



## 超声内镜目前临床的应用

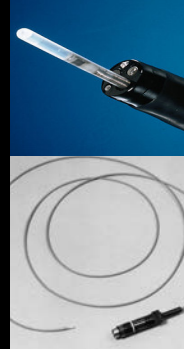
Professor Anthony Yuen Bun, TEOH 张源斌

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Associate Professor  
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The Chinese University of Hong Kong









## Miniprobe examination


- Mechanical transducer
- Oil as the acoustic interface
- Radial image
- 30, 20, 12 Mhz
- Imaging lesions in the GI wall



## Frequency, resolution and penetration

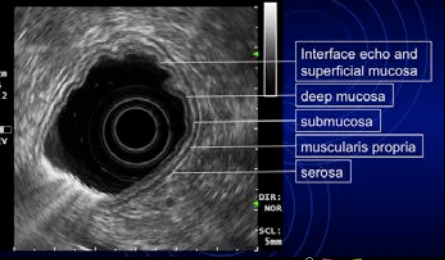
Frequency, resolution and penetration

	Low	Frequency	High
Resolution			
Penetration			




## Five layers of the gastric wall

The five layers of GI tract wall




- Interface echo and superficial mucosa
- deep mucosa
- submucosa
- muscularis propria
- serosa




## Dual planar reconstruction

Dual-Plane Reconstruction


Simultaneous display of radial and linear images




Radial Linear



## Radial Echoendoscope



	Olympus		Pentax Medical	
	GF-UM-200	GF-UM-160	GF-UE-160-ALS	EG-3670URK
Transducer	Mechanical	Mechanical	Electronic	Electronic
Direction of viewing field	Oblique-viewing			Forward-viewing
Scanning angle	360° radial scanning			
Frequency (MHz)	7.5/12	5, 7, 12, 20	5, 6, 7.5, 10	5, 7.5, 10
Insertion tube OD (mm)	13.2	12.7	11.8	12.8
Color and power doppler function	-	-	+	+




### CBD stones



- To select patients for ERCP, avoiding diagnostic ERCP




Liu CL et al. Chin Gastroenterol Hepatol 2005  
 Lee YT et al. Gastrointest Endosc 2008  
 Karakan T et al. Gastrointest Endosc 2009



### Linear Echoendoscope

	Olympus	Pentax
Model No.	GF-UCT140P-ALS GF-UCT140-ALS	EG-3630U EG-3830UT
Scanning angle	180°	100° (120°)
Insertion tube OD (mm)	11.8 (12.8)	12.1 (12.8)
Channel (mm)	2.8 (3.7)	2.4 (3.8)
Frequency (MHz)	5, 6, 7.5, 10	5, 7.5, 10





### Different Needles Available in Market


- Similar in design and operation
- Disposable and single-used
- 19G, 22G and 25G

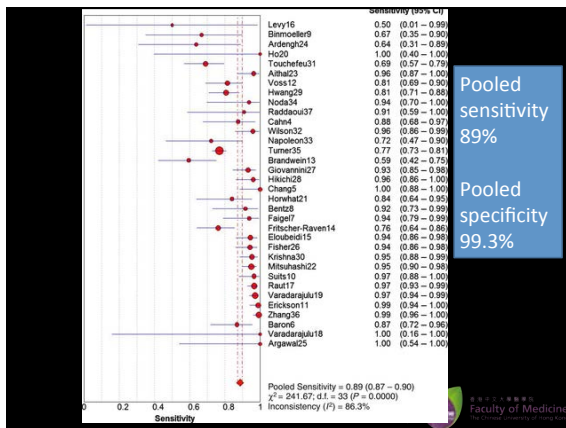
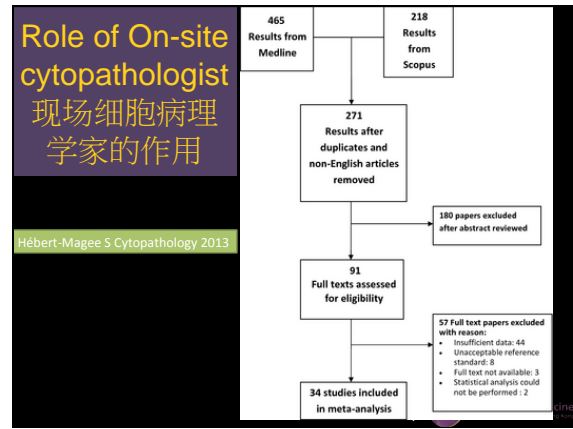
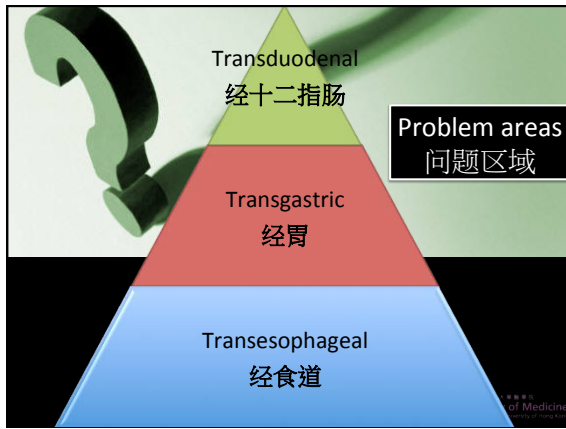





### Factors affecting outcomes of FNA 影响活检的结果的因素

- Needle size 针头大小
- Use of stylet or not 使用钢丝
- Use of suction or not 使用抽吸
- FNA needle maneuver 活检针手法
- Needle type 针类型
- Type of lesion 病变类型
- Location of lesion 病变位置
- Number of passes 通过次数
- On-site cytopathologist 现场细胞病理学家
- Experience of endosonographer 医师经验





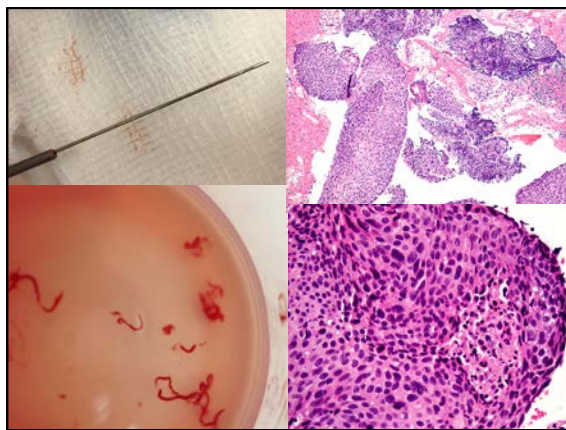
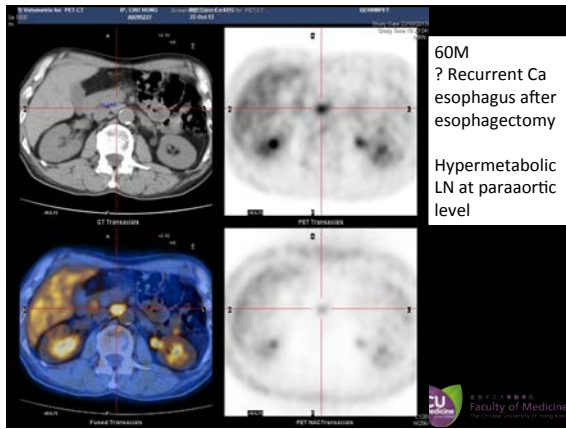
**WHAT NEEDLE TO USE IF HISTOLOGY IS NEEDED?**  
**如果需要活检什么针比较好?**

