Endoscopic ultrasound guided fine needle aspiration biopsy: a large single centre experience

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Abstract

Background—Endoscopic ultrasound guided fine needle aspiration biopsy (EUS-FNA) is a recent innovation in the evaluation of gastrointestinal and pulmonary malignancies.

Aims—To review the experience with EUS-FNA of a large single centre.

Methods—333 consecutive patients underwent EUS-FNA. Follow up data were available on 327 lesions in 317 patients, including 160 lymph nodes, 144 pancreatic lesions, 15 extraintestinal masses, and eight intramural tumours.

Results—A primary diagnosis of malignancy was obtained by EUS-FNA in 62% of patients with clinically suspicious lesions. The overall accuracy of EUS-FNA for the diagnosis of malignancy was 86%, with sensitivity of 84% and specificity of 96%. With respect to lesion types, the sensitivity, specificity, and accuracy were 85%, 100%, and 89% for lymph nodes; 82%, 100%, and 85% for pancreatic lesions; 88%, 100%, and 90% for perirectal masses; and 50%, 25%, and 38% for intramural lesions, respectively. Compared with size and sonographic criteria, EUS-FNA in the evaluation of lymph nodes provided superior accuracy and specificity, without compromising sensitivity. Inadequate specimens were obtained from only six patients, including 3/5 with stromal tumors. Only one complication occurred.

Conclusions—EUS-FNA is safe and can readily obtain tissue specimens adequate for cytopathological diagnoses. Compared with size and sonographic criteria, it is a superior modality for the detection of nodal metastases. While providing accurate diagnosis of pancreatic and perirectal malignancies, results suggest the technique is less useful for intramural lesions. (Gut 1999;44:720-726)

Keywords: endoscopic ultrasound; endosonography; fine needle aspiration biopsy

Compared with other imaging modalities, endoscopic ultrasound (EUS) has proved to be superior for the detection of pancreatic tumours and nodal metastases, as well as for local tumour staging of other gastrointestinal malignancies. However, EUS cannot reliably differentiate nodal metastases from inflammatory nodes or discern pancreatic tumour from focal pancreatitis. The development of echoendo-

scopes capable of performing real time, ultrasound directed needle aspiration cytology has greatly enhanced our ability to assess lymph nodes and differentiate inflammatory from neoplastic masses. Several studies have described the role of EUS guided fine needle aspiration biopsy (EUS-FNA) in the above patient groups and confirmed the improved specificity and accuracy of the technique.¹⁻⁵ We report a large single centre experience with EUS-FNA using the linear array echoendoscope in the diagnosis of malignancy within and outside the gastrointestinal tract.

Patients and methods

All patients who underwent EUS-FNA between June 1994 and September 1997 were reviewed. Patients were referred for EUS guided biopsy based on the need to evaluate suspicious gastrointestinal, pelvic, or mediastinal lesions or for the staging of known gastrointestinal or pulmonary malignancies. A total of 333 consecutive patients (197 men and 136 women) with a mean age of 62.7 (0.7) years (range 18-88) underwent EUS guided biopsy of 347 mass or nodal lesions using a linear array echoendoscope. Informed consent was obtained from all patients. Patients were excluded if there was thrombocytopenia or uncontrolled coagulopathy. The study was approved by the Medical University of Charleston Institutional Review Board.

TECHNIQUE

EUS-FNA was performed in an outpatient endoscopy suite. The oropharynx was sprayed with 1% xylocaine and conscious sedation was achieved using a combination of midazolam and meperidine. Prophylactic antibiotics were given in patients with cystic lesions or perirectal masses undergoing biopsy, as well as for endocarditis prophylaxis when appropriate.

Evaluation of the target lesion and/or staging of tumours was initially performed with a radial scanning echoendoscope (GF-UM20, Olympus America, Melville, New York, USA). EUS-FNA was then done using the curved linear array echoendoscope (FG-32UA, Pentax Precision Instruments Corp., Orangeburg, New York, USA). This echoendoscope with Doppler capability is a 60 degree oblique forward viewing instrument with the ultrasonic transducer mounted in front of the optic lens. As the scanning plane is in the long axis of the

Abbreviations used in this paper: CT, computed tomography; EUS-FNA, endoscopic ultrasound guided fine needle aspiration biopsy; NSCLC, non-small cell lung cancer.

