Contrast-enhanced Ultrasound in Evaluation of Focal Hepatic Lesions: the tips and tricks

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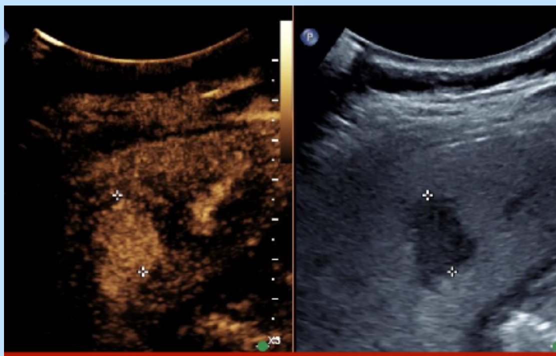

Fig. 1: Arterial enhancing lesion on CEUS. Subsequent images (not shown) with features suggestive of focal nodular hyperplasia (FNH).

Introduction

Contrast-enhanced ultrasound (CEUS) is an imaging technique that uses gas-filled micro-bubbles contrast agents to improve visualisation of blood flow and tissue perfusion in real time. It is a safe and accessible technique for evaluating focal liver lesions without ionizing radiation or the risk of contrast-induced nephropathy. Its application has been endorsed by major guidelines for the evaluation of hepatic lesions, and has gained increase popularity over the years. In this guide, we aim to illustrate our local experience in administering CEUS, offer practical tips and useful advice for radiologists who are beginning to perform CEUS, focusing on the effective administration of CEUS.

Objective

In this pictorial review, we aim to illustrate our local experience in administering CEUS, and provide an overview on the preparation, indication, and techniques on the use of CEUS.

Methods

Images of patients with contrast enhanced ultrasound performed in Pamela Youde Nethersole Eastern Hospital, Hong Kong, within the period 1st January 2023 to 31st December 2024 were retrieved and reviewed. Selected cases were included for illustrative purposes.

Results

Important factors in administering CEUS include patients and lesions selection, US parameters optimisation, and imaging techniques. Indications for CEUS should be considered before it is offered.

Indication for CEUS

- Characterise indeterminate lesions on CT / MRI.
- To characterise and triage new liver lesions, assess necessity for further evaluation with e.g. CT / MRI.
- For pre-ablation planning or ablation guidance.
- Determine adequateness of hepatic lesions following ablation.
- Alternative imaging modality for patients with renal impairment.

Patient Selection

- Lesion size: >1cm.
- Lesion location: best <10cm depth; deeper lesions have worse image quality.
- Visualisation: if lesion is not visible on B-mode ultrasound, consider fusion with CT/MRI.
- Look for contraindication to contrast agents used.

Contrast Agents

Sonovue

- The first registered ultrasound-used contrast in HK.
- A sulfur hexafluoride contrast medium with a main bubble diameter of 2.5 µm.
- Safe, extremely low incidence of side effects. Anaphylactic reaction is very low (0.014%); no deaths reported.
- No cardio-, hepato-, or nephrotoxic effects. Therefore laboratory testing prior to its administration is not required.
- Contraindications:
    - Allergic reaction to its components;
    - Known right-to-left cardiac shunts;
    - Severe pulmonary hypertension (pulmonary artery pressure >90mmHg);
    - Uncontrolled systemic hypertension;
    - Acute respiratory distress syndrome.
- Metabolism: eliminated via the lung. About 80-90% of sonovue are eliminated in 11mins post-administration.

Fig. 2: Sonovue. The first registered contrast used for contrast-enhanced ultrasound.

Sonazoid

- Recently registered ultrasound-used contrast in HK.
- Was not used in our department in the year 2023-2024.

Workflow

Fig. 3: IV access with 3-way, connecting to contrast agent (Sonovue) and saline respectively.

- IV access (20G or larger) with 3-way.
- Dose: 2.4ml IV bolus, followed by 5-10ml saline flush.
    - Paediatric patient 0.03ml/kg, max 2.4ml.
- Observe for 30min after contrast administration.
- Resuscitation facilities must be available, as with the use of all other contrast agents.
- Before repeated contrast administration, all the previously administered contrast must be eliminated. This can be done by:
    - Wait at least 6 minutes.
    - Use of colour doppler mode and sweep.
    - Flash / burst feature.

Ultrasound display setting & optimisation

Transducer frequency

- Microbubble resonance at lower frequencies (1-5 MHz).
- Higher frequency improves spatial resolution, produce strong but transient harmonic signals only.

Acoustic Windows:

- Least depth, and minimal shadowing, include normal liver tissue at same plane for comparison.
- Image acquired usually acquired at sagittal plane, to account for patient’s respiratory movements.

