

Current utilization and performance status of endoscopic ultrasound in a community hospital

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OBJECTIVE: Endoscopic ultrasound (EUS) is an essential tool for cancer staging and investigating gastrointestinal diseases. Although it is not a widespread skill, as its expanded indications became much more advanced so did its popularity and hospital acceptance. We aimed to study the utilization and indications of upper EUS in a Hong Kong community hospital. The secondary aim was to assess our accuracy in staging of esophageal and gastric cancer and in evaluating submucosal tumors.

METHODS: All patients who had undergone upper EUS in Tuen Mun Hospital from January 2002 to December 2006 were recruited. Their background data, indications, radiological investigations, upper endoscopy and operation records and histopathologic results were retrieved for analysis. The accuracy of EUS in esophageal cancer staging, gastric cancer staging and evaluating submucosal tumors was

assessed by comparing surgical and histopathologic findings.

RESULTS: A total of 645 upper EUS examinations were performed and there has been a steady increase in EUS utilization in our hospital. The most common indications were evaluating submucosal tumors and staging esophageal and gastric cancer. The accuracy of T and N staging of esophageal cancer was 71.2 and 79.7%, respectively and for gastric cancer was 64.0 and 74.7%, respectively. Endoscopic ultrasound was 70% accurate in identifying lesions arising from the submucosal layer and 100% accurate in identifying lesions from the muscularis propria.

CONCLUSION: Endoscopic ultrasound is an accurate method and its demand is increasing. The performance in a community hospital can be further improved and its utilization should expand to other indications.

KEY WORDS: community hospital, endoscopic ultrasound, performance, utilization.

INTRODUCTION

Endoscopic ultrasound (EUS) was developed in 1980s to overcome the limitations of transabdominal ultrasound for imaging the pancreas.^{1,2} Since it was developed its clinical applications have broadened to include

assessing gastrointestinal (GI) submucosal lesions, the staging of gastrointestinal and lung cancers, detecting bile duct stones and evaluating pancreatic diseases.^{3,4} It is the only imaging method that allows visualization of different gut wall layers in fine detail.⁵ Rapid improvement in technology and the development of curvilinear array echo-endoscope and EUS-guided fine needle aspiration (EUS-FNA) further increase its diagnostic and therapeutic capabilities.⁶ The accuracy of EUS and its clinical impact has been well established. It is the most accurate method for the loco-regional staging of upper GI cancers.^{7,8} In centers in the developed world, EUS was found to influence decision-making and patient management in 25–75% of cases.^{9–15}

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Despite its advantages over other imaging techniques, EUS was found to be markedly underused when compared with other endoscopic procedures. Parada *et al.* estimated that only 18% of patients with esophageal cancer, 9% of those with pancreatic or gastric cancer, and 4% of those with rectal cancer actually underwent EUS.¹⁶ The situation in the Asian–Pacific region outside Japan was believed to be similar. The EUS service was provided by very limited number of experienced endosonographers, mainly in academic and tertiary centers. This could be attributed to a lack of awareness on the indications and capabilities of EUS by referring physicians or insufficient training opportunities to endoscopists across the region.¹⁷ Published information and comprehensive data regarding the current status on EUS practice in this part of the world are lacking. We perform a retrospective study aiming to describe the utilization and indications of upper EUS in a non-academic community hospital over 5 recent years. We also assess the accuracy of the upper EUS on three most common indications in our center namely, the staging of esophageal and gastric cancer and evaluating suspected submucosal tumors (SMT).

MATERIALS AND METHODS

All the patients who had undergone an upper gastrointestinal EUS examination in Tuen Mun Hospital from January 2002 to December 2006 were recruited for analysis. Our hospital is a public regional hospital with 1405 acute beds, serving a population of 1 095 400 in the year 2006. The patients were identified from the procedure record book in our endoscopy unit and the clinical management system. Their medical records were examined. The following data were retrieved for analysis: the sex and age of the patients, the indication of the EUS, the relevant radiological imaging result, the upper endoscopy report, final treatment, the operation record and the histopathological result, if available.

All examinations were performed by one of four endosonographers who were experienced endoscopists with a special interest in EUS. All had attained an experience of more than 150 diagnostic EUS procedures. In all patients, standard esophagogastroduodenoscopy (OGD) was performed before EUS. The endosonography was performed using a mechanical radial Olympus GF-UM20 (from year 2002–2004) or Olympus GF-UM2000 (from year 2005–2006) echoendoscope. For small SMT or esophageal strictures that were not traversable by an echoendoscope, examinations were performed using a high-frequency ultrasound

miniprobe (UM-2R, 12 MHz and UM-3R, 20 MHz, Olympus). A curvilinear echoendoscope and EUS-FNA were not available in our center.

