This is one of a series of statements discussing the utilization of GI endoscopy in common clinical situations. The Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy prepared this text. In preparing this guideline, MEDLINE and PubMed databases were used to search publications through 2006 related to the role of endoscopic ultrasonography by using the keyword(s) “Endoscopic ultrasound” and each of the following: “Barrett’s esophagus, esophageal cancer, gastric cancer, gastric lymphoma, rectal cancer, submucosal lesions, pancreaticobiliary disease, lymph nodes, mediastinal adenopathy, fecal incontinence and perianal disease, and therapeutic EUS. The search was supplemented by accessing the “related articles” feature of PubMed with articles identified on MEDLINE and PubMed as the references. Pertinent studies published in English were reviewed. Studies or reports that described less than 10 patients were excluded from analysis if multiple series with greater than 10 patients addressing the same issue were available. The recommendations were based on reviewed studies and were graded on the strength of the supporting evidence (Table 1).

Guidelines for appropriate utilization of endoscopy are based on a critical review of the available data and expert consensus. Further controlled clinical studies may be needed to clarify aspects of this statement, and revision may be necessary as new data appear. Clinical consideration may justify a course of action at variance to these recommendations.

This guideline represents an updated review of the role of endoscopic ultrasonography.

EUS combines 2 modalities: endoscopic visualization and high-frequency US. The ability to image the wall of the GI tract as a series of definable layers corresponding to histology, rather than as a single entity, is the basis for most indications for EUS. Other indications have emerged from the ability of EUS to provide detailed images of areas in immediate proximity to the GI tract and to guide needles precisely through the gut wall into surrounding structures.

The addition of endoluminal US offers a unique advantage over traditional endoscopy, allowing precise differentiation of the individual layers of the GI tract, and direct imaging of the surrounding organs and tissue.

EUS allows assessment of submucosal GI lesions, locoregional staging of GI malignancy, tissue diagnosis, and staging of pancreaticobiliary lesions, nonsmall-cell lung carcinoma, and mediastinal disease. In prospective trials, EUS has consistently been shown to have a significant impact on diagnosis and management. EUS-guided FNA has emerged as an adjunctive modality during standard endosonography, allowing tissue diagnosis of submucosal lesions, extraluminal lesions, and/or lymph nodes. Furthermore, therapeutic uses for EUS have been described and are used on a limited basis in some institutions.

EUS has become firmly established as an adjunctive endoscopic imaging study for patients with previously identified lesions of the GI tract and surrounding organs. Multiple studies suggest that EUS is superior to CT for tumor (T) and lymph node (N) staging of luminal and pancreaticobiliary malignancies. The ultimate choice of staging modalities is largely dependent upon patient selection and local expertise.

EUS continues to grow and develop, though relative lack of trained practitioners, high costs of EUS processors, and limited reimbursement relative to time spent per procedure are limiting factors. Image interpretation is more difficult than standard endoscopic visualization and requires extensive training to master. Guidelines for competency as well as quality indicators in EUS have been published. EUS can be carried out with a low complication rate.

INSTRUMENTATION

There are 3 basic echoendoscope designs: a radial array system, a curvilinear array system, and high-frequency catheter-based miniprobes. The radial systems use circumferential views that range from 270 to 360 degrees. Mechanical echoendoscopes utilize oblique-viewing optical systems and scan at frequencies from 5.0 to 20 MHz. Newer models scan electronically at frequencies ranging from 5.0 to 10 MHz, and Doppler capabilities are available. Curvilinear array transducers are generally electronic systems operating at 5.0 or 7.5 MHz and have color Doppler capability. The curvilinear array design also makes it possible to direct needle aspiration, biopsies, and fine needle injection (FNI) under ultrasonographic visualization. Therapeutic echoendoscopes with ≥ 3.8-mm channels allow...
passage of larger-diameter devices, such as large-bore (10F) stents. Catheter-based miniprobes may be passed through accessory channels of conventional endoscopes. Higher frequencies (>20 MHz) increase resolution, albeit with a decrease in the depth of imaging penetration, which consequently does not allow for adequate extraluminal visualization. The technology is particularly useful for assessment of mucosal or submucosal lesions and intraluminal imaging. Because of the narrow width of the catheters, they may also be used to traverse GI luminal strictures that do not permit passage of a dedicated echoendoscope.