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Table 1 Indications for EUS guided biopsy

Indications	Patients (n)	Location of primary lesion
Clinically suspicious for cancer (no primary histopathological diagnosis)	182	Pancreas 119, lung 37, mediastinum 18, ampulla 3, perirectal 3, stomach 2
Locoregional staging of confirmed cancer	105	NSCLC 45, oesophagus 39, pancreas 20, hepatoma 1
Suspected tumour recurrence	15	Genitourinary 8, rectum 3, oesophagus 1, gall bladder 1, breast 1, head/neck 1
Pancreatic pseudocysts	10	
Submucosal lesions	5	Stomach 3, oesophagus 2

NSCLC, non-small cell lung cancer.

Table 2 Final diagnoses of targeted lesions and the methods of confirmation

Lesion	Final diagnoses	Confirmation
Pancreatic mass/cyst (n=144)	Adenocarcinoma 116, neuroendocrine tumour 7, cystadenoma 1, lymphoma 1, pancreatitis 9, pseudocyst 10	Laparotomy 66, clinical follow up 78
Mediastinal node/mass (n=120/n=3)	NSCLC metastases 60, oesophageal cancer metastases 16, distant metastases 4, lymphoma 1, sarcoid 5, benign 34, teratoma 1, thymoma 1, recurrent oesophageal carcinoma 1	Thoracotomy 30, clinical follow up 93
Intra-abdominal node (n=40)	Gastrointestinal metastases 30, NSCLC metastases 3, distant metastases 2, lymphoma 1, benign 4	Surgery 7, clinical follow up 33
Intramural tumour (n=8)	Leiomyoma 4, granular cell tumour 1, linitis plastica 1, leiomyosarcoma 1, ovarian metastasis 1	Laparotomy 3, clinical follow up 5
Perirectal mass (n=10)	Recurrent pelvic cancer 7, lymphoma 1, pelvic abscess 2	Laparotomy 7, clinical follow up 3
Abdominal mass (n=2)	Gall bladder cancer metastasis 1, colorectal cancer metastasis 1	Laparotomy 2
All lesions (n=327)	Malignant 257, benign 70	Surgery 115, clinical follow up 212

NSCLC, non-small cell lung cancer.

instrument, real time visualisation of the biopsy needle is permitted. Two different needle catheter systems were utilised: a 23 gauge, 4 cm adjustable needle (Wilson-Cook Inc., Winston-Salem, North Carolina, USA) and a metal spiral sheath with a 22 gauge, 12 cm adjustable needle (GIP, Medi-Globe Inc., Tempe, Arizona, USA).

After localisation of the target lesion, Doppler imaging was used to identify adjacent vascular structures. Lesions in and adjacent to the head of pancreas were best seen with the transducer in the duodenal bulb, whereas lesions in the body and tail were sampled via the transgastric approach. The coeliac axis was identified branching from the aorta in longitudinal view and was used as a landmark to locate coeliac nodes. Mediastinal nodes in the subcarinal and aortopulmonary window regions were located with the endoscope in the oesophagus. The needle-catheter system was inserted through the working channel of the endoscope and the needle was advanced into the lesion using real time ultrasound, taking care not to pass through intervening vessels or the primary mucosal tumour when sampling lymph nodes.

Following removal of the stylet, a 10 ml syringe was applied to the hub of the needle and suction applied as the needle was moved back and forth within the lesion. For indurated pancreatic masses, aspiration was applied for up to two minutes as compared with 15–30 sec-

onds for soft lymph nodes. Aspiration was terminated if blood became visible in the syringe. When aspiration was completed, suction was released, the needle withdrawn into the sheath, and the catheter system then removed through the biopsy channel. The aspirated material was sprayed onto glass slides and preserved with Diff-Quik stain (American Scientific Products, McGraw Park, Illinois, USA) for immediate review by an on site cytopathologist. Residual material within the needle was sprayed into Hanks's solution and collected for processing into a cell block. The attending cytopathologist verified adequacy of specimens and advised as to the need for additional passes. The procedure was terminated when adequate cellular specimens were achieved or the presence of malignant cells was confirmed.