Mechanical index

- Low mechanical index (MI) <0.1 is employed, to minimise microbubble destruction, maintain signal-to-noise ratio.
- MI is set in the range of 0.06-0.08 in our practice.

Focal Zone

- Place the focal zone just below the lesion.

Gain

- The subtracted display should be adjusted to black or near black, leaving only highly echogenic interfaces.

Time-gain-compensation

- Adjusted before contrast administration to achieve uniformity.

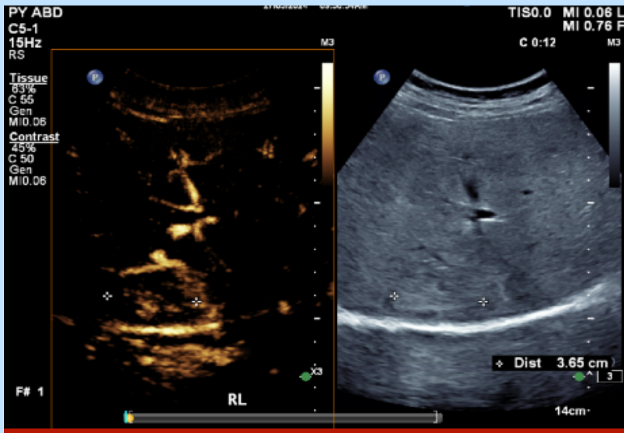

Fig. 4a: CEUS before contrast administration. Lesion was located at 8cm depth, acquired at sagittal plane. Subtracted image was nearly black. Mechanical index (MI) was kept low (0.06). Focal zone was placed just below the lesion.

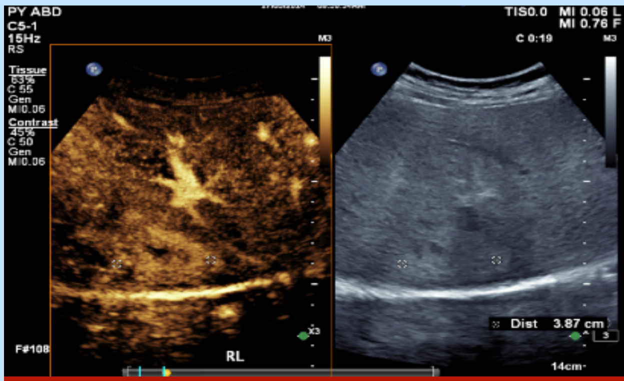

Fig. 4b: Same patient. Imaged obtained at 19 seconds after contrast injection. Time gain compensation (TGC) was adjusted to be uniform. Lesion showed peripheral arterial enhancement. Subsequent CEUS images (not shown) confirmed diagnosis of a haemangioma.

Case Illustration

Haemangioma

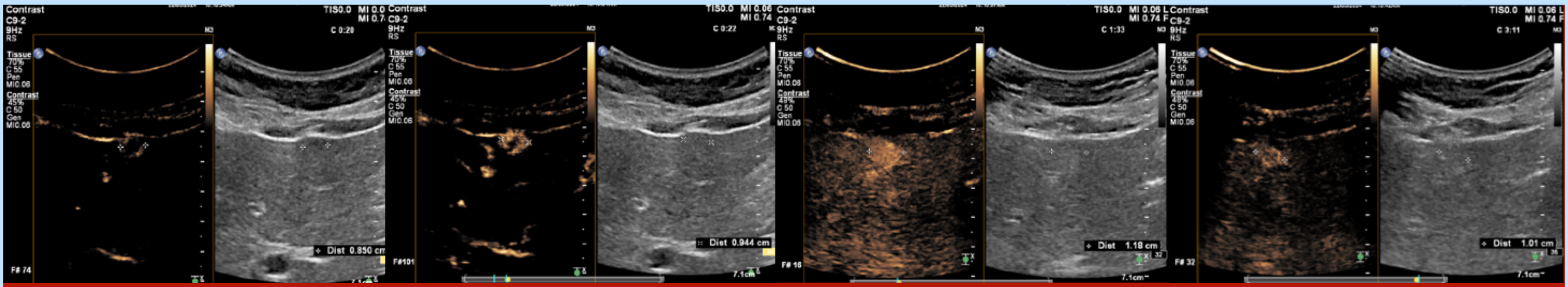

Fig. 5a: Pre-contrast administration. Vague hypoechoic lesion measured 0.9cm at subcapsular location.

Fig. 5b: Arterial phase, 22s after contrast injection. The hypoechoic lesion showed peripheral arterial enhancement.

Fig. 5c: Portovenous phase, 93s after contrast injection. The hypoechoic lesion showed centripetal fill-in.