INDICATIONS

Indications for EUS can be divided into several categories: (1) evaluation of luminal GI malignancies; (2) evaluation of submucosal abnormalities; (5) evaluation of pancreatico-biliary disease; (4) evaluation of mediastinal disease; (5) evaluation of perianal disease; (6) evaluation of extraluminal abnormalities identified on other imaging studies; and (7) therapeutic applications.

EVALUATION OF LUMINAL GI MALIGNANCIES

Luminal GI cancers are staged by the TNM classification, which includes depth of invasion (T), presence or absence of locoregional lymph nodes (N), and presence or absence of distant metastases (M). The TNM staging for each malignancy has been described elsewhere. EUS has been proven accurate in T and N staging of GI tumors that are within reach of the echoendoscope. EUS has been shown to be the most sensitive method for the regional staging of cancer of the esophagus, stomach, and rectum. Whereas M staging is limited, malignant ascites, pleural effusions, liver metastases, and celiac lymph nodes can be safely sampled by using EUS-FNA. Staging information provided by EUS can aid in determining endoscopic or surgical resectability and need for neoadjuvant therapy. Prospective data have shown EUS staging to alter clinical management and cost-effectiveness when compared to other staging modalities.

BARRETT’S ESOPHAGUS AND ESOPHAGEAL CANCER

The principal role of EUS in evaluating patients with Barrett’s esophagus (BE) and high-grade dysplasia (HGD) is to exclude the presence of occult cancer, submucosal invasion, and malignant lymphadenopathy. This is particularly important for the appropriate selection of patients when endoscopic management is considered. There are limited data on the use of EUS in patients...
with BE and HGD, and the reported accuracy for diagnosing occult invasive cancer is variable. The routine application of EUS in BE with low-grade dysplasia or without dysplasia is not recommended because the risk of malignancy in these settings is negligible.

In esophageal cancer, EUS provides accurate staging that is superior to CT scanning and allows for stagedirected therapy. The role of endoscopy in the assessment and treatment of esophageal cancer has been addressed in another guideline.

GASTRIC CANCER AND GASTRIC LYMPHOMA

Selection of an appropriate treatment strategy in patients with gastric cancer is dependent upon accurate tumor staging. Many studies have demonstrated superior accuracy of EUS over CT scanning, ranging from 71% to 88% (T stage) and 77% to 80% (N stage). The accuracy of EUS in staging gastric cancer does not approach that of esophageal cancer because of the inherent difficulty with EUS in differentiating between the subserosa and serosal layers. Understaging, due to microscopic deposits, and overstaging, particularly of T2 tumors, due to tumor-associated fibrosis or inflammation, can occur. CT is preferred for evaluating distant metastases.

EUS is important in the locoregional staging of gastric lymphoma and directly impacts choice of treatment. The accuracy of EUS ranges from 91% to 95% and 77% to 83% for T and N staging, respectively. N-stage accuracy may be improved by EUS-FNA combined with flow cytometry and immunocytochemistry. The endosonographic criteria for malignant lymph nodes are extrapolated from data on esophageal tumors. EUS may predict response to Helicobacter pylori eradication. EUS is also useful in assessing the surface spread (horizontal extension) of gastric lymphomas when surgery is contemplated. EUS-FNA of the gastric wall should be considered if EUS is abnormal but mucosal biopsy results are negative, and consideration should be given to sample-representative lymph nodes regardless of size because up to 25% of metastatic lymph nodes may be <3 mm. EUS may be used for monitoring response to medical therapy (H pylori therapy or chemoradiation therapy), with disease regression manifestation as reduction in wall thickness, increase in wall echogenicity, normalization of wall layer pattern, and absence or reduction in the size or number of lymph nodes, although this practice has been questioned. There is no recommended surveillance program, but a follow-up EUS examination every 3 to 6 months for a period of 2 years should be considered after successful treatment because the risk of recurrence appears to be highest during this time interval.

