Contrast Enhanced Ultrasound: Abdominal Applications

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OBJECTIVES

• At the completion of the program, the participant will be able to:
  
• 1. Understand the mechanism of action of ultrasound contrast agents and appropriate scanning techniques
  
• 2. Understand patient populations who may benefit from contrast enhanced ultrasound (CEUS)
  
• 3. Recognize the role of the sonographer in CEUS examinations
  
• 4. Discuss lesion enhancement patterns using contrast enhanced ultrasound
CEUS BASICS

- WHO?
- WHAT?
- WHERE?
- WHEN?
- HOW?
- WHY?
CEUS BASICS

• WHO?
• WHAT?
• WHERE?
• WHEN?
• HOW?

• WHY?
CEUS BASICS

• WHO?

• WHAT?

• WHERE?

• WHEN?

• HOW?

• WHY?
ULTRASOUND CONTRAST AGENTS (USCA)

- Gas filled microbubbles (< size of RBC)
- Lipid shell on the outside
- Gas in the core
ULTRASOUND CONTRAST AGENTS (USCA)

- Injected intravenously
- Most USCAs are “blood pool” agents
ULTRASOUND CONTRAST AGENTS (USCA)

- Microbubbles oscillate in sound field
- Microbubbles increase image SNR
- Non-linear response (harmonic frequencies produced)
SAFETY

- Safety profiles of USCA have been established
- Short half life – can use multiple injections
CEUS BASICS

• WHO?
• WHAT?
• WHERE?
• WHEN?
• HOW?
• WHY?
WHY CEUS?

Different than in cardiology

-----------------------------INDICATIONS AND USAGE----------------------------------

Lumason is an ultrasound contrast agent indicated for use

• in echocardiography to opacify the left ventricular chamber and to improve the delineation of the left ventricular endocardial border in adult patients with suboptimal echocardiograms

• in ultrasonography of the liver for characterization of focal liver lesions in adult and pediatric patients

• in ultrasonography of the urinary tract for the evaluation of suspected or known vesicoureteral reflux (VUR) in pediatric patients
WHY CEUS?

- Patients who cannot have CT or MRI contrast
  - renal insufficiency
  - allergy to iodinated contrast media

- US/CT/MRI haven’t characterized lesion
WHY CEUS?

• Pediatric patients

• No ionizing radiation ("Image Gently")

• No conscious sedation required
WHY CEUS?

• Post intervention (RFA/ cryo/ TACE, EVAR)

• Ischemic defects (i.e., infarcts, post tx)
  – real time assessment
# LIVER VASCULAR PHASES

<table>
<thead>
<tr>
<th>Vascular phase</th>
<th>Starts (seconds post inj)</th>
<th>Ends (seconds post inj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>arterial</td>
<td>10 – 20</td>
<td>30 – 45</td>
</tr>
<tr>
<td>portal venous</td>
<td>30 – 45</td>
<td>120</td>
</tr>
<tr>
<td>late</td>
<td>&gt; 120</td>
<td>bubble disappearance (4-6 minutes)</td>
</tr>
</tbody>
</table>
LIVER LESION CLASSIFICATION

- **BENIGN**
  - hemangioma
  - focal nodular hyperplasia (FNH)
  - adenoma
  - cyst

- **MALIGNANT**
  - hepatocellular carcinoma (HCC)
  - metastasis
LIVER LESION CHARACTERIZATION


1349 patients
LIVER LESION CHARACTERIZATION

- **BENIGN**
  - Arterial phase depends on lesion (central stellate vs. centripetal filling)
  - Remain enhanced (hyper or iso) in late phase

- **MALIGNANT**
  - Rapid uptake
  - Rapid washout
  - Irregular vessel pattern
PRACTICAL POINTS

• Low MI continuous scanning
  – image initially “black” prior to injection
• Dual screen allows point of reference
• Transducer in place at time of injection
• Have lesion “in plane” - visible with shallow respirations
• Cine clip may be set for up to 3 minutes in length
• Focus placed at most posterior part of image
CLINICAL CASE STUDIES

CEUS Liver

CEUS had a sensitivity of 100%, specificity of 95.0%, PPV 94.7%, and NPV of 100%.