The accuracy of the EUS were determined for the staging of esophageal and gastric cancer and the evaluation of suspected SMT. The accuracy of loco-regional staging for esophageal and gastric cancer was assessed in patients who underwent an operation and whose histopathological results were available for comparison. Endoscopic ultrasound staging was based on the TNM classification system. T staging assessed the extent of the tumor invasion (T1: tumor invades lamina propria or submucosa, T2: tumor invades the muscularis propria, T3: tumor invades the adventitia or serosa, T4: tumor invades adjacent organs). N staging assessed regional lymph node metastasis (N0: no regional lymph node metastasis, N1: regional lymph node metastasis). Regional lymph node metastasis was predicted using established endosonographic criteria of echotexture, size, shape and border.¹⁸ Pathologic TNM classification was made on a surgical specimen and was assigned according to the American Joint Commission for Cancer TNM system.¹⁹

The accuracy for evaluation of suspected SMT was determined for those patients who underwent surgery and whose histopathological result was available. The presumptive diagnosis by EUS based on the GI wall layer of origin was compared with the final pathological diagnosis. We also estimated the clinical impact of the EUS on this indication by determining the number of diagnosis altered by EUS and further follow up prevented by EUS. 'Diagnosis altered by EUS' referred to those cases in which SMT was either not found or was due to compression by normal adjacent organs, such as a distended gallbladder. These patients had no pathological condition and thus no further intervention was needed. 'Further follow up prevented by EUS' referred to those cases in which EUS was normal or was able to establish the benign nature of the lesion, such as a simple cyst, a lipoma or an ectopic pancreas and rendered follow-up endoscopy or imaging unnecessary.

RESULTS

A total 645 upper gastrointestinal EUS examinations were performed from January 2002 to December 2006. There has been a steady increase in the number of EUS performed annually in our hospital (Fig. 1). The most common indication for EUS is the evaluation of a suspected SMT ($n = 202$), followed by the staging of esophageal cancers ($n = 180$) and gastric cancers ($n = 123$). Other indications included evaluating

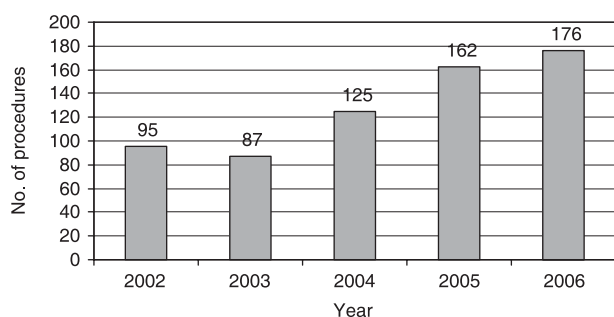


Figure 1. Number of upper gastrointestinal endoscopic ultrasounds performed annually 2002–06.

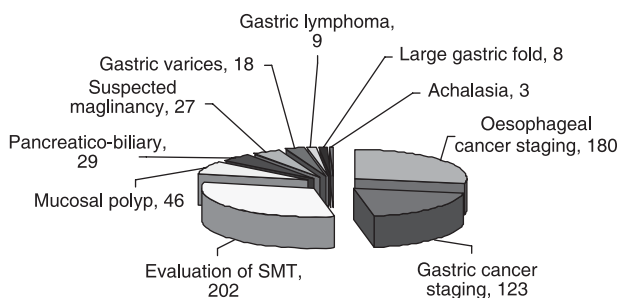


Figure 2. Indications of upper gastrointestinal endoscopic ultrasounds in a community hospital.

mucosal polyps ($n = 46$), assessing pancreatico-biliary diseases ($n = 29$), suspected GI malignancy ($n = 27$), gastric varices ($n = 18$), gastric lymphoma staging ($n = 9$), assessing large gastric fold ($n = 8$) and achalasia ($n = 3$) (Fig. 2). No complications occurred in any patient who underwent a EUS examination during this period.

