Contrast-Enhanced Ultrasound in the Classification of Renal Bosniak Cysts: The EFSUMB Criteria

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**CONTENT**

**BACKGROUND**

**Contrast-Enhanced Ultrasound Development**

- SonoVue, agitated saline used in echocardiography
- Development was slow because of technical limitations
- Last 15 years has seen an explosion in development driven by the discovery of patterns of acoustic behaviour of microbubbles
- Last five years have seen a consolidation in knowledge and practice
- New areas are being explored outside the liver
  - Renal
  - Pancreas
  - Aorta
  - Testis
  - Paediatrics
- Established in clinical practice worldwide
  - EFSUMB Guidelines
  - WFUMB Guidelines
  - AIUM Guidelines
  - ARRS CEUS LIRADS Guidelines

**Contrast-Enhanced Ultrasound Complex Renal Cysts**

- **Background of CEUS**
  - Techniques of CEUS imaging
  - CEUS Safety
  - Regulations for off-label
  - EFSUMB Guidelines
  - Recommendations for use of CEUS in the kidney
  - Current status of CEUS in complex renal cysts

**Contrast-Enhanced Ultrasound Doppler Rescue**
**TECHNIQUES**

Contrast-Enhanced Ultrasound in the Classification of Renal Bosniak Cysts

**SAFETY**

Contrast-Enhanced Ultrasound in the Classification of Renal Bosniak Cysts

**SAFETY**

Contrast-Enhanced Ultrasound in the Classification of Renal Bosniak Cysts

Contrast-Enhanced Ultrasound

<table>
<thead>
<tr>
<th>Technique</th>
<th>MI</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Mechanical Index (MI) Imaging</td>
<td>≤ 0.2</td>
<td>Echovist*</td>
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<tr>
<td>Low MI Imaging</td>
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<td>Schering</td>
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<tr>
<td>Non-Linear Imaging</td>
<td>0</td>
<td>Schering</td>
</tr>
</tbody>
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**Contrast-Enhanced Ultrasound**

- Conventional ultrasound can detect high concentrations of microbubbles – Doppler rescue
- Contrast-specific modes are generally used
- Based on the cancellation and/or separation of linear US signals from tissue and the utilization of the non-linear response from microbubbles
  - Non-linear response from microbubble oscillations at low acoustic pressure, chosen to minimize disruption of the microbubbles
  - High energy broadband non-linear response arising from microbubble disruption

**Safety**

- Radiation exposure from CT scans in childhood and adolescence increases the risk of cardiovascular and second cancers over a single study.
- A single CT scan roughly doubles the cancer risk.
**Contrast-Enhanced Ultrasound Safety**

- No fatalities
- Minor events in 12 investigations (0.0086%)
  - Tingling, nausea, sense of warmth
  - Tachycardia
  - Headache
  - Mild hypotension
- No serious adverse events reported
- Two episodes (hypotension, hypotension)
- Two cases resolved
- Lower adverse event rate reported than contrast for CT and MR imaging

**Post Administration Safety**

Anaphylactoid reactions
- 1:7000 (0.014%)
- Pooled data from 6307 patients
- Headache
- 2.1%
- Nausea
- 0.9%
- Chest pain
- 0.8%
- Chest discomfort
- 0.5%
- Severe Anaphylactoid reactions
- 1:10000
- Fatality
- 14/2,447,083 (0.0006%)
  - (CT iodinated contrast 0.001%)

**Contrast-Enhanced Ultrasound Radiation Dose Reduction**

...it is estimated, that about 1.5–2.0% of all cancers in the United States may be attributable to the radiation from CT studies...

...the estimated risks associated with CT are not hypothetical— that is, they are not based on models or major extrapolations in dose.

Notes: They are based strictly on measured radiation-related cancer rates among the population exposed to the same range of organ doses as delivered during CT studies.