The patients were observed for immediate complications in the recovery room for two hours before discharge. Postprocedural laboratory or radiological data were not obtained unless a suspected complication arose.

DATA ANALYSIS

Information about all patients undergoing EUS and EUS-FNA has been prospectively entered into a database since June 1994. Data recorded included the location, type, size, and endosonographic features of the lesions sampled, the number of passes made and type of needles used, sample adequacy, cytology results, final diagnoses, and procedure related complications. Computer search of the database yielded the study group.

A specimen was considered adequate by the cytopathologist if there was a sufficient number of representative cells from the target lesion. Samples were then interpreted as malignant, suspicious, atypical, or benign. The operating characteristics (sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy) of EUS-FNA were determined by comparison with the final diagnoses of the biopsied lesions, according to surgical pathology or clinical follow up. In this latter group,

Table 3 Operating characteristics of EUS-FNA for the diagnosis of malignancy

Lesion (n)	Passes			Predictive value		
	Mean (SEM)	Sensitivity %	Specificity %	Positive %	Negative %	Accuracy %
Pancreas† (n=144)	3.6 (0.1)	72 (82)*	100	100	38 (51)*	76 (85)*
Lymph node (n=160)	3.2 (0.1)	85	100	100	70	89
Perirectal mass (n=10)	3.5 (0.5)	88	100	100	67	90
Intramural tumour (n=8)	2.8 (0.4)	50	25	100	33	38
Other‡ (n=5)	5.2 (1.2)	40	—	100	—	40
All lesions (n=327)	3.4 (0.1)	78 (84)*	96	100	56 (61)*	82 (86)*

*Figure in brackets: value derived if atypia considered diagnostic for malignancy.

†Including 10 pseudocysts.

‡Mediastinal mass (3), abdominal mass (2)—all malignant.

Table 4 EUS-FNA cytology results for 160 lymph nodes (156 patients)

	Final diagnoses	
	Malignant (n=117)	Benign (n=43)
Mean long axis size (mm)	23.0 (1.3)	19.0 (1.6)
Follow up		
Surgery	13	18
Clinical	104	25
Cytology		
Mediastinal (n=120)		
Malignant	67	0
Benign	13	39
Insufficient	1	0
Total	81	39
Coeliac (n=27)		
Malignant	25	0
Benign	1	1
Total	26	1
Peripancreatic (n=13)		
Malignant	7	0
Benign	3	3
Total	10	3

lesions were considered malignant if there was clinical progression of disease or there was a response to chemoradiation. Benign lesions were characterised by spontaneous resolution or lack of progression on imaging studies on follow up for at least six months in conjunction with continued patient well being.

Mean (SEM) values were calculated unless otherwise indicated. Intragroup comparison of operating characteristics was done using the χ^2 test or Fisher's exact test where appropriate. Non-categorical variables were analysed by the Mann-Whitney U test for non-parametric data. A p value less than 0.05 was considered statistically significant.

Results

Final diagnoses were ascertained for 327 lesions in 317 patients and this subgroup was used for results analysis. Table 1 highlights the indications for EUS guided biopsy. Twenty eight per cent of patients (51/182) with lesions clinically suspicious for malignancy had prior attempts at diagnosis by biopsy and/or cytopuncture that were not conclusive. Table 2 details the final diagnoses of targeted lesions and the methods of confirmation.