RECTAL CANCER

Preoperative EUS staging of rectal cancer is useful in determining the type of surgery and the need for neoadjuvant chemoradiation therapy in patients with advanced locoregional disease. The role of EUS in staging rectal cancer is considered in detail in another guideline.

SUBEPITHELIAL (SUBMUCOSAL) LESIONS

EUS is an important diagnostic modality in the evaluation of subepithelial lesions, commonly referred to as submucosal lesions (SML), of the GI tract. For the purposes of this document, the term SML will be used. When an SML is identified, EUS is the diagnostic test of choice to assess the size, margins, layer of origin, and echotexture of the lesion, and to differentiate between an intramural and extramural lesion. An anechoic lesion is typical of a cystic structure, a hyperechoic lesion favors a fatty tumor (lipoma or liposarcoma), and a hypoechoic lesion in the fourth echolayer is typical of a leiomyoma or GI stromal tumor (GIST). Although these endosonographic findings are helpful in categorizing a lesion, they cannot determine absolutely the type of lesion or whether a lesion is benign or malignant. Based on the clinical context, a tissue diagnosis may be needed. However, correlation of EUS characterization and the final pathology matches in only 77% of SML cases. EUS-guided FNA or core biopsy can help establish a tissue diagnosis and potentially characterize malignant risk. The diagnostic yield for EUS-FNA or core biopsy ranges from 80% to 92%.

The most common SMLs encountered in the upper GI tract are GISTs. Although they typically arise within the muscularis propria, establishing the layer of origin may be challenging. They are often found incidentally during endoscopy, and standard forceps biopsies are usually nondiagnostic. Tumor size exceeding 30 to 40 mm and irregular margins appear to be the most important endosonographic features of GISTs associated with an increased risk for malignancy. There is less agreement on the value of other features, such as echogenic foci, cystic spaces, nonoval shape, heterogeneous echotexture, exophytic development, and ulcerated mucosa. The cytomorphologic and immunohistochemical staining features of GISTs can be reliably diagnosed on cytologic material (cell blocks) and core tissue specimens from EUS-FNA or core biopsy (e.g., trucut biopsy), respectively. The typical immunohistochemical stains for diagnosing GIST are c-Kit (CD117), CD34, and smooth muscle actin. Positive staining for c-Kit is considered diagnostic of GIST. Other markers, such as desmin and S-100 protein, can differentiate GIST from smooth muscle tumors (leiomyoma, leiomyosarcoma, leiomyoblastoma) and schwannoma. Although GIST can be diagnosed on FNA, assessment of malignant potential based on mitotic count requires histology and cannot be evaluated on cytologic specimens. It is also important to recognize that not all GIST are c-KIT positive. A National Institutes of Health consensus conference developed guidelines on assessing the risk of malignant behavior of GIST.
When endoscopic removal of an SML is considered, EUS should be performed to select suitable tumors by determining the layer of origin. Endoscopic resection of SMLs that arise from the muscularis propria or deeper carries a high risk of perforation. Catheter-based EUS (mini-probes) may be used when assessing small lesions. Although EUS surveillance of patients with asymptomatic, small submucosal tumors without endosonographic signs of malignancy may be undertaken, this approach has not been validated. The decision to perform surveillance and the frequency of such surveillance should be individualized, keeping in mind that rapid tumor enlargement is rare and poor patient compliance is common.

**PANCREATICOBILIARY MALIGNANCIES**

**Pancreatic adenocarcinoma**

Pancreatic cancer survival is poor, and surgical resection for attempted cure is possible in only up to 14% of all cases. It is therefore important to stage pancreatic adenocarcinoma accurately in order to allow directed therapy (surgical resection vs palliative approaches). The use of EUS in the staging and management of pancreatic cancer is reviewed in another guideline.

