Staging of esophageal cancer by EUS: staging accuracy revisited

Rahul A. Shimpi, MD, Josh George, MD, Paul Jowell, MD, Frank G. Gress, MD

Durham, North Carolina, USA

Background: EUS plays an important role in the preoperative staging of esophageal cancer. Recent data have called into question the staging accuracy of EUS, particularly in patients with early disease.

Objective: Our goals were to assess our institution's EUS staging accuracy by experienced endosonographers in a contemporary cohort of patients encompassing a wide range of disease stages and to assess staging accuracy after dilation of malignant strictures.

Design: Retrospective data review.

Setting: Single tertiary care center.

Patients and Interventions: A total of 42 patients with esophageal cancer undergoing preoperative EUS staging without neoadjuvant chemoradiotherapy between December 1999 and December 2004 were evaluated.

Main Outcome Measurements: EUS T and N stage sensitivity, specificity, positive predictive value, negative predictive value, and accuracy.

Results: EUS accurately predicted T stage in 76% of cases and N stage in 89% of cases. Staging accuracy for T3 versus T1 and T2 disease and for N0 versus N1 disease was not significantly different. In 11 cases, malignant strictures required dilation, with 6 tumors being passable post dilation. Post dilation, T staging accuracy was 80% in impassable tumors and 100% in passable tumors, and N staging accuracy was 100% in the passable tumors.

Limitations: Relatively small number of patients.

Conclusions: EUS accurately predicts T and N stage in patients with a range of disease stages. EUS provides good staging accuracy after dilation of malignant strictures regardless of whether full tumor traversal post dilation is possible. (Gastrointest Endosc 2007;66:475-82.)

Esophageal cancer is relatively uncommon in the Western world, but its incidence is rapidly increasing.[1] In 2003, an estimated 13,900 new cases of esophageal cancer were expected, with 13,000 deaths.[2] The 5-year survival rate is dismal, at approximately 13%.[1] Esophageal cancer is staged according to the TNM system, where T stage corresponds to depth of tumor invasion through the esophageal wall, N stage corresponds to regional lymph node involvement, and M stage corresponds to the presence or absence of distant metastases. Accurate staging in esophageal cancer is critical because management decisions are heavily affected by initial disease staging. Overall preoperative tumor stage determines whether surgical resection is an option and whether neoadjuvant chemotherapy with or without radiotherapy is given.[3,4]

Abbreviations: GE, gastroesophageal; HFUS, high-frequency US; PET, positron emission tomography.

0016-5107/$32.00
doi:10.1016/j.gie.2007.03.1051

The preoperative staging of esophageal cancer includes the use of EUS. EUS has been shown to provide accurate assessment of the depth of tumor invasion and assessment of regional lymph nodes, and it is an established modality for the preoperative staging of esophageal cancer. Multiple studies have shown the superiority of EUS to other imaging techniques for T and N staging of esophageal cancer.[5-8] Other modalities used in staging esophageal cancer include CT and positron emission tomographic (PET) scanning. CT and PET are accurate in detection of distant metastasis, particularly organ metastasis.[9,10]

Many of the series reporting on EUS staging performance in esophageal cancer have contained a high proportion of patients with advanced disease. A recent study by Zuccaro et al,[11] containing a significant proportion of patients with limited disease, has called into question the true accuracy of EUS staging in a patient

population balanced between early and advanced disease. In that study, EUS predicted T stage in 55% of patients overall compared with the gold standard of surgical pathologic examination. EUS was particularly poor at T staging of early stage disease, with an accuracy of 29% for T1 disease and 42% for T2 disease. N stage was misdiagnosed in 25% of cases, with 41% of pathologic N1 disease staged as N0 disease by EUS.