Staging of esophageal cancers

A total of 180 patients had biopsy-proven esophageal cancer. Their mean age was 65.8 years and male to female ratio was 4.3:1. All these patients underwent EUS routinely for loco-regional staging. Tumor-related esophageal strictures that were not traversable by standard end-view endoscope occurred in 33 patients (18.3%). Dilatation was not performed in our unit solely for staging purposes. The result of T and N staging by EUS is shown in Table 1. Computed tomography (CT) of thorax and abdomen was performed in 166 patients and showed distant metastasis in 23 of them (12.7%). Operations were performed on 60 patients (33.3%). Tumor resections were done and histopathological results were available for 59 patients. When using a surgical histopathological specimen as reference standard, the accuracies of EUS in T staging were 0% in T1 lesions; 33.3% in T2 lesions; 90.2% in T3 lesions

and 25.0% in T4 lesions, whereas the accuracies of N staging were 73.9% in N0 lesions and 83.3% in N1 lesions. The overall accuracies of EUS in T and N staging of esophageal cancer were 71.2 and 79.7%, respectively. Correlation of EUS staging with histopathologic results and accuracy of EUS in predicting each T and N stages are summarized in Tables 2 and 3. Concerning T staging, we over-staged 16.9% and under-staged 11.9% esophageal cancers. It appears that EUS was more accurate in predicting T3 and N1 disease in our center.

Staging of gastric cancers

A total 123 patients with biopsy-proven gastric cancer underwent EUS for loco-regional staging. The mean

Table 1. T and N stage of 180 patients with esophageal cancer by endoscopic ultrasound

T stage	Number of patients (%)	N stage	Number of patients (%)
T1	3 (1.7)	N0	65 (36.1)
T2	23 (12.8)	N1	115 (63.9)
T3	134 (74.4)		
T4	20 (11.1)		

Table 2. Correlation of endoscopic ultrasound (EUS) and histopathologic T staging of esophageal cancer

	Histopathologic T stage			
	T1	T2	T3	T4
EUS T stage				
T1	0	0	0	0
T2	2	4	4	0
T3	0	8	37	3
T4	0	0	0	1
Accuracy (%)	0	33.3	90.2	25.0

Overall accuracy = 71.2% (over-staged: 16.9%, under-staged: 11.9%).

Table 3. Correlation of endoscopic ultrasound (EUS) and histopathologic N staging of esophageal cancer

	Histopathologic N stage	
	N0	N1
EUS N stage		
N0	17	6
N1	6	30
Accuracy (%)	73.9	83.3

Overall accuracy = 79.7%.

age of these patients was 67.5 years and male to female ratio was 2.8:1. The number of patients in each EUS T and N stages are shown in Table 4. CT of the abdomen was performed in 108 patients among whom distant metastasis was shown in 14 patients (11.4%). Operations were performed in 85 patients (69.1%). Tumor resections were achieved and histopathological results were available in 75 patients. When using surgical histopathological result as a reference standard, the accuracies of EUS in T staging were 23.1% in T1 lesions; 42.9% in T2 lesions; 97.2% in T3 lesions and 33.3% in T4 lesions, whereas the accuracies in N staging were 84.6% in N0 lesions and 69.4% in N1 lesions. The overall accuracies of EUS in T and N staging of gastric cancer were 64 and 74.7%, respectively. The correlation of EUS staging with histopathologic results and the accuracy of EUS in each T and N stage are summarized in Tables 5 and 6. Concerning T staging, we over-staged 24.0% and under-staged 12.0% gastric cancers. This shows that EUS was more accurate in predicting T3 and N0 disease in our center.

Evaluation of suspected SMT

A total of 202 patients underwent EUS for evaluation of suspected SMT. All patients had suspected SMT because of their OGD findings. The mean age in this group was 57.9 years and male to female ratio was

Table 4. T and N stage of 123 patients with gastric cancer by endoscopic ultrasound

T stage	Number of patients (%)	N stage	Number of patients (%)
T1	3 (2.4)	N0	59 (48.0)
T2	21 (17.1)	N1	64 (52.0)
T3	88 (71.5)		
T4	11 (8.9)		

Table 5. Correlation of endoscopic ultrasound (EUS) and histopathologic T staging of gastric cancer

	Histopathologic T stage			
	T1	T2	T3	T4
EUS T stage				
T1	3	0	0	0
T2	5	6	1	1
T3	5	8	35	7
T4	0	0	0	4
Accuracy (%)	23.1	42.9	97.2	33.3

Overall accuracy = 64.0% (over-staged: 24.0%, under-staged: 12.0%).

Table 6. Correlation of endoscopic ultrasound (EUS) and histopathologic N staging of gastric cancer

	Histopathologic N stage	
	N0	N1
EUS N stage		
N0	22	15
N1	4	34
Accuracy (%)	84.6	69.4

Overall accuracy = 74.7%

1:1.2. The location of SMT was esophageal in 36 patients (17.8%), gastric in 145 patients (71.8%) and duodenal in 21 patients (10.4%).