EUS can identify lesions not seen on CT or MRI and further characterize smaller lesions. False-negative examinations may be seen in the setting of chronic pancreatitis, diffusely infiltrating carcinoma, prominent ventral/dorsal anlage, and recent acute pancreatitis. The use of EUS for T and N staging has generally been found to be superior to other imaging techniques (helical CT, MRI), and staging sensitivity is greater than 90%. However, the superiority of EUS over CT in determining resectability of pancreatic adenocarcinoma has not been established, and the 2 modalities are considered complementary. EUS-FNA allows cytotologic diagnosis, differentiation between adenocarcinoma, lymphoma, and neuroendocrine tumors, and allows for tissue sampling of malignant lymph nodes. In patients with unresectable disease, cytoplogic diagnosis is often required before institution of palliative chemoradiation therapy. Advantages compared to CT-guided FNA biopsy include the ability to sample smaller lesions, simultaneous lymph node sampling, and a lower incidence of peritoneal carcinomatosis.

In retrospective studies, EUS has been shown to improve patient selection for resection. EUS-FNA has also been found to be the most cost-effective test for pancreatic adenocarcinoma when compared with CT-guided FNA and surgical diagnosis. However, because of the need for screening for distant metastatic disease, other forms of imaging cannot be abandoned in favor of EUS, and helical CT or PET scanning is still advised. Magnetic resonance imaging (MRI) and angiography may be useful adjunctive tests if the presence of vascular invasion cannot be determined on EUS. EUS should be considered in surgical candidates with localized disease.

**Ampullary tumors**

EUS staging of ampullary tumors may be of benefit. The role of EUS for this indication is discussed in another guideline.

**Biliary tumors**

Cancers of the biliary tract (gallbladder carcinoma and cholangiocarcinoma) can be staged by EUS, although the data are considerably limited compared to pancreatic malignancy. EUS and EUS-FNA have been shown to be useful in the tissue diagnosis of cholangiocarcinoma and benign bile duct strictures in patients with negative ERCP brushings. The addition of intraductal EUS to ERCP can help further delineate biliary strictures and improve the differentiation of benign from malignant disease.

**Neuroendocrine tumors**

Neuroendocrine tumors (NETs) of the pancreas are rare, neuropeptide-producing tumors suspected on the basis of clinical presentation and relevant neuropeptide assays. They may be functioning (associated with neuropeptide-related symptoms) or nonfunctioning, and are classified by the predominant neuropeptide (insulin, gastrin, glucagon, vasoactive intestinal peptide, somatostatin, etc). The only curative treatment option is surgical resection; thus, preoperative localization of the tumor is critical to management. Localization of the tumor is often difficult by standard imaging studies (US, CT, MRI). EUS can localize these often small (< 1 cm) tumors with a high degree of accuracy. In prospective studies, EUS localized a NET in 82% to 93% of patients. Studies that compare EUS directly with somatostatin receptor scintigraphy, CT, and MRI for the localization of NETs also show EUS to have the greatest sensitivity for tumor detection. Localization of gastrinomas tends to be lower, particularly if found in the duodenum, where the sensitivity has been reported to be as low as 50%.

Several other factors make EUS attractive in the assessment of NETs. In addition to tumor localization, EUS can also provide a tissue diagnosis by means of FNA. EUS-FNA becomes particularly useful in cases where tumors are small (0.5-1 cm), or if they are nonfunctioning. Furthermore, studies have shown that specificity in diagnosis is improved with the addition of EUS-FNA. EUS has been shown to be cost-effective compared to other imaging modalities.

**BENIGN PANCREATICOBILIARY DISEASES**

**Chronic pancreatitis**

EUS has been proven to be useful in the diagnosis of chronic pancreatitis (CP). The use of endoscopy in CP has been reviewed in a separate guideline. Briefly, characteristic findings include focal or diffuse changes in the pancreatic parenchyma (echogenic foci or stranding, small
Role of EUS

Acute pancreatitis

EUS has been shown to be useful for identifying the presence of bile duct stones in cases of acute gallstone pancreatitis and subsequently for selection of patients for ERCP. However, EUS does not offer the therapeutic advantages that ERCP offers; thus, its role may be as an alternative in patients with an intermediate risk of choledocholithiasis and as an alternative to MRCP. A recent Canadian decision analysis found that EUS was more cost-effective than either ERCP or MRCP in both severe and nonsevere acute biliary pancreatitis. EUS findings in CP may be operator dependent, and a long learning curve may be required, but among experienced experts, interobserver agreement is quite high. Despite this, the diagnosis of mild forms of CP may remain uncertain. EUS may be most reliable when it is clearly positive (>5 criteria; high specificity and positive predictive value) or negative (<2 criteria; high sensitivity and negative predictive value).