**EUS FN Biopsy needle Procore 活检针**

- ProCore needle, reversed bevel design 扭转斜面设计
- 19G, 22G, 25G available

**Procore vs other needles Procore与其他针对比**

Author	Study design, needle size, G	Patients, no.	Target organ	Diagnostic accuracy/sufficiency, ProCore vs. FNA	Median passes, ProCore vs. FNA	Comments
Naguia et al. <sup>1</sup>	Randomized trial, 25	ProCore, 47; FNA, 53	Solid masses	89.1% vs. 87.2%; p=NS	1 vs. 1	Equal efficacy
Strand et al. <sup>2</sup>	Prospective, 22	Both needles in 32 cases	Pancreatic masses	93.8% vs. 28.1%; p<0.001	1.4 vs. 2.9; p<0.001	FNA superior
Korenblit et al. <sup>3</sup>	Randomized trial, 22	Both needles in 101 cases	Solid masses	1st pass diagnostic, 53% vs. 35%	Fewer with ProCore	ProCore superior
Vanbiervliet et al. <sup>4</sup>	Randomized cross-over, 22	Both needles in 80 cases	Pancreatic masses	83.7% vs. 87.5%; p=NS	-	FNA yielded better histology
Ramaj et al. <sup>5</sup>	Retrospective, 22	Both needles in 24 cases	Lymph nodes	100% vs. 87.5%; p=NS	-	Equal efficacy
Choi et al. <sup>6</sup>	Retrospective, 22	ProCore, 38; FNA, 42	Pancreatic masses	89.5% vs. 61.9%; p<0.005	1.2 vs. 1.3; p=NS	ProCore superior
Singh et al. <sup>7</sup>	Retrospective, 22	Both needles in 40 cases	Pancreatic masses	100% vs. 92.5%; p=NS	-	Equal efficacy
De La Mora-Levy et al. <sup>8</sup>	Retrospective, 22	ProCore, 51; FNA, 52	Solid masses	86.5% vs. 82.3%; p=NS	-	Equal efficacy



### EUS in Ca pancreas

- **Diagnosis:**
  - FNA, Trucut
  - Staging of CA pancreas
- **Treatment:**
  - Locally invasive / borderline resectable tumor: Fiducial placement
  - Unresectable tumor: CPN, biliary drainage, delivery of anti-tumoral agents

### Diagnosis of Pancreatic tumors

**Table 3. Summary of studies comparing EUS to helical CT for pancreatic cancer**

Series	Detection		Accuracy for resectability		Sensitivity for vascular invasion	
	EUS	CT	EUS	CT	EUS	CT
Legmann et al. <sup>22</sup>	27/27	25/27	20/22	19/22	6/7	7/7
Midwinter et al. <sup>21</sup>	3/3/4	2/6/4	25/30	23/30	13/16	9/16
Tierney et al. <sup>20</sup>			30/31	25/31	16/16	10/16
Mertz et al. <sup>24</sup>	28/31	16/31	16/16	13/16	6/6	3/6
Total	97%	73%	91%	83%	91%	64%
p Value*	<0.001		0.02		<0.001	

\*Fisher exact test.

Tumor Size	EUS	CT	MRI
<3cm	93%	53%	67%
<2cm	90%	40%	33%

**More accurate in the identification of small pancreatic tumors.**  
**Invasive, operator dependent**

### Diagnosis – EUS-guided FNA

- Pooled sensitivity: 85%
- Pooled specificity: 98%
- PPV: 99%
- NPV: 64%
- Sensitivity improved with the presence of on site pathologist
- Observed complication rate: 1-2%
- Complications: bleeding, infection, self-limiting pancreatitis, tumor seeding; Similar to CT-guided Bx

ORIGINAL ARTICLE: Clinical Endoscopy

**EUS-guided FNA for diagnosis of solid pancreatic neoplasms: a meta-analysis**

Michael Jonathan Steinhilber, MSc,<sup>1</sup> Mark J. W. Meenan, MD,<sup>1</sup> PhD,<sup>1</sup> Lucie Prosser, MD<sup>1,2</sup>, James Dale, MD<sup>1,2</sup>, Douglas Morrison, MD, PhD<sup>1,2</sup>, George J. Bouillon, MD, PhD<sup>1,2</sup>

London, United Kingdom

**Background:** Preoperative diagnosis of solid pancreatic lesions remains challenging despite advances in imaging techniques. EUS has the benefit of being a minimally invasive, well-tolerated procedure, although access to optimal specimens. The addition of EUS-guided FNA provides samples for cytopathologic analysis, a true advantage over other imaging techniques.

**Objective:** To determine the diagnostic accuracy of EUS-FNA for pancreatic cancer.

**Design:** This is a meta-analysis of published studies assessing the diagnostic capability of EUS-FNA. Relevant studies were identified on MEDLINE and were included if they used a minimum number of substantive original histology or clinical follow-up of at least 3 months.

**Main Outcome Measurements:** True from selected studies were analyzed by using meta-analysis software, providing a pooled value for sensitivity, specificity, diagnostic odds ratio, and summary receiver operating characteristic curve. Outlying results were classified as inadequate, benign, negative, or malignant. Predefined subgroup analysis was performed.

**Results:** Thirty-three studies published between 1997 and 2010 were included, with a total number of 486 patients. The pooled sensitivity for malignant (cystic) was 85% (95% confidence interval [CI], 81-88), and pooled specificity was 98% (95% CI, 97-99). If benign and malignant histology results were included to determine true neoplasms, the sensitivity increased to 91% (95% CI, 89-92), however, the specificity was reduced to 96% (95% CI, 95-96). The diagnostic accuracy of EUS-FNA was reduced in prospective, multicenter studies.

**Limitations:** Publication bias was not a significant determinant of pooled accuracy.

**Conclusions:** This meta-analysis demonstrates that EUS-FNA is a highly accurate diagnostic test for solid neoplasms of the pancreas and should be considered when algorithms for investigating solid pancreatic lesions are being planned. (Gastroenterology 2012;142:559-571)

## Staging

**American Joint Committee on Cancer (AJCC) TNM Staging of Pancreatic Cancer (2016)**  
 Because only a few patients with pancreatic cancer undergo surgical resection of the pancreas (and adjacent lymph nodes), a single TNM classification must apply to both clinical and pathologic staging.


<b>Primary Tumor (T)</b>	<b>Regional Lymph Nodes (N)</b>
<b>Tx</b> Primary tumor cannot be assessed	<b>Nx</b> Regional lymph nodes cannot be assessed
<b>T0</b> No evidence of primary tumor	<b>N0</b> No regional lymph node metastasis
<b>Tis</b> Carcinoma in situ*	<b>N1</b> Regional lymph node metastasis
<b>T1</b> Tumor limited to the pancreas, 2 cm or less in greatest dimension	
<b>T2</b> Tumor limited to the pancreas, more than 2 cm in greatest dimension	<b>Distant Metastasis (M)</b>
<b>T3</b> Tumor extends beyond the pancreas but without involvement of the celiac axis or the superior mesenteric artery	<b>M0</b> No distant metastasis
<b>T4</b> Tumor involves the celiac axis or the superior mesenteric artery (unresectable primary tumor)	<b>M1</b> Distant metastasis

\*This also includes the "Pantrill" classification.

**Reported accuracies by EUS:**


- T: 63% - 94%
- N: 41% - 86%
- M: Liver, ascites

<b>Stage Grouping</b>	<b>Tx</b>	<b>N0</b>	<b>M0</b>
<b>Stage 0</b>	Tx	N0	M0
<b>Stage IA</b>	T1	N0	M0
<b>Stage IB</b>	T2	N0	M0
<b>Stage IIA</b>	T3	N0	M0
<b>Stage IIB</b>	T1	N1	M0
	T2	N1	M0
	T3	N1	M0
<b>Stage III</b>	T4	Any N	M0
<b>Stage IV</b>	Any T	Any N	M1




## Staging - Local Staging

- Reported accuracies of local staging by EUS in pancreatic cancer: 62 – 94%

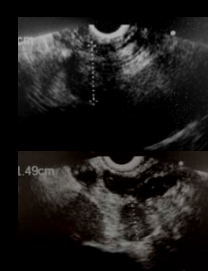



*DeWit J. Comparison of Endoscopic Ultrasound and Computed Tomography for the Preoperative Evaluation of pancreatic cancer: A systematic review. Clin Gastroenterol Hepatol 2006.*  
*Canle J. Endoscopic ultrasonography vs helical CT for locoregional staging of pancreatic cancer: a prospective comparative trial using histology as gold standard. Pancreatology 2004.*  
*Ramsay D. et al. Identification and staging of pancreatic tumours using computed tomography, endoscopic ultrasound and magnetic resonance imaging. Australian Radiol 2004.*  
*Tamm EP. Diagnosis, staging, and surveillance of pancreatic cancer. AJR AM J Roentgenol 2003; 180: 1311-23.*



## Staging – Nodal Staging



- Main stations: perigastric, periduodenal, celiac, hepatic hilum, +/- mediastinal (~5% may present with LN metastasis at this level)
- Accuracy: 64 – 82%
- Difficult to distinguish between malignant and inflammatory lymphadenopathy
  - Round, distinct border, >1cm
- EUS-guided FNAC may be necessary

## Staging – Vascular invasion

- EUS accuracy: 40 – 100%
- Venous invasion:
  - Sensitivity: 56%
  - Overall accuracy: 50%
  - Equal or superior to CT
- Portal vein and confluence:
  - Sensitivity: 60-100%
  - Superior to all imaging modalities
- SMV, SMA, celiac axis:
  - Sensitivity decreases to 17-83%, 17% and 50% respectively
  - Helical CT better

J Garcia. Endoscopic ultrasound in the diagnosis and staging of pancreatic cancer.