The 327 lesions were sampled by a total of 1182 passes (mean 3.4 (0.1) passes per lesion; range 1–9). The Wilson-Cook needle was used to sample 294 lesions and the GIP needle 33 lesions. Inadequate specimens were obtained from only six patients (Wilson-Cook needle, five; GIP, one; $p=0.47$). Table 3 summarises

Table 5 Comparative operating characteristics for the evaluation of lymph nodes

n=160	Sensitivity %	Specificity %	Predictive value		Accuracy %
			Positive %	Negative %	
EUS-FNA	85	100	100	73	89
Mediastinal	83	100	100	74	88
Coeliac	96	100	100	50	96
Sonographic criteria†	91	62*	87*	70	83
Mediastinal	88	62	83	73	80
Coeliac	100	0	96	0	96
Size criteria‡	89	12*	73*	29*	70*
Mediastinal	93	8	69	43	68
Coeliac	88	100	100	25	89

†Malignant: round shape, sharp borders, hypoechoic texture.

‡Malignant: ≥ 10 mm in longest axis.

* $p < 0.001$ compared with EUS-FNA.

Figure 1 (A) Using a radial scanning echoendoscope, bulky hypoechoic lymph nodes are identified in the subcarinal region in a patient with NSCLC. (B) Real time, ultrasound directed needle aspiration biopsy of a subcarinal lymph node is performed. The echogenic needle is visualised within the target node. (C) The aspirate confirms sheets of malignant cells with large nuclei and prominent nucleoli. Necrotic debris is noted in the background. Papanicolaou stain (original magnification $\times 200$).

the operating characteristics of EUS-FNA for the diagnosis of malignancy. Overall a primary diagnosis of malignancy was achieved by EUS-FNA in 62% (113/182) and 57% of patients (29/51) with clinically suspicious lesions and prior inconclusive biopsy specimens respectively.

LYMPH NODES

Table 4 shows EUS-FNA cytology results for 160 lymph nodes. Malignant disease was confirmed prior to the procedure in 89 of these patients (45 non-small cell lung cancer (NSCLC), 39 oesophagus, three pancreas, one

Table 6 EUS-FNA cytology results for 144 pancreatic lesions

	Final diagnoses			
	Malignant (n=123)		Benign (n=21)	
	≥ 30 mm	<30 mm	≥ 30 mm	<30 mm
Follow up (n)				
Surgery (n=66)	37	20	7	2
Clinical (n=78)	49	17	5	7
Cytology (n)				
Malignant	59	25		
Highly suspicious	4	1		
Atypia	9	3		
Benign	13	7	12	9
Inadequate	1	1		
Total	86	37	12	9

Table 7 Operating characteristics of EUS-FNA for pancreatic lesions

n=144	Sensitivity* %	Specificity %	Predictive value		Accuracy* %
			Positive %	Negative* %	
Size ≥ 30 mm (n=98)	73 (84)	100	100	34 (46)	77 (86)
Size <30 mm (n=46)	70 (78)	100	100	45 (53)	76 (83)

*Figure in brackets: value derived if atypia considered diagnostic for malignancy.

stomach, one hepatoma). A primary diagnosis of malignancy of lymph nodes in 34 patients (30 NSCLC, two pancreatic cancer, two lymphoma) was subsequently accorded by EUS-FNA. Table 5 shows the operating characteristics of EUS-FNA compared with subjective endosonographic assessment and size criteria alone. In comparison with nodes less than 10 mm in the longest axis (n=17), aspiration cytology of nodes 10 mm or larger (n=143) resulted in greater sensitivity (50% versus 88%, $p=0.007$) and accuracy (67% versus 91%, $p=0.01$).

Coeliac nodes were sampled from 27 patients with confirmed malignancy (19 oesophageal, five pancreas, one gastric, one lung, one lymphoma). As compared with other nodes cytopuncture of coeliac nodes resulted in greater diagnostic accuracy (96% versus 87%, $p=0.31$) and sensitivity (96% versus 82%, $p=0.08$). Fifty five per cent (14/27) of the sampled coeliac nodes were not identified by computed tomography (CT) and three nodes with positive cytology were less than 10 mm in longest dimension (range 5–9 mm).

For 82 patients with NSCLC, 60 were found to have posterior mediastinal nodal disease on follow up. EUS-FNA cytology for this subgroup was interpreted as malignant in 52 and benign in eight. There were no false positives, resulting in diagnostic accuracy of 90% with sensitivity of 87% and specificity of 100% (fig 1).