Autoimmune pancreatitis

Autoimmune pancreatitis is an increasingly described fibroinflammatory condition that can be difficult to distinguish clinically and radiographically from pancreatic cancer. Cross-sectional imaging of the entity has been described; CT findings include diffuse enlargement of the pancreas with a low-density, capsule-like rim. MRI findings include delayed enhancement and a diffusely decreased signal intensity. EUS has become an important means of diagnosis. EUS features suggestive of autoimmune pancreatitis include diffuse, hypoechoic pancreatic enlargement, and/or focal masses. Vascular invasion and peripancreatic lymphadenopathy similar to that of pancreatic cancer may be seen. Common bile duct strictures are common. EUS-FNA reveals a lymphocytic or plasma cell infiltrate in up to 73% of patients. Trucut core biopsy techniques have been used to diagnose autoimmune pancreatitis and may improve the diagnostic yield compared to standard FNA.

Cystic lesions of the pancreas

Pancreatic cystic lesions represent a heterogeneous collection of entities that may be benign or malignant. EUS can be used both for characterization of these lesions and to guide drainage of benign inflammatory lesions. A more complete discussion of the role of endoscopy and EUS in the diagnosis and management of pancreatic cystic lesions is detailed in another guideline.

Suspected choledocholithiasis

When choledocholithiasis is suspected, EUS has a sensitivity of >90% for the detection of common bile duct stones. These results compare favorably to ERCP and are superior to transabdominal US, without the inherent risk of postprocedural pancreatitis. EUS has also been shown to be a cost-effective initial screening study, in lieu of ERCP, for patients with a low or intermediate risk of bile duct stones. Controlled trials of EUS and MRCP have shown EUS to have a comparable or higher accuracy in the diagnosis of obstructive jaundice and detection of choledocholithiasis. A recent systematic review suggests that EUS be reserved for the evaluation of patients with an intermediate risk of choledocholithiasis. EUS does not have the therapeutic capacity of ERCP for stone removal. While the precise role of EUS for evaluation of suspected choledocholithiasis remains to be defined, algorithms have been developed that incorporate its use into clinical practice.

Evaluation of fecal incontinence

Rectal EUS is capable of visualization of the internal and external anal sphincters and surrounding structures. This allows characterization of perianal disease, such as fistulae and abscesses, and assessment of sphincter integrity in fecal incontinence. The accuracy of EUS in the assessment of perianal disease has been documented in several studies and compares favorably with MRI and CT. Both MRI and EUS appear to have excellent accuracy when compared to examination-under-anesthesia (EUA) and may be complementary to EUA in defining perianal disease.

EUS has also proven extremely useful in the assessment of fecal incontinence. Defects in the internal and external anal sphincters appear as hypoechoic breaks or discontinuity within the normally hypoechoic internal sphincter and/or more hyperechoic external sphincter. Because of high accuracy in the detection of sphincter defects and better patient tolerance, EUS has largely supplanted electromyography in this regard. Sensitivity
for identifying sphincter defects is greater than 90% in several studies. Comparisons with MRI have shown mixed results, but both modalities appear useful. In addition to the detection of sphincter defects, EUS may also be useful in the prediction of the response after sphincteroplasty. Endosonographic evidence of defect closure correlates with improvement in symptoms.

**Evaluation of mediastinal disease**

EUS-FNA is a safe and accurate method for obtaining a tissue diagnosis in patients with mediastinal adenopathy. The role of EUS for evaluation of mediastinal adenopathy is considered in another guideline.

**Miscellaneous**

Miscellaneous applications of EUS include staging of colonic tumors where transanal endoscopic microsurgery may be contemplated and evaluation of large colorectal adenomatous polyps before considering endoscopic resection. Finally, EUS can be valuable in the evaluation of extraluminal abnormalities seen on other imaging studies, including hepatic lesions, ascites, left adrenal lesions, and duplication cysts.