## Case

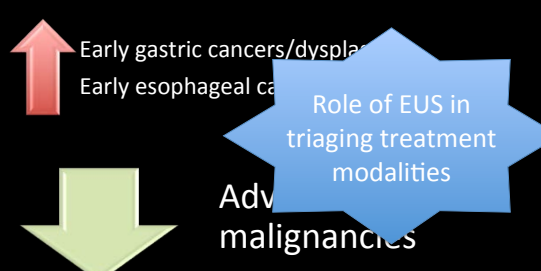
- A 67 year-old gentleman had refused surgery for a PNET
- EUS and CT confirmed a 1cm non-functional hypervascular lesion at the neck of the pancreas
- FNAC reviewed clusters of monotonous tumor cells that were immunoreactive to synaptophysin
- Scheduled for EUS-guided alcohol injection

Teoh GIE 2013





## Changing scope of UGI malignancies




Early gastric cancers/dysplasia

Early esophageal cancer


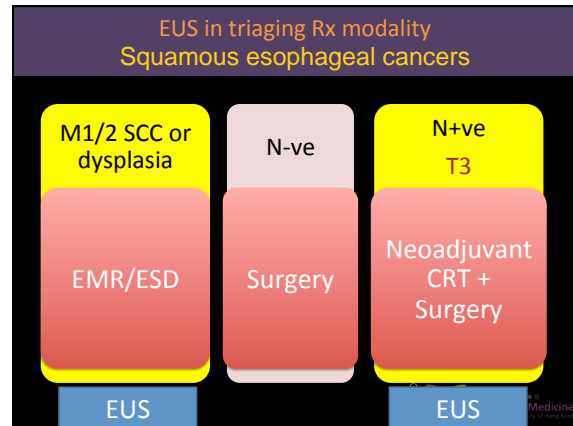
Role of EUS in triaging treatment modalities

Advanced malignancies



**AJCC 7<sup>th</sup> edition esophageal cancer**


Primary tumour (T)	
Tis	High grade dysplasia
T1	Invading to lamina propria
T2	Invading to muscularis propria
T3	Invading adventitia
T4a	Resectable cancer invading adjacent structures
T4b	Unresectable cancer
Regional nodes	
Any peri-esophageal nodes (including cervical and celiac nodes)	
N0	No regional nodes
N1	1-2 regional LN's
N2	3-6 regional LN's
N3	≥ 7 regional LN's

**Early esophageal cancers (EEC)**

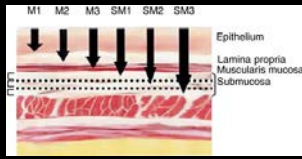
- Involving mucosa (m1,2)
  - Associated with low risk of LN metastasis
- Significantly better survival ~ 90%

Noguchi et al Surg Laparosc Endosc Percutan Tech. 2000




**EEC: Risk of lymph node metastasis**

- M1 + M2 (ESD)
  - No LN metastasis
- M3
  - 9%
- SM1 (< 200µ)
  - 19%





Japanese esophageal society guidelines. Kanehara Suppan 2007; Oyama T et al. Stomach intestine 2002; Yokoyama J et al. Acta Medica Biologica 2002



**EUS staging EEC**

- Exclude tumours with submucosal invasion
- Detect paraesophageal LN's
- Detect of celiac LN's





**Accuracy of EUS in EEC**

- 54 EEC and 52 Barrett's adenoCa
- EUS vs histology
- Overall accuracy 73.5%, PPV 40.6%, NPV 88.9%

	pT1m	pT1sm	Total
uT1m, n (%)	62 (76.5%)	8 (38.1%)	102
uT1sm, n (%)	19 (23.5%)	13 (61.9%)	32

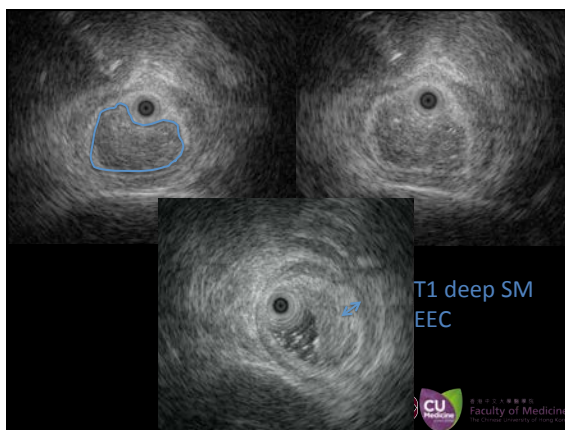
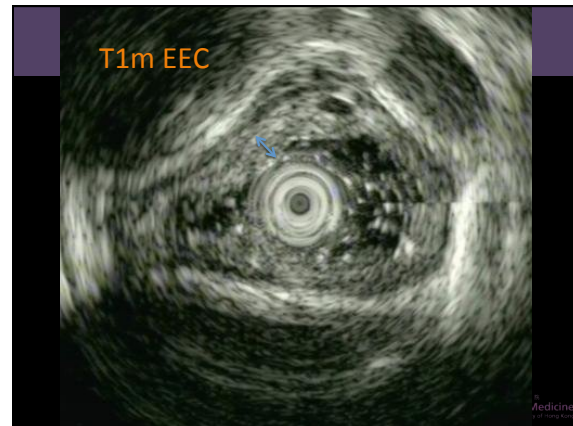
Chemayl et al Endoscopy 2007



### Lymph node staging EUS vs CT

	EUS	CT
Sensitivity	75%	38%
Specificity	97%	100%
Positive predictive value	75%	100%
Negative predictive value	98%	95%

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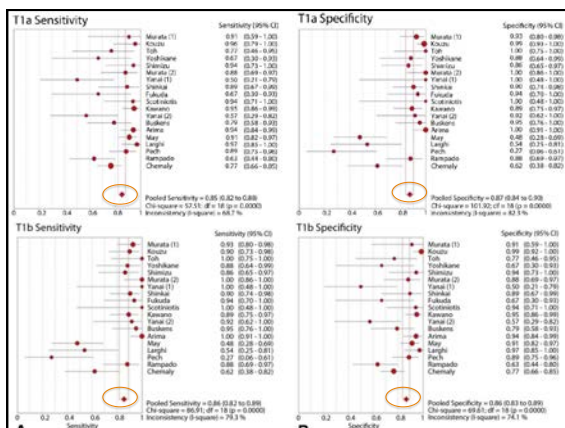


### Diagnostic accuracy of EUS in differentiating mucosal versus submucosal invasion of superficial esophageal cancers: a systematic review and meta-analysis

- 19 studies
- 1019 patients
- Squamous and adenocarcinomas
- Pooled analysis:
- T1a: Sensitivity 0.85 (95% CI, 0.82-0.88), Specificity 0.87 (95% CI, 0.84-0.90)
- T1b: Sensitivity 0.86 (95% CI, 0.82-0.89), Specificity 0.86 (95% CI, 0.83-0.89)

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Thosani GIE 2012



### Selective use of EUS for EEC

**Squamous esophageal carcinoma**

- If high certainty for mucosa involvement only => EMR/ESD
- If suspicious of SM involvement => EUS