Fig. 5d: Delayed phase, 191s after contrast injection. The hypoechoic lesion showed vague sustained enhancement.

Hepatocellular Carcinoma

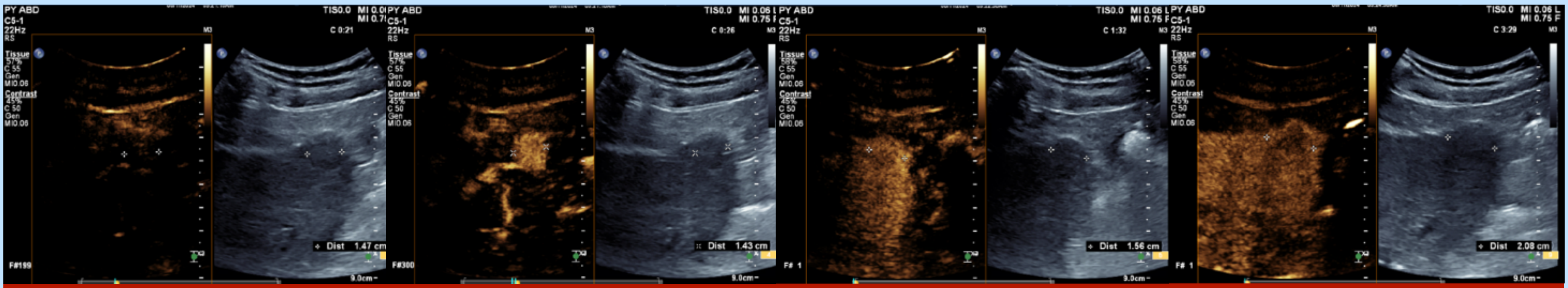

Fig. 6a: Pre-contrast administration. Hypoechoic lesion measured 1.5cm at 5cm depth.

Fig. 6b Arterial phase, 26s after contrast injection. The hypoechoic lesion showed homogenous arterial enhancement.

Fig. 6c: Portovenous phase, 92s after contrast injection. The hypoechoic lesion showed weak washout when comparing with adjacent liver parenchyma.

Fig. 6d: Delayed phase, 209s after contrast injection. Washout persistently detected.

Focal Nodular Hyperplasia

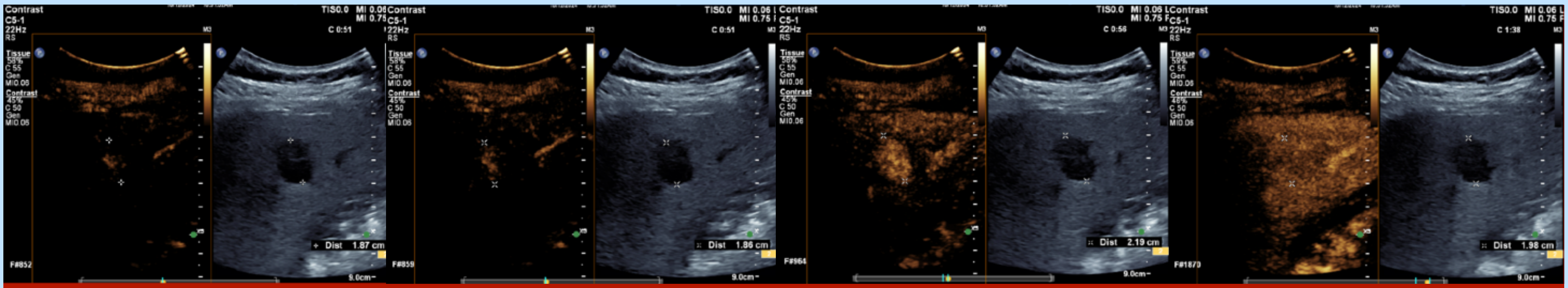

Fig. 7a: Pre-contrast administration. Hypoechoic lesion measured 1.9cm at 5cm depth.

Fig. 7b: Arterial phase. The hypoechoic lesion showed central arterial enhancement.

Fig. 7c Arterial phase, 5s after figure 7b. Arterial enhancement in centrifugal manner, with the lesion showing homogenous arterial enhancement.

Fig. 7d: Portovenous phase. Lesion showed isoenhancement when comparing with adjacent liver parenchyma, without definite washout.

Conclusion

Contrast-enhanced ultrasound is an effective, safe and accurate imaging modality that could provide dynamic and accurate assessment of focal hepatic lesions. Multiple factors are to be considered and employed in its application, including proper patient and lesions selection, US settings optimization. Scanning techniques such as choosing a favourable window, including hepatic parenchyma to assess at same level of lesion, are also invaluable.