Several factors need to be considered with this study. The study included patients undergoing esophageal cancer staging from 1987 through 2001. Endosonographic equipment and techniques have undergone continuous refinement over time, which may have improved the diagnostic accuracy of EUS staging of esophageal cancer in recent years. In addition, it is known that interobserver variability exists with EUS.[9] Endosonographers in this study likely varied with respect to overall endosonographic experience and esophageal cancer staging experience. The role of experience in staging accuracy, however, was not examined in the study. Past studies have demonstrated the importance of experience in accurate EUS staging of esophageal cancers.[12]

Another factor that may affect staging accuracy in esophageal cancer is the presence of strictures requiring dilation before EUS. High-grade strictures in esophageal cancers requiring dilation for complete EUS tumor evaluation are common, occurring in approximately 30% of patients. Past studies evaluating EUS staging performance after dilation of malignant esophageal strictures have shown varying results, with some studies demonstrating inferior T staging accuracy.[13,14]

The purpose of this study was to (1) assess our institution's EUS staging accuracy of esophageal cancer by experienced endosonographers in a contemporary cohort of patients and to (2) assess our staging accuracy of EUS after dilation of malignant esophageal strictures.

Capsule Summary

What is already known on this topic

- Endosonographic equipment and techniques are continuously refined, leading to improved diagnostic accuracy.

What this study adds to our knowledge

- In a retrospective study of 42 patients with esophageal cancer undergoing preoperative staging, EUS accurately predicted tumor stage in 76% of cases and node stage in 89% of cases.
- Staging accuracy for T3 versus T1 and T2 disease and for N0 versus N1 disease was not significantly different.

MATERIAL AND METHODS

Patient selection

From December 1999 through December 2004, 200 patients with esophageal cancer underwent EUS for staging at Duke University Medical Center. Of these, 42 patients undergoing EUS followed by esophagectomy without receiving induction chemotherapy or radiotherapy before surgery constitute the study population. Patients were identified and data collected from our institution's prospective endoscopy database system (ProVation MD, ProVation Medical, Minneapolis, Minn). Patients were identified by searching ''upper EUS'' procedures involving ''esophageal cancer staging'' as a procedural indication. Esophagectomy and surgical pathologic data were collected for each subject patient enrolled from the institutional electronic medical record system. This study was approved by our institution's institutional review board.

EUS staging

All examinations were performed by 1 of 4 endosonographers. Twenty-nine of the 42 examinations (69%) were performed by a single endosonographer who also had the highest EUS volume at our institution, averaging more than 400 total EUS procedures and more than 30 esophageal cancer staging procedures per year. The remaining 13 examinations were performed by endosonographers who had all completed advanced EUS training.

In all patients, standard esophagogastroduodenoscopy was initially performed, followed by EUS. In 39 cases, EUS was performed with either mechanical radial (GF-UM30, Olympus America, Melville, NY) or electronic radial (EG-3630UR, Pentax Medical, Montvale, NJ) echoendoscopes. Twenty-seven examinations used the electronic radial echoendoscope and 12 used the mechanical radial echoendoscope. In addition, high-frequency US (HFUS) probes (UM-3R, 20 MHz, Olympus America) were used in 9 examinations. HFUS examinations were performed after water instillation into the esophageal lumen and suctioning of lumenal air. In 8 of these cases, the EUS examination was performed with an HFUS probe in addition to radial endosonography. In 1 case, with a malignant stricture nontraversable after dilation, the HFUS probe was used alone.

Eleven patients (26% of examinations) had obstructing tumors initially not permitting endoscope passage. All 11 of these patients subsequently underwent dilation in a serial fashion with Savary dilators passed over a guidewire. These patients had a mean of 3.5 dilators passed (range 1-5), with a mean peak dilation size of 13 mm (range 7-15 mm). Despite dilation, 5 patients ultimately had nontraversable tumors, and N staging could not be performed. All patients had T staging performed. In most cases of nontraversable tumors, T stage was adequately assessed from the proximal tumor margin; in 2 cases the tumors were only able to be evaluated with a HFUS probe.