EUS confirmed no abnormality (i.e., normal or impression of SMT due to compression by normal adjacent organs such as the gallbladder or spleen) in 54 patients (26.7%). It showed that the SMT originated from the submucosal layer (third sonographic layer) in 50 patients (24.8%). In these patients, conservative management was adopted for 33 patients because of EUS features suggestive of benign lesions such as a simple cyst, a lipoma or an ectopic pancreas. Endoscopic removal by polypectomy was performed on 10 patients (histopathological findings: three hyperplastic polyps, two carcinoid tumors, two pancreatic heterotopias, one granular cell tumor, one cavernous hemangioma and one leiomyoma). Based on these histopathological findings, EUS is 70% accurate in determining lesions arising from submucosal (third sonographic) layer. Follow up by interval EUS examination was adopted in the remaining seven patients as they refused endoscopic interventions. SMT arising from the muscularis propria (fourth sonographic layer) was found in 84 patients (41.6%). Operative management was decided in 37 patients because of high-risk EUS features and 32 patients underwent surgical resection subsequently. The histopathological result confirmed gastrointestinal stromal tumors (GIST) in 30 patients, leiomyoma in one patient and spindle cell cancer in one patient. Therefore, EUS is 100% accurate in identifying tumors arising from the muscularis propria. Extrinsic compression by pathological condition in adjacent organs as a cause for SMT was shown by EUS in 14 patients (6.9%). This included two patients with hepatic tumors, five patients with a hepatic cyst, five patients with a pancreatic tumor and two patients with pancreatic cyst.

Based on our results, we found that EUS was able to change the diagnosis of SMT in 26.7% of patients in whom no abnormality was found. It also demonstrated

that 6.9% of suspected SMT was due to extrinsic compression from pathology in adjacent organs. Furthermore, the EUS also impacted on clinical management by identifying 87 patients (43.1%, of whom 54 were normal and 33 had a benign SMT) in whom further investigation and follow up were unnecessary. EUS also influenced surgical decisions in 37 out of 84 patients (44.0%) suspected of having high-risk GIST or leiomyoma, according to established criteria.²⁰

DISCUSSION

EUS is the most accurate method for loco-regional staging of upper GI malignancies compared with other cross-sectional imaging. The accuracy of EUS in T and N staging for esophageal and gastric cancer was in the region of 85 and 75%, respectively.^{7,8} However, a recent study containing a significant proportion of patients with limited disease showed that EUS is not as accurate in predicting early disease.²¹ This stimulated the interest in reassessing the staging accuracy of EUS in upper GI malignancies.²² Our study showed that the accuracy of T and N staging for esophageal cancer was 71.2 and 79.7%, respectively, whereas the accuracy of T and N staging for gastric cancer was 64.0 and 74.7%, respectively. It is more accurate in predicting advanced T3 diseases than other T stages. Our accuracy was lower than that reported in other experienced centers, particularly for early-stage cancer. In another study performed in an academic center, the overall accuracy of T and N staging of esophageal cancer by EUS was 76 and 89%, respectively. The staging accuracy for T3 versus T1 and T2 disease and for N0 versus N1 disease was not significantly different.²² We believe our poorer result may be related to the endosonographers' experience, the inferior resolution of the earlier model of echoendoscope in the initial study period and the lack of a EUS-FNA service. We do not predilate malignant strictures of esophagus purely for staging purpose because risk of complications from it may be high.²³ In these cases, we employ a miniprobe for the local staging of esophageal cancer. A previous study has demonstrated high T staging accuracy with a miniprobe in tumors that are not traversable with a standard echoendoscope.²⁴ However, we could not assess the possibility of celiac lymph node metastasis that may influence the management decision. Furthermore, it is well known that the staging of gastric cancer is more difficult than that of esophageal cancer. The presence of ulcer scars or inflammatory reactions below the cancer can lead to an over-estimation of the tumor invasion. This could account for the high over-staging rate of gastric cancer in our study.

EUS assumes a very important role in clarifying SMT found during a standard OGD examination.³ It is highly accurate in differentiating SMT arising from the GI tract wall and from extrinsic lesions.²⁵ It demonstrates excellent inter-observer agreement in diagnosing cystic lesions, lipomas, leiomyomas and extrinsic compressions.²⁶ The result has a great impact on patient management.²⁷ In our experience, EUS was highly accurate in locating the layer of origin of the SMT and predicting the nature of the lesion (Fig. 3). It helped to stratify the risk of SMT so that benign lesions can be observed and prevented from further investigation. The echo features can identify high-risk GIST and influence the decision for surgical treatment.²⁰