1018 indeterminate renal lesions
RENAL LESION CHARACTERIZATION

• **BENIGN**
  - no flow on CEUS
  - flow in thin septations

• **MALIGNANT**
  - marked enhancement
  - wash out
  - nodular formation on septae
CLINICAL CASE STUDIES

CEUS Kidney
CEUS BASICS

• WHO?
• WHAT?
• WHERE?
• WHEN?
• HOW?
• WHY?
IMAGE OPTIMIZATION

• Contrast specific software
• Image settings in abdomen are agent specific, rather than organ specific
• Initial settings and exam protocols already established
HOW TO (in Radiology)

• Select patient (discuss with referring MD)
• Obtain informed consent (written vs. verbal)
• Start IV (no smaller than 20g)
• Activate drug
HOW

• Perform a standard exam
• Locate area/lesion of interest
• Activate contrast specific software
• Activate dual screen (if desired)
HOW

• Inject contrast agent followed by saline flush
  (need 2 people – 1 to inject and 1 to scan)
HOW

• Start timer (at beginning of saline flush)

• Start clip save (up to 3 minutes)

• Collect data as needed for patient
  – stay in one position or scan entire organ
  – have lesion “in plane” with breathing
  – shallow breathing
HOW

• End study (after deciding if additional injection required)

• Acquire still images from video clip after exam is finished (if desired)

• Remove IV
CEUS BASICS

- WHO?
- WHAT?

- WHERE?
  decided by facility
- WHEN?
- HOW?
- WHY?
CEUS BASICS

• WHO?
• WHAT?
• WHERE?
• WHEN?
• HOW?
• WHY?
IMPLEMENTATION OF CEUS

• PARADIGM SHIFT

• Radiologists accustomed to interpretation – CT, MRI

• Sonographers
  – Scanning technique, pattern recognition
  – Exam time lengthened
  – “Non invasive” mindset
TEAM APPROACH

• “Implementation of a contrast program requires a strong commitment to quality on the part of the medical director.” (Mulvagh et al. J Am Soc Echocardiography 2008; 21(11), 1179-1201)

• Work with referring clinicians to increase awareness/ increase utilization of CEUS

  – can suggest CEUS when interpreting other exams

  (standard US, CT, MRI)
TEAM APPROACH

• Sonographer must understand equipment optimization for microbubble agents (very low MI)

• Foster implementation and administration of contrast agents
  
  – CEUS will add time to the exam

• Explain procedure to the patient

• Possibly insert IV (not probable)
TEAM APPROACH

• Availability of nurse or IV trained sonographer (depending on institutional and state regulations)

“Establishment of IV access remains one of the biggest obstacles to administering UCAs in clinical echocardiography laboratories”  (Porter et. al.  *J Am Soc Echocardiogr* 2014;27:797-810)
<table>
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<tr>
<th>CPT &amp; HCPCS Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>Q9950&lt;sup&gt;1&lt;/sup&gt; LUMASON&lt;sup&gt;®&lt;/sup&gt; ultrasound contrast agent</td>
<td>Sulfur hexafluoride lipid microspheres, per mL; there are 5 mL per single-use vial of LUMASON. LUMASON&lt;sup&gt;®&lt;/sup&gt; is paid separately in the physician office/IDTF. It is also paid separately in HOPPS for Medicare patient due to its Pass-Through payment status</td>
</tr>
<tr>
<td>New CPT&lt;sup&gt;®&lt;/sup&gt; code: Jan. 1 2019: 76978&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Ultrasound, targeted dynamic microbubble sonographic contrast characterization (non-cardiac); initial lesion</td>
</tr>
<tr>
<td>New! Jan. 1 2019 Add-on CPT&lt;sup&gt;®&lt;/sup&gt; code: +76979&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Ultrasound, targeted dynamic microbubble sonographic contrast characterization (non-cardiac); each additional lesion with separate injection (List separately in addition to code for primary procedure)</td>
</tr>
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Note: C9744 is deleted as of Dec. 31, 2018 and replaced by new CPT<sup>®</sup> codes

In HOPPS: 76978 is in Level I - Imaging with contrast- the fee for 2019 is $201.74
ASSESSING REPERFUSION

• High MI brief “flash” – bursts bubbles
• Area re-evaluated as bubbles reperfuse ROI
• Limited number of available bubbles
CONTRAST DYNAMICS

• Can evaluate perfusion of ROI
• Time-intensity curves generated
IN SUMMARY

• CEUS can be beneficial to a number of patients

• Team approach required
  – Defined roles of team members

• Need for appropriate clinician education
QUESTIONS?