EUS staging was based on the TNM classification system: T1, invasion up to the third wall layer (submucosa); T2, invasion into but not through the fourth wall layer

TABLE 1. Baseline clinical, endoscopic, and clinicopathologic characteristics

Variables	No.	% of 42
Clinical		
Male sex	37	88
White race	35	83
Black race	4	10
Other race	3	7
Endoscopy		
Tumor location		
Proximal esophagus	0	0
Mid esophagus	6	14
Distal esophagus	24	57
GE junction	12	29
Pathology		
Histopathologic type		
Adenocarcinoma	36	86
Squamous	5	12
Neuroendocrine	1	2
Histologic grade		
Well	8	19
Moderate	18	43
Poor	16	38

(muscularis propria); T3, invasion beyond the fourth wall layer (adventitia); and T4, invasion of adjacent structures (ie, aorta, pleura, lung). Classification of regional lymph nodes used established endosonographic criteria of echotexture, size, shape, and border.[15] EUS classification of N stage was as follows: Nx, inability to assess regional lymph nodes; N0, no regional lymph node metastasis; and N1, regional lymph node metastasis. In 1 patient, EUS-guided FNA of suspicious locoregional lymph nodes was used to determine N stage. EUS classification of distant metastasis was as follows: M0, no distant metastasis; and M1, distant metastatic disease. Because EUS has been shown to be inaccurate in diagnosing nonnodal distant metastatic disease,[16] at our institution, unless celiac lymph node involvement or metastatic liver lesions are found on EUS, Mx stage is assigned. In addition, Mx stage was assigned to all nontraversable tumors.

Pathologic TNM classification was made on esophagectomy specimens. Pathologic staging was assigned according to the American Joint Commission for Cancer TNM system.[17] Because advanced disease often affects patient management, we also classified patients as either having disease limited to the esophageal wall (T1-T2, N0, and M0) or advanced beyond the esophageal wall (T3-T4, N1, or M1). The assignment of limited or advanced disease was made on both EUS and surgical pathology staging.

TABLE 2. Overall EUS and pathologic staging

Staging	EUS (% of total)	Pathologic (% of total)
T1N0	13 (35)	17 (40)
T2N0	6 (16)	4 (10)
T3N0	8 (22)	6 (14)
T1N1	1 (3)	1 (2)
T2N1	0 (0)	2 (5)
T3N1	9 (24)	12 (29)
M1 (all T3N1 tumors)	2 (5)	4 (10)
Advanced disease (T3/T4 or N1 or M1)	18 (49%)	21 (50%)

TABLE 3. Pathologic versus EUS T staging

	Pathologic staging			
	T1	T2	T3	T4
EUS				
T1	12	2	0	0
T2	4	2	0	0
T3	2	2	18	0
T4	0	0	0	0

Esophagectomy

Esophagectomy by use of a transthoracic approach with lymphadenectomy was perfomed in 10 patients (24%). Transhiatal esophagectomy with lymph node sampling was performed in 32 patients (76%).

Data analysis

Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy, with 95% CIs for each of the diagnostic measures, were calculated for each individual T and N stage. In addition, these measures were calculated for limited disease and disease advanced beyond the esophageal wall as a whole. The gold standard in all cases was pathologic staging of esophagectomy specimens. The 95% CIs for diagnostic test statistics were calculated by using the Wilson score method with continuity correction.

RESULTS

A total of 42 patients were evaluated. There were 37 males (88%) and 5 females (12%). The clinical, endoscopic,

TABLE 4. EUS diagnostic accuracy by T stage

Stage	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Accuracy (95% CI)
T1	67% (41-86)	92% (72-99)	86% (56-98)	79% (49-94)	81% (65-91)
T2	33% (6-76)	89% (73-96)	33% (6-76)	89% (41-100)	81% (61-90)
T3	100% (78-100)	83% (62-95)	82% (59-94)	100% (82-100)	90% (77-97)

TABLE 5. Pathologic versus EUS N staging

	Pathologic staging	
	N0	N1
EUS		
N0	24	3
N1	1	9

and clinicopathologic tumor characteristics are summarized in Table 1. The majority of tumors were located in the distal esophagus (57%) and at the gastroesophageal (GE) junction (29%). Adenocarcinomas made up the majority of histopathologic tumor types (86%), with the remainder being squamous cell and neuroendocrine cancers. Histologically, the involved tumors were predominantly moderately and poorly differentiated.