Sarcoidosis was diagnosed in five men (mean age 46 (8) years, range 26–75) after aspiration of granulomatous material from bulky posterior mediastinal nodes. All patients had a clinical response to steroids.

PANCREATIC LESIONS

Table 6 shows cytology results obtained for 144 pancreatic lesions (113 head, 17 body, 11 tail, three ampulla). There was no significant difference in the mean size of malignant and benign lesions (longest axis: 35 (1.2) mm versus 32 (2.2) mm, $p=0.37$). The operating characteristics for all pancreatic lesions were as

Figure 2 (A) A heterogeneous hypoechoic mass is identified in the head of pancreas and is obstructing both the common bile duct (CBD) and main pancreatic duct (PD). The mass can also be seen to invade the portal vein (PV). (B) Using a linear scanning echoendoscope, the echogenic fine needle tip is directed into the pancreatic mass. Aspiration cytology confirmed adenocarcinoma.

follows: sensitivity 72%, specificity 100%, positive predictive value 100%, negative predictive value 38%, and diagnostic accuracy 76%. If atypical cytology was considered diagnostic for malignancy, the operating characteristics changed as follows: sensitivity 82%, specificity 100%, positive predictive value 100%, negative predictive value 51%, and diagnostic accuracy 85%. When stratified by size there was no significant difference in the operating characteristics for lesions 30 mm or larger (n=98) compared with those less than 30 mm (n=46) in longest axis (see tables 6 and 7). A primary diagnosis of malignancy was achieved by EUS-FNA in 69% of patients (77/111) that had no prior (n=70) or previously inconclusive brush/biopsy (n=41) (fig 2).

Twenty cystic lesions were sampled. All 10 lesions with endosonographic features of simple pancreatic pseudocysts (five head, five body) were confirmed as such by surgery (n=4) or clinical follow up (mean, 19 (4.3) months, range 6–31). Aspirated cystic fluid (volume range 1–65 ml) returned benign cytology in all cases. Ten complex cystic masses (seven tail, three head) had irregular, thickened walls and/or internal echogenic septae with solid components. Final diagnoses of these lesions included neuroendocrine tumours (n=4), cystadenocarcinoma (n=5), and cystadenoma

($n=1$), with EUS-FNA providing correct diagnoses in 80% (8/10). In the seven neuroendocrine tumours (two Zollinger-Ellison syndrome, five masses on CT), EUS-FNA cytology identified chromogranin staining clusters of abnormal round cells in four lesions, malignant cells in one, and benign glandular cells in the remaining two.

EXTRAINTESTINAL MASS LESIONS AND INTRAMURAL TUMOURS

Table 3 shows the operating characteristics of EUS-FNA for 15 patients with extraintestinal mass lesions (10 perirectal, three mediastinal, two intra-abdominal). The mediastinal and intra-abdominal masses (teratoma, thymoma, recurrent oesophageal cancer, metastases) were all malignant, with EUS-FNA identifying malignant cells in only 2/5 lesions. In 10 patients with perirectal masses, eight were proved to be malignant (two ovarian, two cervical, two colorectal, one prostate, one lymphoma; six post-resection recurrences) and two were pelvic abscesses. Prior CT guided biopsy provided correct diagnosis in only 1/4 patients with recurrent disease. EUS-FNA cytology of the eight malignant lesions was interpreted as malignant in seven and benign in one. There were no false positives. Thus, EUS-FNA of perirectal masses provided a diagnostic accuracy of 90%, sensitivity of 88%, and specificity of 100%.

Eight intramural tumours arising from the oesophagus ($n=2$), stomach ($n=5$), and colon ($n=1$) were sampled. Final diagnoses were confirmed by surgery ($n=3$) or clinical follow up ($n=5$). Of the five stromal tumours, insufficient material was obtained in three cases of leiomyoma, representative smooth muscle cells were identified in one other leiomyoma, and the single case of leiomyosarcoma was not identified by cytology. Of the remaining lesions, EUS-FNA provided positive cytology in two cases (oesophageal granular cell tumour, ovarian metastasis to rectal wall) but was falsely negative for gastric linitis plastica.

