Contrast-enhanced sonography (CEUS) in patients with indeterminate PET findings

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Aims and objectives

Fluorodeoxyglucose (¹⁸F) - Positron emission tomography (FDG-PET) is a powerful imaging modality, playing a pivotal role in the staging, assessment of treatment response, and follow-up of many cancers. However, widespread use of PET may carry a number of indeterminate and falsely positive findings to be investigated. Contrast-enhanced sonography (CEUS) has proved effective in the assessment of patients with indeterminate CT or MR examinations. In this single-cancer centre, retrospective study we investigated the role of CEUS as a second level option after an inconclusive PET scan.

Methods and materials

CEUS is frequently employed in our institution as a simple and quick solving tool in patients with indeterminate or discrepant findings at CT, MR, or PET. By a RIS-PACS search we reviewed the CEUS studies performed from January 2010 to December 2013 selecting 70 exams performed to better assess an unclear PET result. Typical scenarios included liver uptake of the fdg early in the post-operative period, nonspecific liver uptake of the fdg in the staging or follow-up of cancer patients, subtle splenic uptake of the in hematologic patients. Final diagnosis was confirmed by biopsy, surgery, further imaging, or follow-up.

The 70 subjects underwent preliminary sonography examination, which included a tissue harmonic imaging mode and a power and color Doppler assessment. Baseline sonography was performed with a MyLab 70 Twice scanner (Esaote, Genoa, Italy) using multifrequency (2.5-5 MHz) convex probes. This preliminary study allowed us to locate the lesion and to establish the best scanning approach for the subsequent CEUS study.

Contrast-enhanced studies were performed with contrast-specific, low-mechanical-index software (CnTI, Contrast Tuned Imaging). The agent employed was Sonovue (Bracco, Milan, Italy), a sulfur hexafluoride-filled microbubble contrast medium. It was injected into the antecubital vein in bolus fashion, in a volume of 2.4 mL followed by a flush of 10 mL of 0.9% normal saline solution. We employed a dual-frame real-time mode with the fundamental mode sonography image on the right part of the monitor and the contrast-enhanced mode image on the left. The ultrasound beam was focused at the deeper aspect of the lesion examined. After contrast injection, continuous scanning began immediately and lasted 4-5 min. A low acoustic power setting was used (40-45 kPa derated pressure, expressing a mechanical index of approximately 0.06). A timer on the sonography unit was activated at the moment of injection, and the entire examination movie was archived on the scanner.
The process of CEUS was classified into arterial (10-15 to 25-35 s after injection), portal (30-45 to 120 s), and sinusoidal (>120 s to the disappearance of microbubbles) phase.

Final diagnosis was confirmed by biopsy, surgery or further imaging.

Results

In the four-year period considered, 70 CEUS studies were performed after a PET scan. These included 44 PET exams, 19 unenhanced PET-CT exams, and 7 contrast-enhanced PET-CT exams. The target organ was the liver in 55 cases (79%), the spleen in 12 cases (17%), and the pancreas, gallbladder and kidney in 1 case each (Fig. 1). In 26/70 cases (37%) the PET findings were categorized as indeterminate and non specific (i.e. non-specific fdg uptake in the PET report with no SUV given). CEUS allowed to reach a correct diagnosis in 25/26 cases (96%) with one falsely negative CEUS study (Fig. 2). In 34/70 cases (49%) PET was classified as indeterminate but specific (i.e. a well defined fdg uptake with a SUV provided). CEUS allowed to obtain a correct diagnosis in 30/34 cases (88%) (Fig. 3). The remaining 10/70 cases (14%) PET was categorized as determinate but to be investigated because of discrepancy with clinical or imaging findings (i.e. well defined fdg uptake with a SUV provided). In this subset of patients CEUS allowed to achieve a definitive diagnosis in 9/10 cases (90%).

Images for this section:
Fig. 1: Results of CEUS studies performed after a PET scan.

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Fig. 2: Presence on the lower edge of liver segment 4 of a focal area of hyperaccumulation that seems to be referable to non-specific uptake in the gallbladder wall (also showing a large stone). Despite several attempts to acquire scans in inspiratory apnea it was impossible to give a correct localization of the given area (intra- or extra hepatic). The CEUS control showed a single, enhancing gallbladder polyp that at surgery was a primary carcinoma.

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**Fig. 3:** PET study showed a small spot of tracer uptake at level of the liver some. No certain significance of abnormality. CEUS control showed a single liver metastasis, confirmed subsequently at resection.

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Conclusion

CEUS is an effective second-level option in the assessment of cancer patients with indeterminate PET findings. However, the need for further investigation decreases with the increasing use of PET-CT compared to PET alone.

Images for this section:

![Table Image](image-url)

**Fig. 4:** Prevalence of correct CEUS diagnosis in the three different subgroups of patients. There was no difference in the CEUS accuracy between the three PET categories (p value = 0.5)

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