EUS and pathologic staging

Results of overall EUS and pathologic staging are shown in Table 2. The ''EUS'' column of the table excludes the 5 patients who did not have N stage assessed by EUS because of inability to traverse the tumor. By pathologic examination, 21 of the 42 patients (50%) had disease advanced beyond the esophageal wall (T3 or greater, N1, or M1); the remaining 21 patients (50%) had disease confined to the esophageal wall.

T staging

Pathologic versus EUS T staging is depicted in Table 3. Overall, EUS accurately predicted T stage in 76% of cases. EUS accurately predicted T stage in 67% of T1 tumors, 33% of T2 tumors, and 100% of T3 tumors. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of EUS for individual T stages are shown in Table 4. EUS was relatively insensitive for early stage disease (T1 and T2) but had high specificity in these cases. EUS was highly sensitive for T3 tumors, with good specificity and accuracy. Of note, EUS was significantly more sensitive for T staging of T3 disease (100%; 95% CI 78%-100%) than for T2 disease (33%; 95% CI 6%-76%).

Ten of 42 (24%) EUS examinations in total had incorrect T staging. Of these, 6 were examinations of T1 tumors and 4 of T2 tumors. All the incorrectly staged T1 tumors were overstaged (4 were staged T2, 2 were staged T3). Two of the incorrectly staged T2 tumors were overstaged (both as T3 tumors), and 2 were understaged (both as T1 tumors). In 1 of the misclassified cases, tumor abutted the muscularis propria without clear muscularis propria invasion although staged as a T2 tumor on EUS; pathologic examination revealed this to be a T1 tumor. Another misclassified tumor involved limited EUS imaging given tumor nontraversal (a T2 tumor inaccurately staged as T3). A third misclassified tumor involved difficult EUS imaging because of tumor bulk and significant air trapping between tumor lobulations (a T1 tumor incorrectly staged as T3). A fourth T1 tumor incorrectly staged as T3 had a coincidental large underlying submucosal leiomyoma found during pathologic examination of the esophagectomy specimen, likely contributing to the EUS overstaging.

N staging

Pathologic versus EUS N staging is shown in Table 5. Overall, EUS accurately predicted N stage in 89% of cases. EUS correctly predicted N stage in 96% of N0 tumors and 75% of N1 tumors. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of EUS for N0 and N1 disease are shown in Table 6. In one section of Table 6, the 5 patients whose N stages were not assigned because of tumor impassability are excluded, whereas in a second section of the table the results for those 5 patients are included as inaccuracies in the calculation of diagnostic test statistics. The accuracy of EUS N staging was 79% if all nontraversable tumors were deemed to be incorrectly staged. In the single examination with FNA, N stage was correctly predicted on the basis of FNA cytopathology results. In 3 cases, N1 tumors were underclassified as N0 disease; in one case an N0 tumor was overclassified as N1 disease. EUS accuracy in N staging was high, with good sensitivity for N0 tumors and good sensitivity and specificity for N1 tumors.

M staging

The diagnostic accuracy of EUS for M1 staging is shown in Table 7. In one section of Table 7, the data for those

TABLE 6. EUS diagnostic accuracy by N stage

Stage	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Accuracy (95% CI)
For only the 37 patients whose strictures could be traversed					
N0	96% (78-100)	75% (43-93)	89% (70-97)	90% (71-98)	89% (74-97)
N1	75% (43-93)	96% (78-100)	90% (54-100)	89% (53-99)	89% (74-97)
For all 42 patients whose data were reviewed*					
N0	80% (61-92)	75% (43-93)	89% (70-97)	60% (40-78)	79% (63-89)
N1	75% (43-93)	80% (61-92)	60% (33-83)	89% (61-99)	79% (63-89)

*Those 5 patients whose strictures could not be traversed were assigned stages Nx and Mx, which are considered as inaccuracies in the calculation of diagnostic test statistics.