COMPLICATIONS

Only one patient (0.3%) in this study population experienced a complication following EUS-FNA. A 63 year old woman developed streptococcal sepsis with high fever and abdominal pain 48 hours following aspiration of a cystic mass in the tail of pancreas. CT scan of the abdomen did not reveal an intra-abdominal abscess and the patient had an uneventful recovery after antibiotic treatment and subsequent resection of a pancreatic cystadenoma.

Discussion

This large single centre experience confirms that EUS-FNA is an accurate modality for the diagnosis of nodal metastases, pancreatic tumours, and perirectal malignancy. EUS is superior to other imaging modalities such as CT in lymph node staging of gastrointestinal and pulmonary malignancies.³⁻⁶⁻⁹ However, size and sonographic criteria cannot reliably differentiate malignant from reactive nodes and the

problem of limited specificity remains. It is therefore important to obtain histological confirmation.

The majority of sampled nodes in our study population were from the mediastinum and coeliac axis region. We acknowledge that it is difficult to be completely certain as to the final diagnoses of lymph nodes, as comparative surgical pathology was available for only 31 patients. However, false positive cytology results are rare in the hands of experienced operators and where both malignant and benign nodes occur in the same patient, as is often the case in the mediastinum, false negative cytology results as determined by serial imaging could indeed be true negatives. Generally though, such errors are uncommon with careful evaluation and follow up. Within these limitations we found that, compared with size or sonographic criteria alone, EUS-FNA of lymph nodes resulted in superior specificity and accuracy for the detection of metastatic disease without compromising sensitivity.

Mistakes in diagnoses still occur with false negative aspirates, particularly in the sampling of small nodes. This is reflected by the lower sensitivity for nodes less than 10 mm compared with nodes 10 mm or larger (50% versus 88%, $p=0.007$). This is probably due to the inherent difficulty in identifying microscopic metastatic foci by cytopuncture in contrast to larger nodes that have been replaced totally or substantially by cancer. Nonetheless positive results were obtained for nodes as small as 5 mm in the longest axis.

The identification of coeliac nodal metastases usually precludes curative surgery or selects them as candidates for neoadjuvant protocols. However, CT has limited sensitivity in the detection of coeliac nodal disease, as reflected in our group in which more than 50% of sampled nodes were not identified by staging CT. In contrast, EUS-FNA proved highly efficient for the diagnosis of coeliac nodal metastases, resulting in "upstaging" and subsequent change of therapeutic strategies for these patients. From data presented in table 5, it could be inferred that the detection of coeliac nodes by sonography alone would be adequate for diagnosis, as sonographic criteria were 96% accurate with 100% sensitivity. However, such criteria for identifying nodal metastases are not universally accepted and are operator dependent, producing variable study results.⁴⁻¹⁰⁻¹² A positive cytological diagnosis provides a greater degree of diagnostic certainty and is often necessary for enrolment into treatment protocols.

The detection of mediastinal nodal metastases in NSCLC is also crucial in determining treatment strategies and prognosis.¹³ Posterior mediastinal nodes are readily accessible by EUS-FNA, with reported accuracy rates of 89–96% for the preoperative nodal staging of NSCLC.⁴⁻¹⁴ In our group, EUS-FNA of mediastinal nodes in 82 patients with NSCLC resulted in diagnostic accuracy of 90%, with 87% sensitivity and 100% specificity. These results suggest the potential to

avoid more invasive staging procedures such as mediastinoscopy or thoracoscopy with substantial cost savings and little compromise in accuracy.^{4 15}