Despite its high accuracy and substantial clinical impact, EUS has been underutilized when compared with other mainstream endoscopic procedures. The main obstacles to its widespread use are its limited availability and a lack of trained endosonographers. The services of EUS are concentrated in a few large endoscopy centers in Hong Kong. In particular, EUS-FNA is available in only three out of 16 acute public hospitals, two of which are university hospitals. The same situation also occurs in other Asian-Pacific regions.¹⁷ Reasons commonly cited are the high cost of

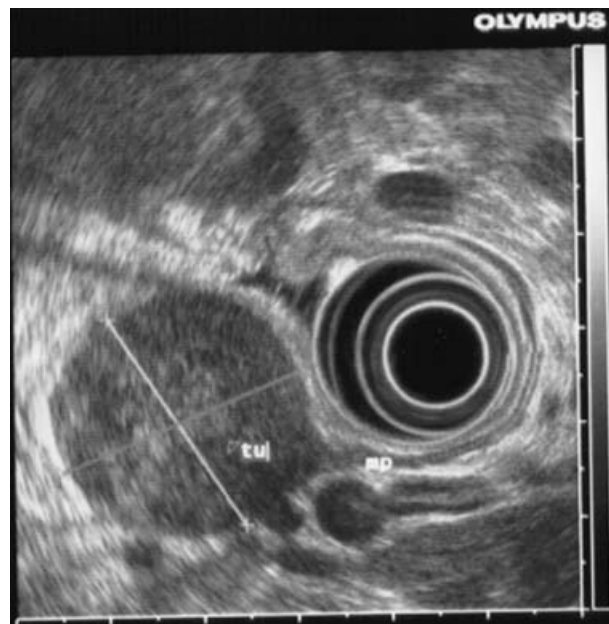


Figure 3. Endoscopic ultrasound showing a heterogeneous hypoechoic lesion arising from the muscularis propria suggestive of a gastrointestinal stromal tumor. Frame, 1/112; scale, 5 mm; direction, normal. mp, muscularis propria; tu, tumor.

installing the equipment, disproportionately low reimbursement, lack of adequate training and availability of experienced endosonographers to perform this procedure. These problems need to be addressed so that more patients can benefit from this useful and rapidly evolving technique.

Our study showed that EUS performed in a community hospital setting can achieve a reasonable accuracy for guiding patient management. The demand for EUS is also increasing. According to Parada *et al.* current resources will soon be insufficient to meet the demand of EUS. It will soon be necessary to increase the number of procedures performed in established centers or to increase the number of units practicing EUS.¹⁶ We strongly believe this endoscopic technique should be promoted. More resource should be allocated to this aspect and an EUS service should be made available in every major community hospital.

Our study has the usual limitations of retrospective design, such as recruitment bias and discrepancy in follow-up protocols. In some circumstances, the endosonographer is the physician or surgeon in charge who manages the patients. They understand EUS better and their assessment of the clinical impact of EUS may be biased towards its maximal effect. We did not determine the impact of EUS on upper GI cancer management. In real life, the treatment decision of upper GI cancers takes multiple factors into consideration, such as the patient's general health and preferences, the presence of complication such as GI bleeding and the availability of different treatment modalities, instead of imaging result alone. Like many other non-academic EUS centers, we do not have a EUS-FNA service. In a recent survey performed in Asian-Pacific regions, only half of 71 experienced practicing endosonographers performed a curvilinear EUS.¹⁷ The availability of EUS-FNA for celiac lymph nodes and ascites fluid sampling to confirm metastatic disease pathologically may further enhance its impact.^{28,29,30} Patients with inoperable cancer, as demonstrated by EUS (Fig. 4), could then be spared futile surgical exploration and resources could be redistributed to other treatment modalities.

Our result also indicate that EUS was seldom used in some established indications such as assessing pancreatico-biliary disease (only 29 cases over 5 years) and other emerging indications, such as the staging of lung cancer. This could be partially explained by a lack of awareness of these indications by referring physicians. In future, physician education on the indications of EUS and providing them with formal EUS training is



Figure 4. Endoscopic ultrasound showing a gastric cancer with invasion to pancreas suggestive of a T4 tumor. Frame, 1/160; scale, 10 mm; direction, normal. PAN, pancreas; TU, tumor.

essential to cope with the ever-increasing demand and rapid development of this endoscopic technique.

Conclusion

Endoscopic ultrasound is an accurate tool that has a substantial influence in the management of patients with upper GI diseases. It is an essential component in the armory of diagnostic and therapeutic endoscopy. The demand for EUS is increasing and the technique can further improve performance in a community hospital. Further effort to enhance physicians' awareness of its indications and enhance its utilization is justified.

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