TABLE 7. EUS diagnostic accuracy for M1 disease

Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Accuracy (95% CI)
For only the 37 patients whose strictures could be traversed				
33% (2-88)	97% (83-100)	50% (3-97)	94% (17-98)	92% (77-98)
For all 42 patients whose data were reviewed*				
13% (1-53)	97% (83-100)	50% (3-97)	83% (12-100)	81% (65-91)

*Those 5 patients whose strictures could not be traversed were assigned stages Nx and Mx, which are considered as inaccuracies in the calculation of diagnostic test statistics.

patients assigned Mx stage because of tumor impassability are excluded, whereas in a second section of the table the results for those 5 patients are included as inaccuracies in the calculation of diagnostic test statistics. Two tumors were staged as M1 by EUS on the basis celiac node involvement; both these patients subsequently went to esophagectomy when preoperative PET imaging revealed no evidence of celiac nodal disease. FNA was not used to confirm metastatic disease in either of these cases. Positive celiac node involvement on surgical pathology was found in one of these 2 patients. Two tumors staged as Mx on EUS had celiac nodal disease found on surgical specimen examination. All 3 of the pathologically confirmed M1 tumors required dilation, and full tumor traversal was possible after dilation in all 3 cases, including the 2 tumors incorrectly staged Mx on EUS. Although the numbers are small, EUS was insensitive to the presence of celiac nodal disease.

Advanced disease staging

Diagnostic accuracies of EUS staging for local disease (T1-T2, N0, and M0) and for disease advanced beyond the esophageal wall (T3-T4, N1, or M1) are shown in Tables 8 and 9, each with 2 sections including only the 37 patients whose strictures could be traversed and all 42 patients whose data were reviewed. EUS had good sensitivity and accuracy for both limited and advanced disease. Of the 21 patients with limited disease, EUS correctly identified 17. Of the 21 patients with locally advanced disease, EUS correctly identified 14. The overall error for limited and locally advanced disease was 16% if the nontraversed tumors were excluded from analysis. Two advanced tumors were incorrectly staged as limited disease, both N1 tumors staged as N0. Four tumors with limited disease were incorrectly staged as advanced disease, 1 T1N0 tumor staged as T1N1 and 3 T1 or T2 tumors staged as T3. Of the 3 cases misstaged as a result of T overstaging, one was the examination with limited imaging given tumor nontraversability after dilation and another was the examination with poor visualization because of tumor bulk and air trapping between tumor lobulations.

Postdilation staging

Of the 11 examinations requiring dilation, EUS correctly predicted T stage in 10 cases (accuracy 91%). N staging was correct in all 6 tumors that were fully

TABLE 8. EUS diagnostic accuracy for limited disease

Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Accuracy (95% CI)
For only the 37 patients whose strictures could be traversed				
81% (57-94)	88% (60-98)	90% (66-98)	78% (53-92)	84% (67-93)
For all 42 patients whose data were reviewed*				
81% (57-94)	67% (43-85)	71% (49-87)	78% (56-91)	74% (58-86)

*Those 5 patients whose strictures could not be traversed were assigned stages Nx and Mx, which are considered as inaccuracies in the calculation of diagnostic test statistics.

TABLE 9. EUS diagnostic accuracy for advanced disease

Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Accuracy (95% CI)
For only the 37 patients whose strictures could be traversed				
88% (60-98)	81% (57-94)	78% (52-93)	90% (65-98)	84% (67-93)
For all 42 patients whose data were reviewed*				
67% (43-85)	81% (57-94)	78% (52-93)	71% (45-88)	74% (58-86)

*Those 5 patients whose strictures could not be traversed were assigned stages Nx and Mx, which are considered as inaccuracies in the calculation of diagnostic test statistics.

traversable post dilation. Ten of the 11 examinations requiring dilation were T3 tumors and 8 of the 11 were N1 tumors on the basis of surgical pathologic examination. The inaccurately staged tumor, however, was a T2 tumor staged as T3. This particular examination was limited by tumor impassability after dilation, and the tumor was assessed only from the proximal margin. No procedure-related complications occurred in any of the patients undergoing dilation.