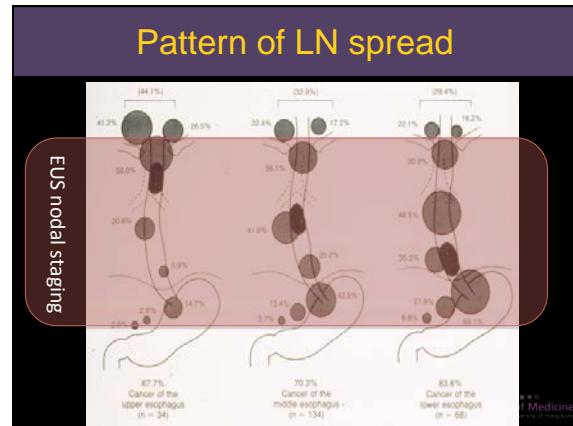
**Adenocarcinoma esophagus**

- If high certainty of mucosal or SM involvement only => EMR/ESD
- EUS performed to rule out T2 involvement

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### Advanced Esophageal cancers Role of EUS

- Determine patients for neoadjuvant or definitive CRT
  - N +ve
  - Serosal involvement
- Assess presence of adjacent organ invasion
  - Trachea
  - Aorta
  - Pleura

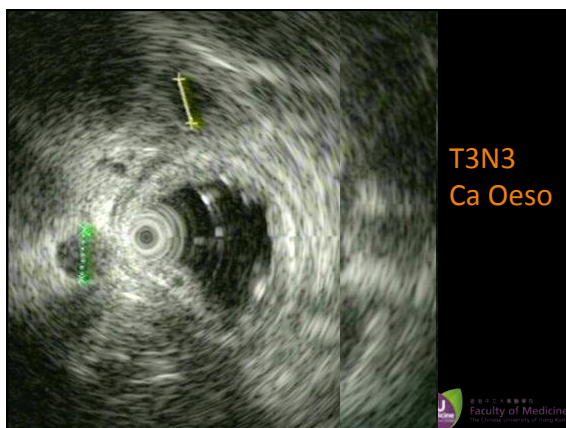
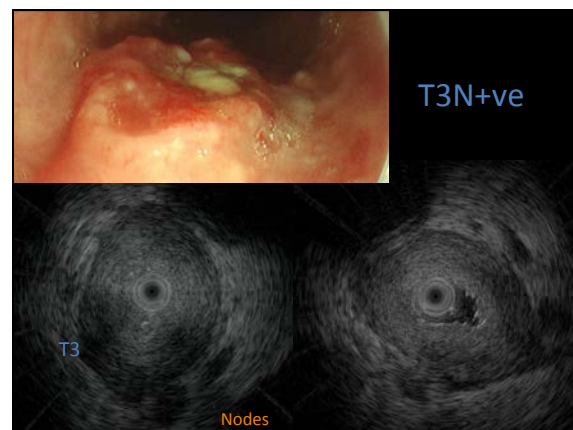
### Accuracy of EUS in advanced esophageal cancers

Technique	No. of studies patients	T accuracy % (range)	N accuracy % (range)
CT	1154	45 (40-50)	54 (48-71)
EUS	1035	85 (59-92)	77 (50-90)

Rosch GI endosc Clin N Am 1995

Technique	No. of studies	Sensitivity (%)	Specificity (%)
CT T stage	5	40-80	14-97
EUS T stage	13	71-100	67-100
CT N stage	7	40-73	25-67
EUS N stage	20	60-97	40-100

Kelly et al Gut 2001



### AJCC 7<sup>th</sup> edition Ca Stomach

- Changes in definition
- T3 & T4
- Nodal

TX	Primary tumor cannot be assessed
T0	No evidence of primary tumor
Tis	Carcinoma in situ: intraepithelial tumor without invasion of the lamina propria
T1	Tumor invades lamina propria, muscularis mucosae, or submucosa
T1a	Tumor invades lamina propria or muscularis mucosae
T1b	Tumor invades submucosa
T2	Tumor invades muscularis propria
T3	Tumor penetrates subserosal connective tissue without invasion of visceral peritoneum or adjacent structures. T3 tumors also include those extending into the gastrocolic or gastrophrenic ligaments, or into the greater or lesser omentum, without perforation of the visceral peritoneum covering these structures
T4	Tumor invades serosa (visceral peritoneum) or adjacent structures
T4a	Tumor invades serosa (visceral peritoneum)
T4b	Tumor invades adjacent structures such as spleen, transverse colon, liver, diaphragm, pancreas, abdominal wall, adrenal gland, kidney, small intestine, and retroperitoneum
NX	Regional lymph node(s) cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis in 1 to 2 regional lymph nodes
N2	Metastasis in 3 to 6 regional lymph nodes
N3	Metastasis in 7 or more regional lymph nodes

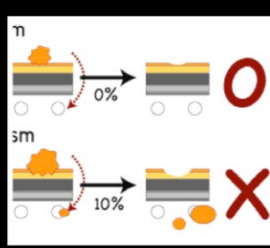


### EUS in triaging Rx modality Gastric Cancers

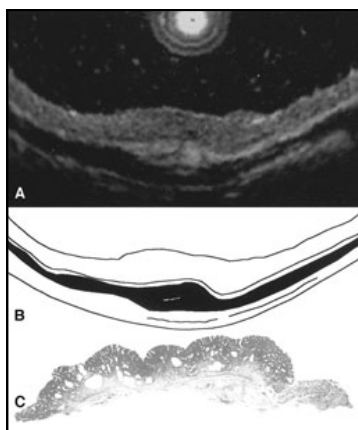
T1m or sm1	T1sm 2&3, T2	T3 or N+ve	Metastatic
ESD	Laparoscopic gastrectomy	Open gastrectomy	Palliative chemo
EUS			EUS

### Role of EUS Early gastric cancer

- Exclude tumors with **DEEP** SM of invasion
- Exclude para-gastric and regional LN mets

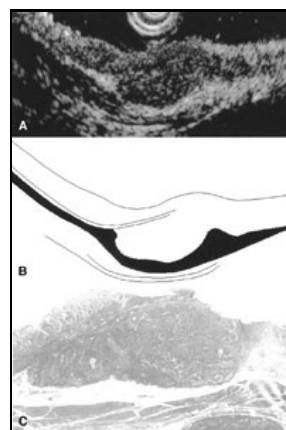


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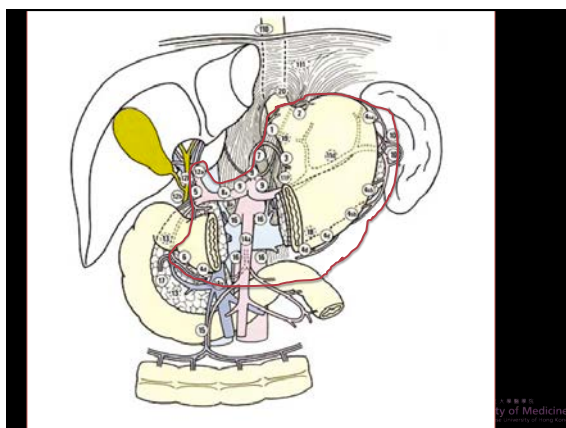
- T1m
- No change in the mucosal or submucosal layer

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- EUS - T1sm2
- Arched shaped Sm layer
- Histology – invasion to submucosa

