Endoscopic Ultrasound (EUS): Visualizing Lesions under the Surface

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Outline

1. Basic primer in EUS
2. How has EUS changed patient care and community referrals?
3. When do you refer for an EUS? What is appropriate referral?
4. When is EUS useful? / What are limitations / Complications?
5. Applications of EUS at Lutheran General Hospital
6. Future Applications of EUS
What is EUS?

• Endoscopic Ultrasound has expanded the breadth of GI Endoscopy
  – Introduced in 1980s: Japan / USA / Germany
  – Able to visualize pancreas through the stomach wall
  – Permits detailed imaging of GI wall layers
  – Enables accurate locoregional tumor staging
The EUS Scopes

Radial

Radial Transducer

Balloon attachment

Digital Imaging Lens

Linear (FNA)

Miniprobe

rotating miniprobe
Basic principles of Ultrasound

- Hyper-echoic (bright)
- Hypo-echoic (dark)
- An-echoic (black)
- Iso-echoic (same)

(mucosa)
(muscularis mucosa)
(muscularis propria)
(adventitia / serosa)
EUS Fine Needle Aspiration
Fine Needle Aspiration (FNA)
How EUS has changed patient care

Esophageal cancer staging:

EUS results could dramatically change the patient’s treatment course
Role of EUS in Esophageal Ca

- Central role in initial staging as outcome is strongly associated with stage
- Useful in monitoring disease recurrence
- Has complementary role with other imaging:
  - EUS for locoregional staging
  - CT / PET: eval for mets / stage IV dz
Comparing CT scan vs. EUS in detecting Lymph Nodes

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>29% (17-44)</td>
<td>89% (72-98)</td>
</tr>
<tr>
<td>EUS</td>
<td>71% (56-83)</td>
<td>79% (59-92)</td>
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</tbody>
</table>

(Lymph node staging in Esophageal Cancer)

Esophageal Cancer Staging Algorithm

Primary Diagnosis (EGD)

CT Scan (+/- PET)

Unresectable Disease
T4 or M1

Stage Dependent Treatment

Resectable Disease

EUS

T1 (T2) N0
Surgical Resection

T3 or TxN1
Chemo / XRT Resection

T4 or M1
ChemoXRT Palliation

Unresectable Disease T4 or M1

Stage Dependent Treatment

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Surgical Resection

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Stage Dependent Treatment

T1 (T2) N0
Surgical Resection

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ChemoXRT Palliation

Unresectable Disease T4 or M1
### EUS T + N Staging

<table>
<thead>
<tr>
<th>T-stage</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>T1</strong></td>
<td>Invasion up to Layer 3 (submucosa)</td>
</tr>
<tr>
<td><strong>T2</strong></td>
<td>Invasion into (but not thru) Layer 4 (musc. Propria)</td>
</tr>
<tr>
<td><strong>T3</strong></td>
<td>Breaks thru musc. propria</td>
</tr>
<tr>
<td><strong>T4</strong></td>
<td>Invasion into adjacent structures</td>
</tr>
</tbody>
</table>

**EUS T1 to T4**

- **T1**: Invasion up to Layer 3 (submucosa)
- **T2**: Invasion into (but not thru) Layer 4 (musc. Propria)
- **T3**: Breaks thru musc. propria
- **T4**: Invasion into adjacent structures
Why is T Stage Important? Risk of LN Mets

Depth of tumor predicts LN involvement

<table>
<thead>
<tr>
<th>T Stage</th>
<th>N1 Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tis</td>
<td>0%</td>
</tr>
<tr>
<td>T1</td>
<td>11%</td>
</tr>
<tr>
<td>T2</td>
<td>43%</td>
</tr>
<tr>
<td>T3</td>
<td>77%</td>
</tr>
</tbody>
</table>

Compared to T1 patient:

- T2 = 6x more likely to have N1
- T3 = 23x
- T4 = 35x

Utility of EUS in EMR
Clinical impact of EUS

- 25 with BE/HGD
  - 13 ok for EMR
  - 5 with submucosal invasion
    - EMR vs. reconsider surgery
      - 2 benign
    - FNA
      - 7 with suspicious LN
        - 5 malignant
          - EMR ok
  - NO EMR!