Catheter-based HFUS miniprobe staging

Catheter-based HFUS miniprobes were used in 9 examinations. Seven of these were early cancers (T1N0 tumors). In this group, 2 patients were referred for Barrett's esophagus with high-grade dysplasia on prior endoscopic biopsy, and 3 patients were referred for Barrett's esophagus with esophageal nodules found to be intramucosal adenocarcinoma on prior endoscopic biopsy specimens. Two patients were referred for known esophageal adenocarcinoma without a preceding history of Barrett's esophagus. By surgical pathologic study, all 7 of these patients had T1 and N0 disease. The accuracy of HFUS was 100% (95% CI 56%-99%) for both T and N stage. Two examinations using HFUS were cases with tumor impassability after dilation. T staging was accurate in both examinations (both were T3 tumors). Nx stage was assigned in these 2 cases given lack of penetration with the 20-MHz probe.

DISCUSSION

The T staging accuracy in our series is comparable to that of past series evaluating EUS in esophageal cancer.[1,2,4] Our overall T staging accuracy was higher than that of the series reported by Zuccaro et al (76% vs 55%).[11] Of note, the sensitivity for limited disease (T1 and T2) was mediocre in both series, calling into question the ability of EUS to accurately stage T1 or T2 tumors of the esophagus. In our staging series, however, we also used HFUS probes, which demonstrated a much higher sensitivity for T1 tumors than did radial echoendoscopy.

Overall, N stage was inaccurately classified in 11% of patients in our series. This excludes 5 examinations in which N stage was not obtained because of tumor impassability. Importantly, the sensitivity for N1 disease was 75%, higher than that in the series of Zuccaro et al (59%).[11] Our diagnostic accuracy for N staging compares quite favorably to that of past series, in which N stage accuracy has mostly ranged from 70% to 90%.[1,18]

EUS-FNA was used for locoregional lymph node staging in 1 case in our series and resulted in correct N staging. EUS-FNA was not performed in more cases for 2 reasons. First, suspicious nodes were often located immediately adjacent to or contiguous to the tumor mass. Second, in many cases either lymph nodes were not seen that could be subjected to FNA sampling or they were located too far

away for safe sampling. In past series, EUS-FNA has been shown to increase diagnostic accuracy in overall nodal staging in esophageal cancer compared with EUS alone, with sensitivities ranging from 83% to 93%, specificities ranging from 93% to 100%, and accuracies ranging from 87% to 93%.[19-21] These series included substantial numbers of patients with celiac nodal disease. Whether regular use of EUS-FNA would significantly improve either N or M accuracy in a patient population such as ours remains to be studied.

Because disease locally advanced beyond the esophageal wall is often treated with preoperative chemoradiotherapy, EUS classification of disease extent affects therapy. Classification as locally advanced disease can result from increased depth of tumor invasion (T3-T4 disease) or locoregional lymph node involvement (N1). Thus, overstaging T or N may result in inappropriate preoperative chemoradiotherapy, whereas understaging may result in the withholding of potentially beneficial induction therapy. Our series demonstrates that EUS has good accuracy for distinguishing between limited and advanced disease and therefore accurately directs the use of preoperative chemoradiotherapy. Among misstaged lesions, errors in advanced disease classification were as likely to result from incorrect T staging as from incorrect N staging.

In our series, HFUS miniprobes were used in 7 early stage cancers (T1N0 tumors). Accuracy for both T and N staging was perfect in these examinations. This excellent diagnostic accuracy compares favorably with that of past series using miniprobes in early stage cancers.[22,23]

