, like the liver, have 2 types of arterial circulation that generate different patterns of enhancement in lung lesions.[6] The pulmonary arteries, moreover, have a practically zero capacity for neoangiogenesis, so any lesion that needs additional blood supply must obtain it from the bronchial arteries. This involves changes in lung parenchymal enhancement that can be evaluated by contrast-enhanced ultrasound. The administration of a contrast agent does not excessively lengthen the time of conventional ultrasound scanning and narrows down the differential diagnosis.[5] Nevertheless, in cases of large consolidations or multiple involvement, contrast-enhanced ultrasound can explore only 1 area of consolidation and/or 1 lesion, and this is a disadvantage compared to other techniques such as magnetic resonance imaging or dual-energy computed tomography that can evaluate overall pulmonary perfusion. However, ultrasound may be helpful in critical patients who cannot be transferred to the radiology department and in pregnant patients.

Contrast-enhanced lung consolidations or masses are evaluated using various parameters: time to enhancement, pattern and extent of enhancement, and time to wash-out. These parameters are evaluated qualitatively, although the most modern ultrasound machines already have in-built programs that provide a quantitative assessment on completion of the patient's examination. Both pulmonary and bronchial arterial blood supplies show different times to enhancement, although the difference between them is minimal. Pulmonary artery enhancement occurs within 6 s of contrast agent injection and bronchial arterial enhancement occurs within 7 s. This time may be altered in patients with heart failure, with central venous lines, etc. Some authors suggest basing evaluations on enhancement of the chest wall, which is irrigated by systemic arteries, such as the bronchial arteries.[7] Thus, any enhancement that occurs before chest wall enhancement would indicate a pulmonary arterial supply.

Some authors conclude that it is impossible to differentiate between benign or malignant lung disease. However, we believe that these studies have a significant bias, since they included multiple types of benign lesions with different vascularization patterns, some of which are very specific. Pulmonary infarctions usually appear as a triangular consolidation with no ultrasound contrast enhancement at the different phases of the study, although they may sometimes manifest as peripheral enhancement of an inflammatory type.[8] They are usually found in the lower lobes, where there is greater vascularization.[9] Bacterial pneumonias usually show homogeneous enhancement in the pulmonary arterial phase with a late washout.[10] However, in complicated pneumonias, foci of hypoenhancement corresponding to areas of hypoperfusion or even areas with no opacification can be seen, indicating the presence of lung abscesses. Atelectasis characteristically shows enhancement in the pulmonary arterial phase and may retain contrast agent for several minutes after injection.[11]

Patterns of enhancement in malignant tumors may be more heterogeneous, and are determined by the degree of tumor differentiation. Thus, the vast majority of squamous carcinomas show late enhancement (in the bronchial arterial phase), with a heterogeneous pattern and wash-out that can be early or late. Lung adenocarcinomas have, according to their histological subtype, a pattern of enhancement similar to that of squamous carcinoma. In contrast, less aggressive histological subtypes show an air bronchogram pattern of enhancement, pulmonary arterial enhancement, and a homogeneous distribution pattern.[12]

Recent publications on the role of contrast-enhanced ultrasound in COVID-19 pneumonia demonstrate the heterogeneity of pulmonary perfusion in these patients[13,14] and identify multiple areas with no enhancement, suggestive of microinfarctions. More studies in this field are likely to be needed and may be of interest for classifying the severity of lung involvement.

One of the main uses of contrast-enhanced lung ultrasound, supported by several publications, is to guide biopsy. The administration of ultrasound contrast agents prior to performing such

☆ Please cite this article as: Vollmer I, Domènech-Ximenos B, Sánchez M. Ecografía pulmonar con contraste: un nuevo horizonte. Arch Bronconeumol. 2021;57:385–386.

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procedures allows for greater detection of necrosis than in B-mode only. It increases the yield of the technique, reducing the number of inconclusive biopsies due to the presence of necrosis or scant material without significantly increasing complications or procedure time.[15] In our daily clinical practice, we administer the ultrasound contrast agent before any ultrasound-guided interventional procedure, and we have even managed to rule out biopsy in some cases after studying the characteristics of the lesion in the contrast-enhanced study.[16]

As occurred previously with lung ultrasound, the development of new technologies is lagging behind advances in other areas. In recent years, papers have been published that support the usefulness of this technique. We now have the chance to develop new indications for lung ultrasound, and studies are now needed to determine the true benefits of ultrasound contrast agents in the study of lung disease. Future advances in this technique must incorporate the study of lung perfusion, the use of pulmonary elastography, and the implementation of fusion studies combining contrast-enhanced ultrasound with CT. The possibilities are very promising and the challenge is very exciting.

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