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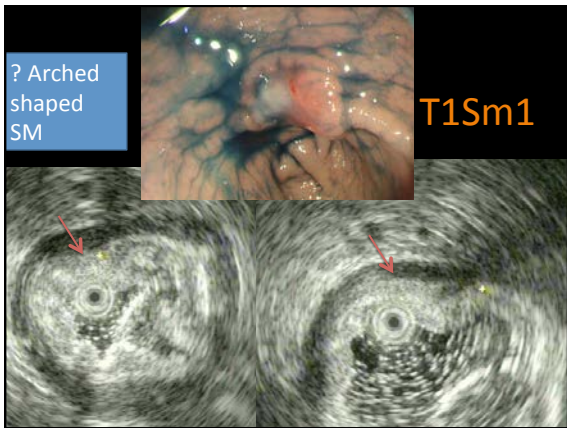
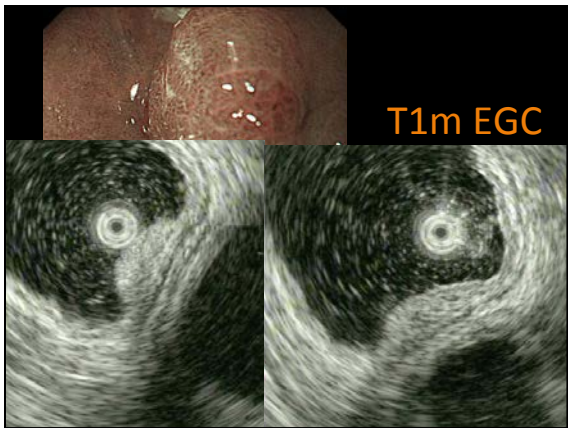
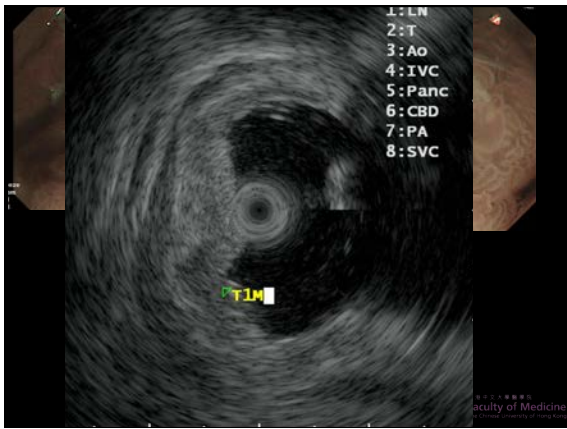
### Accuracy of EUS compared to histology Early gastric cancer

- 178 patients
- Overall accuracy 80.7%
  - Mucosal Ca : 97.6%
  - Ulcerative cancers or SM invasion: 83.6%
- 235 patients
- Mucosal
  - 99% M or SM1
- Superficial SM
  - 87% M or SM1

Kim et al J Gastroenterol Hepatol 2010

Mouri et al J Clin Gastroenterol 2009

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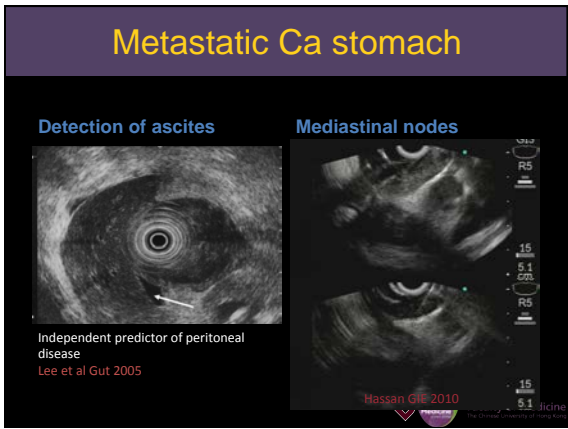
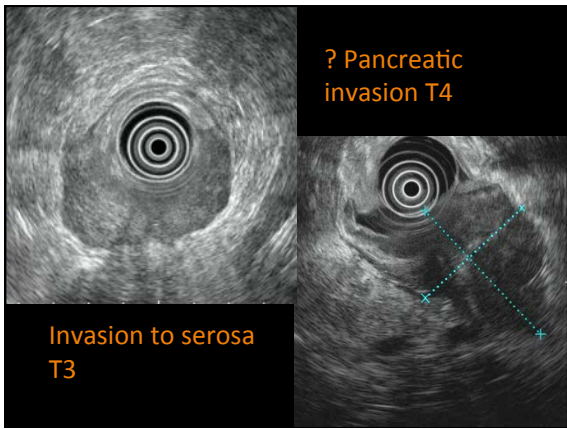


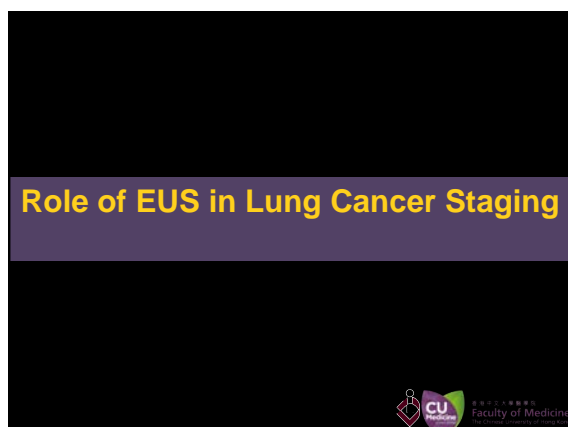
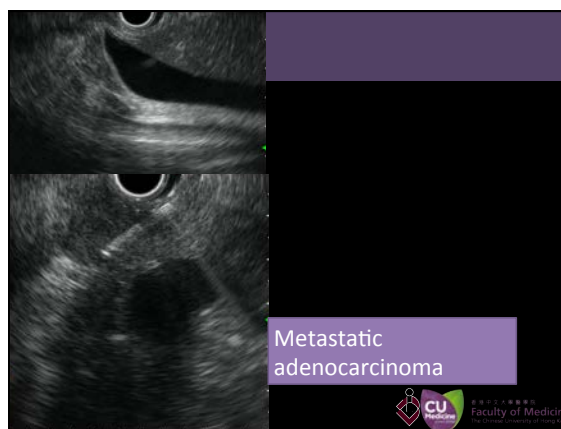
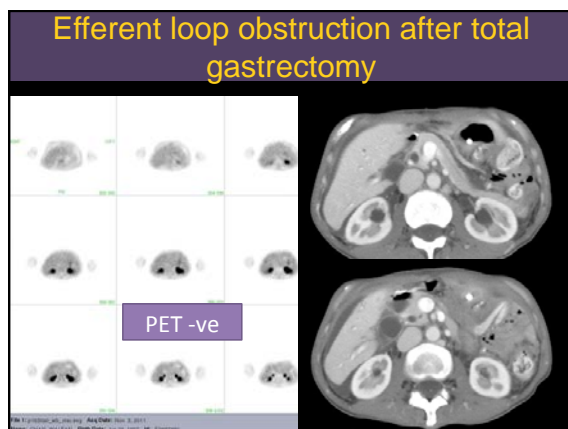
### Accuracy of EUS Advanced gastric cancers

T staging	Patients	EUS (%)	CT (%)	MRI (%)
Ziegler et al	108	86	43	-
Kuntz and Herfath	82	73	51	48
Bhandari	63	88	83	-

N staging	Patients	EUS (%)	CT (%)	MRI (%)
Kuntz and Herfath	82	87	65	69
Zielga	108	74	51	-
Bhandari	48	79	75	-





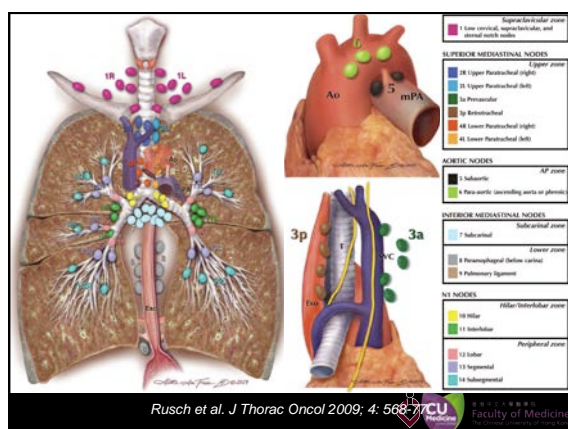
### Seventh Edition of TNM Classification of Lung Cancer

NSCLC Staging		T Staging	Criteria	a. Size	b. Endo-bronchial Location	c. Local Invasion
IA	IIA	T1a	a & b & c	≤ 2cm	No invasion more proximal than lobar bronchus	N0
		T1b	a & b & c	> 2cm but ≤ 3cm	No invasion more proximal than lobar bronchus	N0
IB	IIB	T2a	Any a, b, c or d	> 3 cm but ≤ 5cm	Involves main bronchus, ≥ 2 cm distal to carina	Visceral pleura
		T2b	Any a, b, c or d	> 5cm but ≤ 7cm	Involves main bronchus, ≥ 2 cm distal to carina	Visceral pleura
IIB	IIIB	T3	Any a, b, c or d	> 7cm	Involves main bronchus, < 2cm from carina	Chest wall, diaphragm, phrenic nerve, mediastinal pleura, parietal pericardium
		T4	Any b, c, or d	Any	Involves carina	Mediastinum, heart great vessels, trachea, recurrent laryngeal nerve, esophagus, vertebra