A total of 11 patients (26%) in our study required pre-EUS dilation, a proportion consistent with past series. Most tumors requiring dilation were locally advanced (T3) and had locoregional lymph node involvement (N1). A preponderance of advanced-stage disease in tumors requiring dilation has been identified in past studies.[9,10,24] A higher percentage (45%) of patients had nontraversable tumors after dilation in our series than in previous studies. One possible reason for this could be the type of echoendoscopes used to perform our procedures. Most of our cases (73%) were performed with Pentax radial echoendoscopes as opposed to Olympus equipment in most other series. The outer diameter of the Pentax radial instrument insertion tube used in our institution is 12.1 mm compared with 11.7 mm for the Olympus radial instrument. Furthermore, the Pentax instrument has a blunt tip as opposed to the tapered tip of the Olympus instrument, and the Pentax instrument has forward-viewing optics whereas the Olympus instrument has oblique-viewing optics. Despite this, EUS was still highly accurate for T staging and correctly predicted N stage in all cases in which the tumor was ultimately traversable.

In a past study, Pfau et al[14] questioned the contribution of wall layer disruption caused by hemorrhage and swelling after dilation to decreased T staging accuracy. Although the number of cases in our series is small, our T stage accuracy in postdilation examinations surpasses that demonstrated in the study by Pfau et al (61%), a large study of 81 patients, and is similar to the accuracy in another small study using dilation in 14 patients (86%).[25] Of note, our T staging accuracy in cases of tumor impassability post dilation remained high (80%), despite the inability to evaluate these tumors along their entire length. In 2 cases, HFUS miniprobes were used to stage impassable tumors, with accurate T staging in both examinations. Past series have demonstrated high T staging accuracy with miniprobes in tumors not traversable with standard echoendoscopes.[26] Our data overall suggest that EUS can be quite accurate in staging esophageal cancers requiring dilation regardless of whether these tumors are traversable after dilation. The type of instrument used to stage these tumors may play a role in staging accuracy.

Our data are limited by the inclusion of patients with a somewhat narrowed clinical spectrum of disease, in that very small numbers of patients with celiac nodal disease and no patients with T4 tumors were included. Unfortunately, this was inevitable owing to the nature of the study. Given the need for an accurate gold standard (surgical pathology), patients receiving neoadjuvant chemoradiotherapy before esophagectomy were excluded. In addition, our study involves only a single academic institutional experience, with examinations performed by experienced endosonographers, and thus the results may not be applicable to all centers.

Overall, our study shows good diagnostic accuracy for EUS T staging in esophageal cancer. Although EUS appears to be insensitive for staging T1 and T2 disease, it has a reasonable error rate in these tumors. The diagnostic accuracy of N staging by EUS in our series is quite good. Most important, our series shows the ability of EUS to distinguish between limited and advanced disease, accurately guiding the use of preoperative chemoradiotherapy. Furthermore, our data show good diagnostic staging accuracy of EUS after dilation of malignant strictures, regardless of whether complete tumor traversal post dilation is possible.

DISCLOSURE

All authors deny any conflict of interest.

REFERENCES

1. Devesa SS, Blot WJ, Fraumeni JF Jr. Changing patterns in the incidence of esophageal and gastric cancer in the United States. Cancer 1998;83: 2049-53.
2. Jemal A, Murray T, Samuels A, et al. Cancer statistics, 2003. CA Cancer J Clin 2003;53:5-26.
3. Walsh TN, Noonan N, Hollywood D, et al. A comparison of multimodal therapies and surgery for esophageal adenocarcinoma. N Engl J Med 1996;335:462-7.