*In this study, EUS/FNA dramatically changed 20% (5/7) patients management course

Cost analysis of EUS

Impact of pre-op EUS on Esophageal cancer management and cost

• 26% of patients undergoing pre-op EUS staging would be spared combined modality therapy who were found to be Stage I or IV.

In other words:
– Estimated for every 100 pts undergoing pre-op EUS for Esophageal cancer staging:
  • 14 pts with Stage I would be spared neo-adjuvant CTX (Total Cost savings $122,192)
  • 12 pts with Stage IV would be spared surgery (saving a total of $285,600)
  • Average cost savings $3443 per patient

(Shumaker, et. al Gastrointest Endosc. 2002 Sep;56(3):391–6.)
Question: Are community physicians aware of the indications of EUS?
# EUS Indications

## ASGE Recommended Indications for EUS

1. Staging of tumors of GI tract, pancreas, bile ducts, mediastinum
2. Evaluating abnormalities of the GI-tract wall or adjacent structures
3. Tissue sampling of lesions within, or adjacent to the wall of the GI tract
4. Evaluation of abnormalities of pancreas (masses, PC, chronic pancreatitis)
5. Evaluation of abnormalities of the biliary tree
6. Providing endoscopic therapy under US guidance
EUS Indications / Limitations

• 1st study to assess knowledge of referring indications of EUS among physicians

• Setting: Mayo Clinic, Rochester

• 25 question survey
  – Surveyed: 121 GI
    259 Internists
    129 non-GI subspecialties
    150 Surgeons

## Average Score per Specialty

<table>
<thead>
<tr>
<th>Organ system</th>
<th>GI</th>
<th>IM</th>
<th>Non-GI</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagus</td>
<td>81%</td>
<td>68%</td>
<td>69%</td>
<td>68%</td>
</tr>
<tr>
<td>Liver, Pancreas, Biliary</td>
<td>84%</td>
<td>63%</td>
<td>58%</td>
<td>50%</td>
</tr>
<tr>
<td>Colon/rectum</td>
<td>80%</td>
<td>62%</td>
<td>56%</td>
<td>58%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>84.3%</strong></td>
<td><strong>68.9%</strong></td>
<td><strong>65.4%</strong></td>
<td><strong>65.3%</strong></td>
</tr>
</tbody>
</table>

What does this mean?

- Gastroenterologists still responded incorrectly to 15% of questions
- Liver, Pancreas, and Lower intestine EUS were the least understood among referrers
- More education is needed regarding EUS use and its limitations
## Use of EUS at LGH

### Utilization of EUS for locoregional staging for Esophageal Cancer & GEJ CA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total EsophCA + GEJ CA Diagnosis</th>
<th># Diagnoses Made</th>
<th># EUS Performed for staging by site</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>20</td>
<td>Esoph = 13</td>
<td>6/13 (46.2%)</td>
</tr>
<tr>
<td></td>
<td>EUS cases performed: 12/20 (60%)</td>
<td>GEJ = 7</td>
<td>6/7 (85.7%)</td>
</tr>
<tr>
<td>2006</td>
<td>16</td>
<td>Esoph = 12</td>
<td>5/12 (41.7%)</td>
</tr>
<tr>
<td></td>
<td>EUS cases performed: 9/16 (56.3%)</td>
<td>GEJ = 4</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>2007</td>
<td>14</td>
<td>Esoph = 7</td>
<td>5/7 (71%)</td>
</tr>
<tr>
<td></td>
<td>EUS cases performed: 8/14 (57%)</td>
<td>GEJ = 7</td>
<td>3/7 (42.9%)</td>
</tr>
<tr>
<td>3 Year Total</td>
<td>50</td>
<td>Esoph = 32</td>
<td>16/32 (50%)</td>
</tr>
<tr>
<td></td>
<td>EUS cases performed: 29/50 (58%)</td>
<td>GEJ = 18</td>
<td>13/18 (72.2%)</td>
</tr>
</tbody>
</table>

*EUS Available at LGH 1/2005.*

Limitations of EUS

- Ultrasound can only “see so far”
- Time-consuming.
  - Doing EUS when there is no target lesion is like looking for a needle in a haystack.
- Technical challenges:
  - Altered anatomy
  - Small mucosal lesions
  - Non-diagnostic FNA passes
- Newer FNA needles allowing “core biopsies” for pathology
- On-site cytopathologist improves diagnostic yield of EUS