**Contrast-Enhanced Ultrasound in the Classification of Renal Bosniak Cysts**

OFF LABEL USE: REGULATORY POSITION

Contrast-Enhanced Ultrasound Regulatory Position

- SonoVue/Lumason™ is only licensed for the liver in the USA!
Contrast-Enhanced Ultrasound EFSUMB Guidelines

**80 year for EVAR – Bosniak IV cyst in right kidney**

**CEUS IN COMPLEX RENAL CYSTS**
The Bosniak Classification System

- The classification of cystic renal lesions introduced by Bosniak for CECT in 1986 remains pertinent to the CECT diagnosis and management of complex cystic lesions.
- Cysts are classified based on the presence of certain imaging features that determine the likelihood of malignancy including hyper density, septations, calcifications, wall thickening, and enhancement characteristics.
- A "Bosniak" score is assigned to reflect the interpretation, with an increasing likelihood of malignancy:
  - Category I–II: The cystic lesion is a simple or a minimally complex cyst, regarded as "clearly benign" with no further evaluation required. The prevalence of malignancy in Bosniak categories I and II is reported at 3.2% and 6.0% respectively.
  - Category IIF: The cystic lesion is "presumably benign" with imaging surveillance advised. The malignancy rate for Bosniak category IIF is 6.7%. During imaging surveillance, reclassification to Bosniak category III/IV was necessary in 12% with a malignancy rate as high as 85% in reclassified cystic lesions.
  - Category III: The cystic lesion is "indeterminate" for malignancy. The malignancy rate in Bosniak category III is 55.1%.
  - Category IV: The cystic lesion is likely malignant. The malignancy rate in Bosniak category IV is 91%.

The Bosniak classification system is not intended to be used to guide management of cystic renal lesions. Management decisions are dependent on the individual patient's combination of imaging findings, clinical factors, and available treatment options.
Contrast-Enhanced Ultrasound Bosniak Cysts

Contrast-enhanced ultrasonography for evaluation of cystic renal masses in comparison to contrast-enhanced CT and conventional ultrasound.

Objectives: To assess the value of contrast-enhanced ultrasonography (CEUS) in evaluating cystic renal lesions compared with conventional ultrasound (US) and contrast-enhanced computed tomography (CT).

Methods: One hundred and three patients with complex cystic renal masses underwent preoperative US and CEUS, among which 70 conducted CECT at our institution. The images were analyzed with the number of septa, septa and wall thickness and the presence of solid component, and final diagnosis was made.

Results: In malignancies, CEUS demonstrated more septa, thicker wall or septa, and more solid components than US and CECT. CEUS permitted categorization of 51.7% (30/58) and 28.6% (10/35) of malignant tumors in higher grade than by US and CECT, respectively. In benign lesions, CEUS detected more septa than CECT and correctly diagnosed benign cysts which appeared as solid lesions in US. CEUS permitted downgrading of 71.1% (32/45) and 17.1% (6/35) of benign lesions compared to US and CECT. The diagnostic performance of CEUS was better than US for benign cystic lesions. The phenomenon that solid-like component by US did not enhance by CEUS was a strong predictor of benign disease, with a positive predictive value (PPV) of 100%. Enhancement of solid, soft tissue by CEUS was highly predictive of malignancy, with a PPV of 100%.

Conclusions: CEUS was superior to US and CECT in visualizing the number of septa, septa and wall thickness, and the presence of solid component of cystic renal lesions. CEUS may play a similar role to CECT in the diagnosis of renal cystic lesions, and better than US.
The established Bosniak renal cyst classification is computed tomography based, and is well established in determining the malignant potential of complex renal cysts.

Ultrasound has not traditionally been incorporated into this pathway, but with the development of ultrasound contrast agents, coupled with the superior resolution of ultrasound, the possibility of redefining imaging of renal cysts is currently an active research area.

An EFSUMB Expert Task force reviews, analyses and describes the accumulated knowledge, limitations and presents the current position on the use of ultrasound contrast agents in the evaluation of complex.

As CEUS inherently demonstrates more complexity in cystic lesions, caution should be used when applying the Bosniak criteria to CEUS findings.

Comparison of CEUS and CT for renal cyst classification: CT Bosniak III CEUS Bosniak II

CONCLUSIONS

• CEUS offers improved spatial and temporal resolution
  ...but you need to visualise the abnormality
• CEUS offers a safe technique with no reactions, non ionising radiation
• No need to be concerned about renal function
• Very limited information on efficacy of CEUS in complex renal cysts
• Need to redefine the Bosniak classification to suit CEUS
• Need large multicentre prospective clinical trial with robust reference standard
  ...but likely that CEUS will become dominant in clinical practice
  ...but not as yet approved – ‘off-label’
  ...takes more physician time!
Contrast-Enhanced Ultrasound
Bosniak Cysts