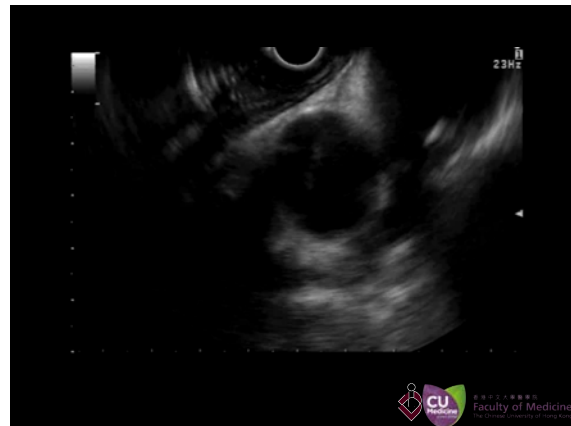
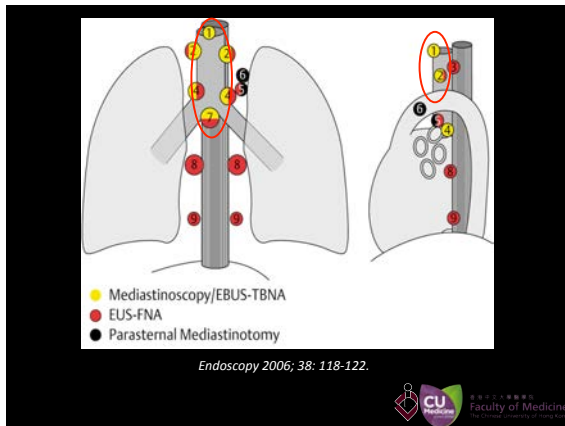
  

N Staging (Lymph Node)			
N0	N1	N2	N3
-	+	Any	Any
-	-	+	Any
-	-	-	+
-	-	-	-

(ipsilateral peribronchial (#12-#14)  
 Hilar (ipsilateral) (#10-#11)  
 Subcarinal (#7)  
 Mediastinal (ipsilateral) (#2-#9)  
 Mediastinal (contralateral) (#2-#9)  
 Scalenic or supraclavicular (#1)



Procedure	Advantages	Disadvantages
Thoracotomy (Surgical opening of the chest)	Allows the most thorough inspection and sampling of lymph node stations, may be followed by resection of tumor, if feasible	Most invasive approach, not indicated for staging alone, significant risk of procedure-related morbidity
Left parasternal mediastinotomy	Access to station 5 (aortopulmonary window lymph node)	Limited applications, invasive
Cervical mediastinoscopy	Still considered the gold standard by many, excellent for 2RL-4RL	Does not cover all mediastinal lymph node stations, invasive
Video-assisted thoracoscopy	Good for inferior mediastinum, station 5 and 6 lymph nodes	Invasive, does not cover superior anterior mediastinum
Trans thoracic percutaneous FNA under CT guidance	More widely available than some other methods	Traverses a lot of lung tissue, therefore high pneumothorax risk, some lymph node stations inaccessible
Bronchoscopy with blind transbronchial FNA	Less invasive than above methods	Relatively low yield, not widely practiced, bleeding risk
<b>Endobronchial ultrasound (EBUS)</b>	Direct visualization of lymph node stations. Complements EUS: covers lymph node stations 2R and 4R which are difficult to access by EUS	More invasive than EUS, few practitioners, but rapidly growing in popularity
<b>Endoscopic ultrasound (EUS)</b>	Least invasive modality, uses the esophagus to access mediastinal lymph nodes, excellent for station 5, 7, 9 lymph nodes, Useful for station 2L and 4L, L adrenal, celiac lymph node and liver	Cannot reliably access right sided paratracheal lymph node stations 2R and 4R



### Endoscopic Ultrasound-Guided Fine Needle Aspiration of Mediastinal Lymph Node in Patients With Suspected Lung Cancer After Positron Emission Tomography and Computed Tomography Scans

Ann Thorac Surg 2005;79:263-8

104 patients with suspicious PET or CT

Table 4. Operating Characteristics of CT, PET, EUS and EUS-FNA in Detecting Malignancy in Suspicious Mediastinal Lymph Nodes

TEST	Sensitivity (95% CI) p-value	Specificity (95% CI) p-value	PPV (95% CI) p-value	NPV (95% CI) p-value	Accuracy (95% CI) p-value	LR Positive
CT	—	—	39.2% (26.7-49.4)	—	40.3% (30.9-50.5)	1.03 (0.98-1.08)
PET	—	—	40.3% (29.1-55.1)	—	50.0% (37.2-61.4)	1.30 (1.11-1.53)
EUS*	80.0% (64.4-90.1)	62.5% (49.5-74.3)	57.2% (41.2-70.3)	83.3% (60.8-92.5)	69.2% (59.4-77.9)	2.13 (1.50-3.03)
EUS-FNA*	92.5% (79.6-98.4)	100% (94.3-100)	100% (90.5-100)	95.5% (87.5-99.1)	97.1% (91.8-99.4)	118.9 (7.5-1883)

### JAMA® Endoscopic Ultrasound Added to Mediastinoscopy for Preoperative Staging of Patients With Lung Cancer

Jouke T. Annema, Michel I. Versteegh, Maud Veselic, et al.  
JAMA. 2005;294(8):931-936 (doi:10.1001/jama.294.8.931)

Table 2. Preoperative Staging of Patients With Non-Small Cell Lung Cancer

Stage	No. of Patients (N = 100)		
	Mediastinoscopy	EUS-FNA	Mediastinoscopy + EUS-FNA
N0	80	70*	62
N2 (false-positive)	0	2	2
N2 or N3	19	22	31
T4 (+N2)	1	6 (1†)	5 (3†)
T4 and/or N2 or N3	20	28	36

Table 3. Diagnostic Values in the Analysis of N2/N3 Lymph Node Stations in Non-Small Cell Lung Cancer

	No. (%) of Patients			
	Computed Tomography (n = 100)	Mediastinoscopy* (n = 93)	EUS-FNA* (n = 92)	Mediastinoscopy + EUS-FNA (n = 100)
Sensitivity	69 (69)	91 (85)	71 (76)	86 (86)
Specificity	49 (49)	93 (100)	90 (97)	97 (97)
Predictive value				
Positive	43 (43)	93 (100)	86 (92)	94 (94)
Negative	73 (73)	82 (88)	85 (91)	93 (93)
Accuracy	56 (56)	84 (90)	85 (91)	93 (93)

### Endoscopic Ultrasound Reduces Surgical Mediastinal Staging in Lung Cancer

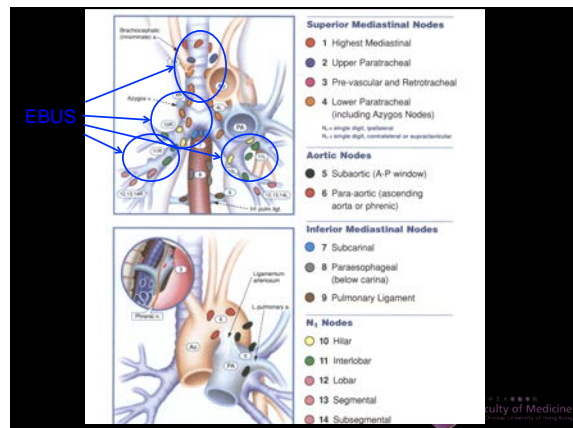
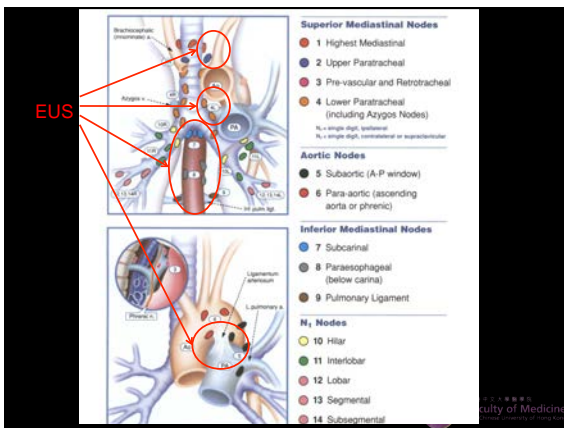
A Randomized Trial Am J Respir Crit Care Med Vol 177, pp 531-535, 2008

