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Review

Transcutaneous contrast-enhanced sonography of pleural-based pulmonary lesions

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Abstract

Objective: Transcutaneous ultrasound enables visualization of pleural-based lesions but with a poor correlation to specific pathology. Ultrasound contrast agents in conjunction with contrast-specific imaging techniques are increasingly accepted in clinical use. Based on the dual arterial supply of the lung, this organ is suited for evaluation of arterial vascularity by contrast-enhanced sonography (CES). This review will present first data about practise and clinical use of CES in patient with peripheral lung lesions.

Methods: This review is based on the experience of transcutaneous CES in 350 patients with chest pathology diagnosed by B-mode sonography at an internal medicine center. CES studies were performed with a contrast-devoted unit (Acuson, Sequoia, Siemens medical solution) that had contrast-specific, continuous-mode software. A low mechanical index was used. A sulfur hexafluoride-based microbubble contrast medium (Sonovue®, Bracco SpA, Milan, Italy) was injected. Pulmonary lesions were characterized by CES regarding time to enhancement (TE) and extend of enhancement (EE).

Results: CES in peripheral lung lesions is feasible and depending on underlying diseases lesions may show a variable TE and EE. CES enables to distinguish pulmonary arterial supply from bronchial arterial supply by TE. First experiences with CES have shown that various peripheral lung lesions do have a characteristic CES pattern regarding TE and EE. First clinical data show that there are clinical conditions, which may show a diagnostic advantage of CES in comparison to B-mode US. CES may be helpful (1) to confirm diagnosis of pleurisy, (2) to confirm diagnosis peripheral pulmonary embolism, (3) to characterize lung opafication to atelectasis, pneumonia, and tumor, and (4) to assist in interventional procedures.

Conclusion: : CES of the chest is limited to pleural-based lesions. CES enables to characterize lung lesions regarding TE and EE. The clinical benefit is yet unclear, but first results are encouraging.

Keywords: Contrast-enhanced sonography; Thoracic ultrasound; Pulmonary lesions

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1. Introduction

In the chest, the value of ultrasound has traditionally been limited to the evaluation of pleural effusion and pleural-based lesions. Based on the dual arterial supply of the lung, this organ is, similar to the liver, suited for evaluation of arterial vascularity by contrast-enhanced sonography (CES) [1–3]. CES enables to differentiate and classify pulmonary from systemic bronchial arterial supply of lung lesions regarding time to enhancement and extend of enhancement after contrast agent infusion [4,5]. The aim of this review is to describe CES patterns with a transcapillary second-generation contrast agent (SonoVue®, Braco) in patients with pleural-based lung lesions and to discuss possible indications for CES in patients with suspected chest diseases.

2. General considerations of CES

CES studies were performed immediately after baseline sonography with a contrast-devoted unit (Acuson-Sequoia GI, Siemens medical solution) that had contrast-specific, continuous-mode software. A low mechanical index was used. A sulfur hexafluoride-based microbubble contrast medium (SonoVue®) was injected intravenously within 2 s via a 20-gauge cannula. A volume of 2, 4 ml was administered, followed by a 5 ml saline flush. This contrast medium contains a low-solubility gas and is therefore suitable for low mechanical index (MI) imaging. Low MI techniques with low-solubility gas contrast agents permits continuous, real-time imaging of all phases [6,7]. Time to enhancement (TE) was measured after i.v. injection and extent of enhancement (EE) of pleural lesions was evaluated using the splenic tissue enhancement as an "in vivo" reference [8]. In healthy probands contrast enhancement appears in the right heart between 1 and 5 s (indicating the time window of pulmonary arterial vascularity), and between 8 and 11 s in the left heart after injection (indicating the time window of systemic bronchial arterial vascularity). So a short TE under 6 s indicates a pulmonary arterial supply and a delayed TE over 6 s may indicate a systemic bronchial arterial supply (Fig. 1). It should be mentioned, that in patient with chronic heart failure and chronic pulmonary disease the values of TE for pulmonary arterial supply may be longer than 6 s. For discrimination pulmonary arterial from bronchial arterial vascular supply by CES additionally observation of TE of the surrounding chest wall, liver or spleen is helpful. TE of these tissues will indicates time to the systemic arterial supply.

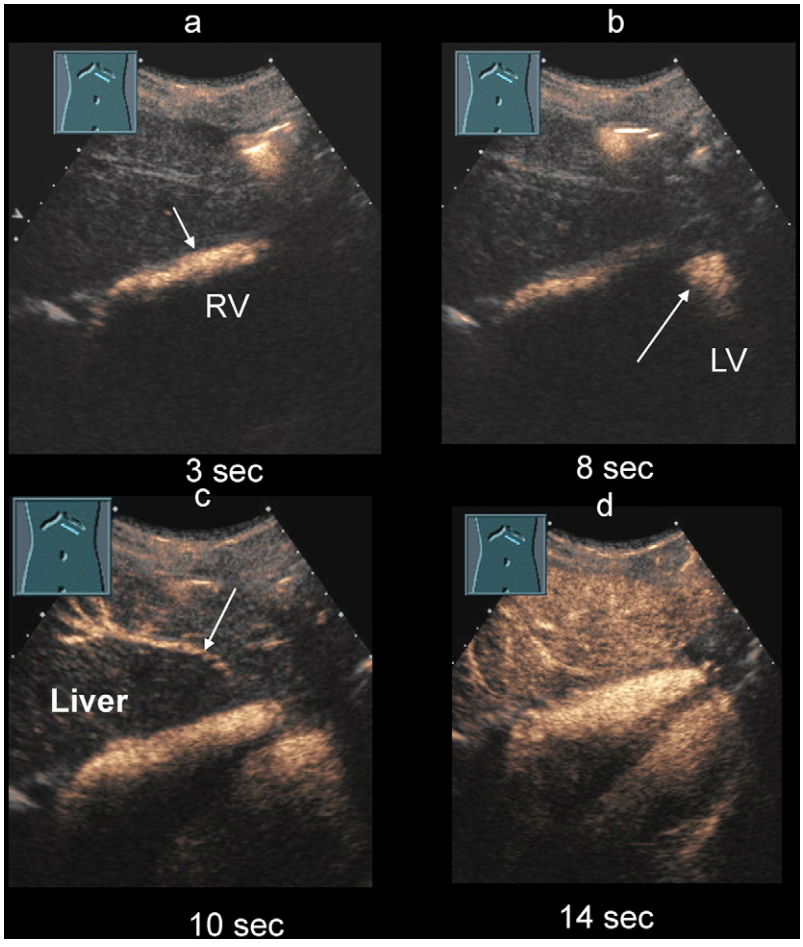

Fig. 1. Subcostal scan through the right and left heart in a healthy young adult with visualisation of the contrast enhancement after contrast medium application into a peripheral vein. (a) Contrast enhancement of the right heart (RV) appears about 3 s (arrow). (b) Contrast enhancement of the left heart (LV) appears about 8 s (arrow). (c) Arterial contrast enhancement of the liver appears after 10 s (arrow). (d): After 14 s complete enhancement of the liver and the heart is seen.