4. Urschel JD, Vasan H. A meta-analysis of randomized controlled trials that compared neoadjuvant chemoradiation and surgery to surgery alone in resectable esophageal cancer. Am J Surg 2003;185:538-43.
5. Rösch T. Endosonographic staging of esophageal cancer: a review of literature results. Gastrointest Endosc Clin North Am 1995;5:537-47.
6. Van Dam J. Endosonographic evaluation of the patient with esophageal cancer. Chest(4 Suppl) 1997:112, 184-90S.
7. Chak A, Canto M, Gerdes H, et al. Prognosis of esophageal cancers preoperatively staged to be locally invasive (T4) by endoscopic ultrasound (EUS): a retrospective cohort study. Gastrointest Endosc 1995;42:501-6.
8. Kelly S, Harris KM, Berry E, et al. A systematic review of the staging performance of endoscopic ultrasound in gastro-oesophageal carcinoma. Gut 2001;49:534-9.
9. Luketich JD, Schauer PR, Meltzer CC, et al. Role of positron emission tomography in staging esophageal cancer. Ann Thorac Surg 1997;64:765-9.
10. Flamen P, Lerut A, Van Cutsem E, et al. Utility of positron emission tomography for the staging of patients with potentially operable esophageal carcinoma. J Clin Oncol 2000;18:3202-10.
11. Zuccaro G Jr, Rice TW, Vargo JJ, et al. Endoscopic ultrasound errors in esophageal cancer. Am J Gastroenterol 2005;100:601-6.
12. Catalano MF, Sivak MV Jr, Bedford RA, et al. Observer variation and reproducibility of endoscopic ultrasonography. Gastrointest Endosc 1995;41:115-20.
13. Catalano MF, Van Dam J, Sivak MV Jr. Malignant esophageal strictures: staging accuracy of endoscopic ultrasonography. Gastrointest Endosc 1995;41:535-9.
14. Pfau P, Ginsberg GG, Lew RJ, et al. Esophageal dilation for endosonographic evaluation of malignant esophageal strictures is safe and effective. Am J Gastroenterol 2000;95:2813-5.
15. Catalano MF, Sivak MV Jr, Rice T, et al. Endosonographic features predictive of lymph node metastasis. Gastrointest Endosc 1994;40:442-6.
16. Lightdale CJ. Practice guidelines: esophageal cancer. Am J Gastroenterol 1999;94:20-9.
17. American Joint Committee on Cancer AJCC cancer staging manual. In: 6th ed. Philadelphia: Lippincott-Raven; 2002.
18. Catalano MF, Alcocer E, Chak A, et al. Evaluation of metastatic celiac axis lymph nodes in patients with esophageal carcinoma: accuracy of EUS. Gastrointest Endosc 1999;50:352-6.
19. Vazquez-Sequeiros E, Wiersema MJ, Clain JE, et al. Impact of lymph node staging on therapy of esophageal carcinoma. Gastroenterology 2003;125:1626-35.
20. Vazquez-Sequeiros E, Norton ID, Clain JE, et al. Impact of EUS-guided fine-needle aspiration on lymph node staging in patients with esophageal carcinoma. Gastrointest Endosc 2001;53:751-7.
21. Wiersema MJ, Vilmann P, Giovannini M, et al. Endosonography-guided fine-needle aspiration biopsy: diagnostic accuracy and complication assessment. Gastroenterology 1997;112:1087-95.
22. May A, Gunter E, Roth F, et al. Accuracy of staging in early oesophageal cancer using high resolution endoscopy and high resolution endosonography: a comparative, prospective, and blinded trial. Gut 2004;53:634-40.
23. Hunerbein M, Ulmer C, Handke T, et al. Endosonography of upper gastrointestinal tract cancer on demand using miniprobes or endoscopic ultrasound. Surg Endosc 2003;17:615-9.
24. Wallace MB, Hawes RH, Sahai AV, et al. Dilation of malignant esophageal stenosis to allow EUS guided fine-needle aspiration: safety and affect on patient management. Gastrointest Endosc 2000;51:309-13.
25. Kallimanis GE, Gupta PK, Al-Kawas FH, et al. Endoscopic ultrasound for staging esophageal cancer, with or without dilation, is clinically important and safe. Gastrointest Endosc 1995;41:540-6.
26. Menzel J, Hoepffner N, Nottberg H, et al. Preoperative staging of esophageal carcinoma: miniprobe sonography versus conventional endoscopic ultrasound in a prospective histopathologically verified study. Endoscopy 1999;31:291-7.

Received October 18, 2006. Accepted March 21, 2007.

Current affiliations: Department of Gastroenterology, Duke University Medical Center, Durham, North Carolina, USA.

Reprint requests: Frank G. Gress, MD, Department of Gastroenterology, Duke University Medical Center, Box 3662, Durham, NC 27710.