Kurt G. Tournoy<sup>1</sup>, Frederic De Ryck<sup>1</sup>, Lieve R. Vanwalleghe<sup>1</sup>, Frank Vermaesen<sup>1</sup>, Marleen Praet<sup>1</sup>, Joachim G. Aerts<sup>2</sup>, Georges Van Maele<sup>3</sup>, and Jan P. van Meerbeeck<sup>1</sup>

Characteristics	Surgical Staging* (n = 19)	EUS-FNA (n = 19)	P Value
Sensitivity	73 (39-93)	93 (66-99)	0.29
Specificity	100 (69-100)	100 (47-100)	NA
Positive predictive value	100 (63-100)	100 (75-100)	NA
Negative predictive value	73 (39-93)	83 (35-99)	1.00

Procedure Variable	Surgical Staging (n = 21)	EUS-FNA (n = 19)	P Value
Surgical staging procedure, n (%)			
No	0 (0)	13 (68)	<0.0001
Yes	21 (100)	6 (32)	
Complications, n (%)*			
Perforation/bleeding	1 (5)	0 (0)	1.00
Hospital stay, nights, median (range) <sup>†</sup>	2 (1-22)	0 (0-5)	<0.0001

## Do we still need EUS if EBUS is available?



### EUS-FNA → Extra-thoracic

- Liver (especially left lobe)
- Celiac axis
- Para-aortic LN
- Adrenal gland (especially left side)

**JAMA** Minimally Invasive Endoscopic Staging of Suspected Lung Cancer  
 Michael B. Wallace, Jorge M. S. Pascual, Massimo Raimondo, et al.  
 JAMA. 2008;299(5):540-546 (doi:10.1001/jama.299.5.540)

**Table 3.** Estimated Sensitivities and Negative Predictive Values (NPVs) for Separate and Paired Procedures


Procedure	Sensitivity	Fraction (%) [95% CI] <sup>a</sup>	NPV
TBNA	15/42 (36%)	23 (78) [70-85]	
EUS-FNA	29/39 (74%)	39 (88) [80-93]	
EBUS-FNA	30/39 (77%)	40 (100) (88) [80-93]	
EUS-FNA + TBNA	30/39 (77%)	96/105 (91) [84-96]	
EBUS-FNA + TBNA	30/39 (77%)	96/106 (91) [83-95]	
EUS-FNA + EBUS-FNA	30/39 (77%)	96/99 (97) [91-99]	

**Table 4.** Selected Comparisons

Comparison	Sensitivity Difference, Fraction (%) [95% CI] <sup>a</sup>	P Value <sup>b</sup>
EBUS vs TBNA	14/42 (33) [14-51]	.003
EUS + EBUS vs EUS + TBNA	6/42 (14) [5-28]	.03
EUS + EBUS vs EUS	10/42 (24) [12-39]	NA
EUS + EBUS vs EBUS	10/42 (24) [12-39]	NA
EUS + TBNA vs EUS	4/42 (10) [3-23]	NA
EUS + TBNA vs TBNA	18/42 (43) [30-59]	NA

**Red callout:** EUS + EBUS Sensitivity = 93% Negative Predictive Value = 97%


## EUS guided interventions




### EUS 2008 Working Group Recommendations

Celiac Plexus Neurolysis	High priority
Drainage of pancreatic fluid collection	
Biliary ductal drainage	
Ablation of pancreatic cyst neoplasm	
Drainage of pelvic abscess	Moderate priority
Implantation therapy	
Injection therapy	
Anti-tumor therapy (RFA)	Low priority
Pancreatic duct drainage	

GIE Supplement Feb 2009





## EUS-guided celiac plexus neurolysis or ganglion neurolysis



### EUS-guided celiac plexus block/ neurolysis for pain relief

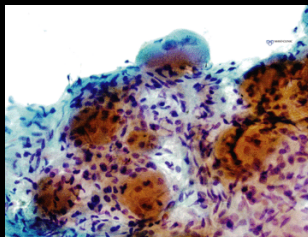

- **Celiac nerve block (CPB)**  
Injection of corticosteroid for temporary block
- **Celiac plexus neurolysis (CPN)**  
Injection of absolute ethanol to destroy the plexus

**EUS visualization and direct celiac ganglia neurolysis predicts better pain relief in patients with pancreatic malignancy (with video)**

Gil Ascunce, MD, Afonso Ribeiro, MD, Ildilinha Reis, DrPH, Calo Rocha-Lima, MD, Danny Sleeman, MD, Jaime Merchan, MD, Joe Levi, MD  
Miami, Florida, USA


- The celiac ganglia located to the left of the celiac artery, anterior to the aorta
- Predominantly oval or almond shaped, with irregular margins, ranging in size from 2x3 mm to 7x20 mm

### EUS Guided Direct Celiac Ganglia Neurolysis

	All patients		EUS-CPN-G		EUS-CPN-T		P value
	No.	%	No.	%	No.	%	
Patients	64	100	40	100.0	24	100.0	
<b>Pain</b>							
<b>Baseline</b>							
Mean (SD)	6.7 (1.9)		6.4 (2.0)		7.1 (1.6-7.0)		.110
Median (range)	7.0 (3-10)		6.5 (3-10)		7.0 (4.5-10)		
<b>At 1 week</b>							
Mean (SD)	4.5 (2.3)		3.7 (1.9)		5.9 (2.2)		<.001
Median (range)	4.8 (0-9)		4.0 (0-9)		6.0 (1-9)		

Ascunce GIE 2011





### EUS CPN vs CGN : Multicenter RCT

- 68 patients upper abdominal cancer pain
- Visualization of ganglia was possible in 30 cases (88 %) in the EUS - CGN group.
- The positive response rate was significantly higher in the EUS - CGN group (73.5 % vs 45.5 %; P = 0.026).
- The complete response rate was also significantly higher in the EUS - CGN group (50.0 % vs 18.2 %; P = 0.010)
- EUS - CGN is significantly superior to conventional EUS

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### EUS-guided drainage of peripancreatic fluids

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### Treatment of Pancreatic Necrosis

- Open necrosectomy:
  - Standard definitive treatment
  - Morbidity 95%
  - Mortality 39%
  - Significant risk of long-term pancreatic insufficiency

Traverso JGS 2005  
Connor Surgery 2005  
Buchler Ann Surg 2000

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### EUS vs surgical cyst-gastrostomy

Surgical cyst-gastrostomy	EUS cyst-gastrostomy
• N = 20	• N = 20
• Success rate: 100%	• Success rate: 95%
• Complication: none	• Complication: none
• Recurrence: 1	• Recurrence: 0
• Re-intervention: 10%	• Re-intervention: 0%
• Hospital stay: 6 days	• 2 days (P<.001)
• Cost per case: \$15052	• \$7011 (P=.003)
	• Better QOL (physical & mental health scores)

Varadarajulu Gastroenterology 2013

CU Faculty of Medicine

### New devices for cystogastrostomy

Lumen apposing stent (AXIOS, Xlumena)      Lumen apposing stent (Niti-S Spaxus, Taewong)      Bi-flanged (Nagi, Taewong)

Moon GIE 2014  
Yamamoto GIE 2013  
Ittoi GIE 2012

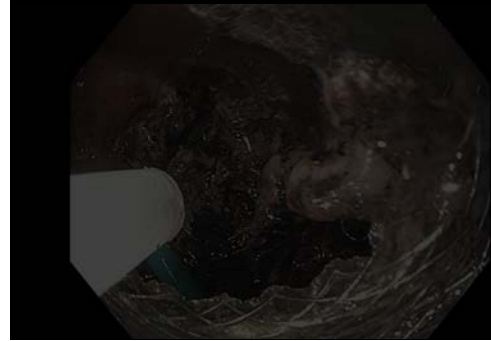
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### Cautery tipped lumen apposing stent



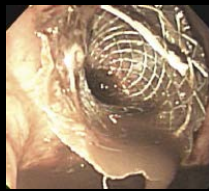
7.50M R7.0 G74 C10 A1

### Direct TEN through stent



### Nagi stent for pseudocyst

- 9 patients (5 pseudocyst and 4 WOPN)
- 100% technical success rates
- 77.8% clinical success
- No early complications
- 2 late complications (bleeding and migration)
- 100% removal