EUS has proved to be superior in the detection and staging of pancreatic carcinoma compared with imaging modalities such as ultrasound and CT, but cannot reliably differentiate malignant tumours from focal pancreatitis.^{9 16 17} The results for pancreatic lesions in our study confirm the enhanced specificity provided by FNA and compare favourably with other series.^{1-3 5} Although other investigators report less accurate results for smaller masses,¹⁸ we obtained equivalent operating characteristics for both small (less than 3 cm in longest axis) and large lesions. Problems still arose with false negative cytology and relatively low negative predictive value, as pancreatic tumours are frequently indurated, accompanied by inflammation, and difficult to penetrate with a conventional needle system. We would thus concur with other commentators that patients with negative EUS-FNA cytology but high clinical suspicion of resectable pancreatic malignancy should still be considered for surgery.⁵

As a single modality then, EUS-FNA is best able to characterise pancreatic tumours, obtain tissue diagnosis, and provide accurate locoregional staging that enhances diagnostic certainty and helps identify appropriate patients for resection or palliation. Outcome studies are awaited that assess the clinical and economic impact of EUS-FNA of the pancreas compared with other emerging staging modalities.

Despite small numbers aspiration of perirectal masses also proved accurate for the diagnosis of malignancy. Compared with CT guided biopsy, EUS-FNA was better able to obtain neoplastic tissue (25% versus 88%). As rectal EUS does not usually require conscious sedation or the administration of contrast agents, EUS-FNA can be considered as an adjunctive modality to CT for the diagnosis of pelvic malignancy or suspected recurrence.

We found that EUS-FNA did not prove as useful for the evaluation of intramural tumours as for other lesions. In 3/4 patients with confirmed leiomyoma, sufficient cytological material was not obtained. Despite suspicious endosonographic and clinical features, both leiomyosarcoma and gastric linitis plastica were not correctly diagnosed. This limited series reflects the experience of other groups in that, while endosonography can categorise intramural tumours, it proved difficult to obtain adequate cellular material by EUS-FNA and to distinguish benign from malignant stromal tumours.^{1 2} In light of such results we do not routinely perform EUS guided aspiration cytology of stromal tumours. If tissue biopsies are considered necessary, alternatives such as guillotine biopsy¹⁹ or endoscopic mucosal resection should be considered.

For the whole series, a primary diagnosis of malignancy was obtained in 113 patients. Similarly, 57% of patients (29/51) with malignancy and previously inconclusive biopsies of

targeted lesions had the correct diagnosis achieved by EUS-FNA. Sarcoidosis or lymphoma was also identified in patients with mediastinal lymphadenopathy, as has been described in other series.^{1 2 20} These results would suggest that EUS-FNA can be considered as a first line technique for obtaining tissue diagnoses, particularly in the evaluation of extraintestinal and pancreatic masses and unexplained lymphadenopathy.

EUS-FNA using the linear scanner has proved to be remarkably safe in experienced hands, with reported complication rates up to 2.5%.^{2 5 21 22} In the current study only one complication occurred (0.3%). Due to a higher incidence of complications,^{2 23} we recommend pre-emptive antibiotics before puncture of cystic lesions and now generally avoid aspiration of simple pancreatic pseudocysts. As most reported complications of EUS-FNA have occurred with the radial instrument,³ our safety profile lends weight to the recommendation that a linear echoendoscope be preferentially used for aspiration biopsies.

Although there are no specific guidelines, we recommend the presence of an experienced cytopathologist at the time of tissue sampling. Although up to nine passes were necessary for some lesions, immediate verification of sample adequacy is likely to have contributed to the very low number of insufficient specimens in our series. Conversely, an attending cytopathologist can minimise the number of passes required to make a diagnosis, save time, and likely be safer for the patient.²³⁻²⁵

In conclusion, EUS-FNA using the linear echoendoscope has proved to be safe and can readily obtain tissue specimens adequate for cytopathological diagnoses. The technique is a sensitive modality for the detection of mediastinal and coeliac nodal metastases, with improved specificity and accuracy as compared with sonographic criteria and size alone. As a single stage procedure it can accurately diagnose pancreatic cancer in addition to providing precise staging information. These operating characteristics have the ability to influence patient management and future studies are awaited that address the impact of EUS-FNA in clinical decision making and cost effectiveness.

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