(Klapman JB et al., Am J Gastroenterol. 2003 Jun;98(6):1289-94.)
Complications of EUS

- **Infection risk after FNA**
  - Primarily in pancreatic cyst aspiration
    - Studies show bacteremia incidence of 0.4% - 1% (Voss et al. Gut 2000:46:244–9)
    - IV antibiotic pre/post procedure

- **Bleeding**
  - Extraluminal bleeding: 1.3% (Affi et al. GIE 2001; 53:221–5)

- **Perforation**
  - Standard EGD risk: 0.03% (Eisen et al. GIE 2002; 55:784–93)
  - Diagnostic EUS risk: 0.07% (Rahod & Maydeo GIE 2002; 56:AB169)

- **Pancreatitis after EUS/FNA: 1%-2%** (Gress et al. GIE 2002;56:864–7)

- **EUS is very safe; Similar risks to diagnostic EGD**
Applications of EUS at LGH

- Esophageal cancer locoregional staging
- “Abnormal CT scan” – pancreatic lesion
  - Solid & cystic pancreatic lesions
    - Pancreatic cyst fluid analysis
- Mediastinal lymphadenopathy (with EBUS)
- Evaluation of submucosal lesions
- Difficult polypectomy cases
  - Evaluation prior to EMR
- Celiac plexus neurolysis
- EUS-guided Pancreatic pseudocyst drainage
- EUS-guided “Rendez-vous” ERCP
- Rectal EUS
EUS guided Celiac Plexus Neurolysis

- **Pancreatic cancer:**
  - Pain score reduction in 78% of pts at 2 wks, and sustained for 24 wks

- **Chronic Pancreatitis:**
  - Pain score reduction in 50% of pts and sustained for 24 wks.
Utilizing EUS in Polypectomy

- 43 y.o. athlete referred to evaluate incidental antral nodule found on EGD during workup of abdominal pain.
Utilizing EUS in Polypectomy
Utilizing EUS in Polypectomy

Marking Borders

Saline Lift
Utilizing EUS in Polypectomy

Snare within Cap

Resection Site
Utilizing EUS in Polypectomy
Localization of Neuroendocrine Tumor

2006 - EGD
Localization of Neuroendocrine Tumor

2008 - EGD
Localization of Neuroendocrine Tumor

2008 - EGD
3/25/2008 – Octreotide scan
3/25/2008 – Octreotide scan

- Head to Feet
- Transversal
- Slice thickness 9.02 mm
- Right to Left
- Sagittal
- Slice thickness 9.02 mm
- Anterior to Posterior
- Coronal
- Slice thickness 9.02 mm
Localization of Neuroendocrine Tumor
5/29/2008 - EUS
Localization of Neuroendocrine Tumor
5/29/2008 - EUS

FNA revealed neuroendocrine cells consistent with Gastrinoma
Pancreatic Pseudocyst Drainage
EUS-guided cystgastrostomy in Pancreatic pseudocyst drainage
EUS-guided Rendezvous

- 47 y.o. woman with symptomatic pancreas divisum for minor papilla
EUS-guided Rendezvous

Failed ERCP attempt of minor papilla
EUS-guided Rendezvous

Dilated main pancreatic duct
EUS-guided Rendezvous

Transgastric access of main pancreatic duct
EUS-guided Rendezvous

Trans-gastric puncture into PD
EUS-guided Rendezvous

Trans-gastric puncture into PD
EUS-guided Rendezvous

Guidewire puncture into stomach

Wire exiting minor papilla
EUS-guided Rendezvous

Minor pancreatogram

Stent in minor papilla
Future Applications of EUS

• Moving from Diagnostic ➔ Therapeutic
  – Direct delivery of chemotherapeutic agents to target lesion
  – EUS-guided placement of Brachytherapy radiation seeds
  – EUS guided Angiography

• Advances in EUS Imaging
  – 3D “Spiral” EUS
Summary

- EUS is the most accurate staging modality for locoregional staging of esophageal and pancreatic cancers
- EUS is cost effective and very safe
- More education to referring physicians is needed for appropriate EUS indications
- EUS has allowed us to add a whole new dimension of innovation in GI procedures by allowing us to move beyond the lumen.