**Evaluation of lymph nodes**

The assessment of regional and distant lymph nodes in patients with a malignancy is critical in the staging process. EUS features suggestive of malignant lymph nodes include size ≥ 1 cm, hypoechoic and homogeneous echo pattern, rounded shape, and well-defined borders. Although no single feature is diagnostic, the likelihood of malignancy increases in the presence of multiple features. These endosonographic criteria for malignant lymph nodes are extrapolated from data derived from esophageal malignancies and may not be applicable to all malignant lymph nodes. Use of EUS-FNA enhances the ability to differentiate benign from malignant infiltration and should be considered in all patients when results would alter treatment.

**THERAPEUTIC EUS**

In addition to its well established diagnostic roles, EUS is emerging as a useful tool for therapeutic purposes. Its use in guiding transmural drainage of pancreatic pseudocysts is well documented and reviewed in another guideline. Other uses of EUS include celiac plexus block for pain from chronic pancreatitis, and celiac plexus neurolysis for pancreatic cancer pain. Fine-needle injection and EUS-guided cholangiopancreatography can provide effective pain relief in patients with pancreatic cancer. Two prospective trials have shown that pain improves in 78% to 88% of patients. The efficacy of celiac plexus block is less established in chronic pancreatitis pain, but up to 50% of patients have a short-term response, and the EUS-guided approach may be more effective than CT-guided blocks in this patient population.

**SUMMARY**

**Barrett’s esophagus**

- The role of EUS in evaluating patients with BE and HGD is to exclude the presence of occult cancer, submucosal invasion, and malignant lymphadenopathy (1C).
- The routine application of EUS in BE with low-grade dysplasia or without dysplasia is not recommended (3).

**Esophageal cancer**

- In esophageal cancer, EUS provides accurate locoregional staging that is superior to CT scanning (1C+).
- Preoperative EUS staging of esophageal cancer is cost effective and can guide preoperative management (1C+).
- Gastric cancer and lymphoma
- EUS is useful in the locoregional staging of gastric carcinoma and lymphomas (1C+).
- EUS may be used to monitor response to therapy with disease regression in gastric lymphoma (1C).

**Rectal cancer**

- EUS is accurate in the preoperative locoregional staging of rectal cancer (1C+).
- Preoperative EUS staging of rectal cancer is cost effective and can guide preoperative management (1C+).
- Submucosal lesions
- When a submucosal lesion is identified, EUS should be considered to further characterize the lesion (1C).
- EUS-FNA or core biopsy can help establish a tissue diagnosis and potentially characterize malignant risk (1C+).
- EUS should be performed before consideration of endoscopic removal of SML (3).

**Pancreatic cancer**

- Pancreatic adenocarcinoma can be accurately identified, staged, and diagnosed by EUS and EUS-FNA (1C+).
- Neuroendocrine tumors can be localized and sampled by EUS (3).

**Chronic and acute pancreatitis**

- EUS is the most sensitive imaging study for the detection of structural changes of chronic pancreatitis (1C).
- EUS has been shown to be useful for identifying the presence of bile duct stones in cases of acute gallstone pancreatitis and in selecting patients for ERCP at intermediate risk for choledocholithiasis (1C).

**Autoimmune pancreatitis**

- EUS, EUS–FNA, and EUS core biopsy can help establish the diagnosis of autoimmune pancreatitis (3).
- Pancreatic cystic lesions
Use of EUS and EUS-FNA to differentiate benign from malignant lymph nodes

EUS is highly accurate in the detection of choledocolithiasis and has fewer complications than ERCP (1C). Medialinal lymphadenopathy

EUS-FNA is a safe and accurate method for obtaining a tissue diagnosis in patients with mediastinal adenopathy (1C+).

Lymph nodes

Use of EUS and EUS-FNA to differentiate benign from malignant lymph nodes should be considered in patients when results would alter treatment (1C+). Therapeutic EUS

EUS-guided celiac neurolysis can provide significant reduction of pancreatic cancer pain (1C).

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Role of EUS


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