Yamamoto GIE 2013



### EUS-guided biliary drainage



### Potential advantages 潜在的好处

1. Logistic advantage 逻辑优势
  - Performed in the same session as ERCP
  - 在ERCP检查同一进行
2. Physiological advantage 生理优势
  - Internal drainage without need of external drains
  - 体内引流术无需体外引流
3. Anatomic advantages 引流管道优势
  - Options of anatomical drainage available according to patient 可根据患者的选择引流位置



### Indications 引流原因

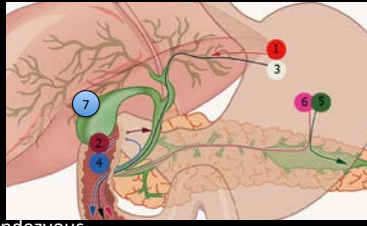
- Any cause of failure to access the bile duct  
任何插管失败原因
- Failed ERCP - ERCP失败
  - Malignant obstruction of duodenum 十二指肠恶性梗阻
  - Surgically altered anatomy 手术改道



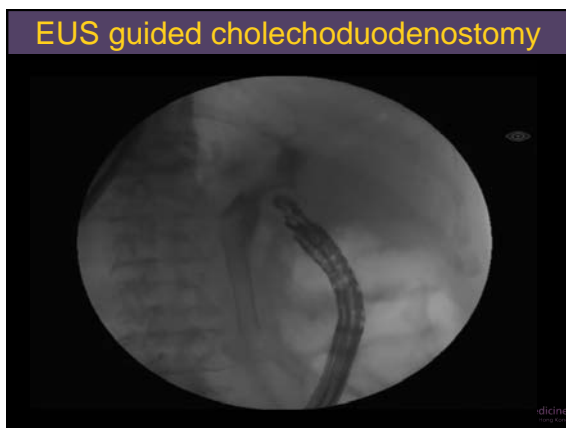
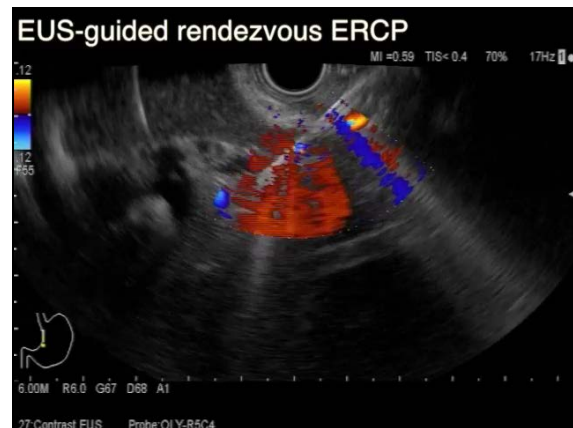


### EUS guided drainage – anatomical considerations

1. Biliary
  - Access routes
    - Transhepatic
    - Extrahepatic
  - Drainage route
    - Transmural
    - Transpapillary
2. Pancreatic
  - Antegrade / rendezvous
3. Gallbladder



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### EUS Bile duct drainage 超声内镜引导下胆管引流术

- Technical success rates 成功率 80-100%
- Complication rates 并发症率
  - 11 - 20%
  - Most common pneumoperitoneum 气腹
  - Bile leak 胆漏
  - Bleeding 出血
  - ? Dependent on access and drainage routes
  - 取决于穿刺和引流途径

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### The important question!!

- Does EUS methods provide longer patency as compared to ERCP and SEMS?
- 超声内镜方法和ERCP相比, 支架通畅率谁比较好?
- Is EUS BD comparable to surgery in terms of patency?
- 是超声内镜胆管引流相比手术引流, 通畅率谁比较好?

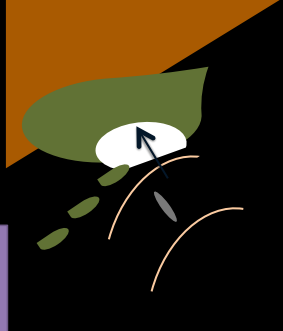
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### EUS guided gallbladder drainage

**Issues**

- Non-adherent organ
- Freely mobile
- Increased risk
  - Stent migration
  - Bile leak
  - Pneumoperitoneum

**Low margin of error!!!  
Need of lumen apposing stent is essential!**



### EUS guided-gallbladder stenting 内超声透壁胆囊内置入喇叭形金属支架

- Novel lumen apposing stent - AXIOS
- Developed by K Binmoeller
- Nitinol fully covered SEMS
- 全膜金属支架
- Flared flanges for anchorage 终端扩口固定
- Luminal diameter 10-15mm
- 直径10-15mm



Itai GIE 2012  
de la Serna-Higuera GIE 2013

CU Medicine Faculty of Medicine

### Pros and cons 优点和缺点

- Allows endoscopic assessment of gallbladder 允许胆囊内镜检查
  - Stone removal 取石
  - Detection of malignancy 检测恶性肿瘤
- Lacks external drain and improved comfort 缺乏外部引流管并提高舒适度
- Low risk of unintended bile duct injury 胆管损伤的风险较低
- Technically demanding 技术要求高
  - Small margin of error
- Possible chance of food trapping in gallbladder 食物留在胆囊的机会
- Expensive 昂贵



### New HOT AXIOS

Single-step endoscopic ultrasound-guided gallbladder stenting with a cautery equipped stent delivery system for the lumen apposing stent.

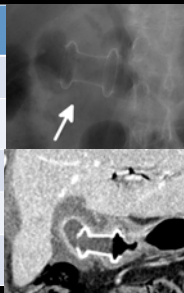
Teoh AYB<sup>1</sup>, Binmoeller KF<sup>2</sup>, Lau JYW<sup>1</sup>

<sup>1</sup>Department of Surgery, Prince of Wales Hospital, Chinese University of Hong Kong, Hong Kong SAR, China.  
<sup>2</sup>California Pacific Medical Centre, San Francisco, California, USA

### GALAXY 银河多中心研究


EUS-guided GBD with the AXIOS stent in patients with acute cholecystitis unsuitable for surgery: a feasibility study

Institution	Number of patients
Prince of Wales Hospital	17
University Medical Center Utrecht	2
Tokyo Medical University	4
Gemelli Hospital	2
Hospital Univeristario Rio Hortega	5




### GALAXY Findings

- EUS-guided gallbladder drainage has been shown to be feasible with the AXIOS stent
- Based on the GALAXY study, technical and clinical success 100%
- Morbidity rate 13%
- Stone retrieval possible in 11 patients (33.3%)



## EUS guided GB drainage vs Percutaneous cholecystostomy in surgically unfit patients



### EGBD vs PTC [1]

Teh DDW 2015


	EGBD N = 58	PTC N = 58	P-value
Age (years)	83.83 (7.32)	81.22 (7.94)	0.312
ASA grade I/II/III/IV	1 / 4 / 9 / 4	1 / 5 / 8 / 4	0.982
EGBD may potentially replace PC as the treatment of choice in patients that are unfit for surgery			
Mortalities (%)	2 (11.1)	1 (5.6%)	1
Unplanned admissions (%)	6.9	70.7	<0.001
Recurrent cholecystitis (%)	0	3.4	0.244

### Feasibility of GB intervention

#### 胆囊内镜治疗的可行性


Chan, Teh DDW 2015

- 17 patients received cholecystoscopy
- NBI magnifying endoscopy of GB mucosa possible and correlated with histology
- 放大内镜检查
- 4 patients with stone removal, lithotripsy in 1 patient with large gallstones 碎石
- Probe based confocal and EUS in 1 patient with suspected Ca GB 激光共聚焦检查




### Aid in diagnosing early GB cancer?

- Follow-up cholecystoscopy 3/12 after EUS GBD
- Polypoid lesion seen in GB
- NBI + confocal + EUS
- Bx confirmed adenoca GB



## Conclusions 结论

- EUS-guided biliary drainage increasing performed 超声内镜引导下胆管引流越来越流行
- The procedure is opening new possibilities to access the biliary tract
- 该程序打开进入胆道新的可能性
- Further large scale studies are required to assess how the procedure compares to traditional procedures
- 进一步的大规模研究来评估程序的功效

