Type of the Paper (Research article)

The Superiority of Endoscopic Ultrasound over CT in the Diagnosis of Pancreatic Focal Lesions

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Received: 14 November, 2024 Reviewed: 12 February, 2025
Accepted: 25 June, 2025 Published online: 20 September 2025

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Abstract:

Introduction: Accurate differentiation of focal pancreatic lesions (PFLs) is critical for effective management by healthcare professionals, including surgeons, radiologists, endoscopists, and oncologists. While computed tomography (CT) remains the most commonly employed diagnostic tool for PFLs, no single imaging modality is universally optimal.

Aim of the study: This study aimed to evaluate the role of endoscopic ultrasonography (EUS) as an adjunct to CT in the diagnosis, staging, and potential intervention for PFLs.

Subjects and Methods: This study, conducted at the National Liver Institute and Ahmed Maher Teaching Hospital, included fifty patients with PFLs. All patients underwent CT and EUS ± fine-needle aspiration (FNA).

Results: EUS demonstrated superior diagnostic performance for PFLs compared to CT. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of EUS detecting pancreatic lesions were 95.2%, 100%, 100%, 95.5%, and 97.6%, respectively. In contrast, CT showed sensitivity, specificity, PPV, NPV, and overall accuracy of 61.9%, 82.8%, 78.2%, 68.5%, and 72.3%, respectively.

Conclusion: EUS is highly effective in detecting PFLs, particularly in cases where CT results are inconclusive. It facilitates early diagnosis and provides a precise characterization of tumor pathology through EUS-FNA, making it a valuable initial diagnostic modality for PFLs.

Keywords: Endoscopic ultrasonography (EUS); computed tomography (CT); focal pancreatic lesions (PFLs).

1. Introduction

In 2020, the American Society of Pancreatic Cancer (PC) reported that PC ranks as the 10th most common cancer diagnosed in men and the 9th in women [1], with global incidence rates on the rise [2]. The prognosis for PC remains extremely poor, making it the fourth leading cause of cancer-related mortality in the United States. The one-year survival rate is approximately 24%, while the five-year survival rate is only 9% [3].

Early detection of PC, particularly when lesions are smaller than 10 mm, can significantly improve outcomes, with the five-year survival rate reaching up to 80.4%, and as high as 85.8% for stage 0 cases [4,5]. Consequently, precise and rigorous diagnostic approaches are vital to enhance patient prognosis and avoid radical interventions for benign lesions.

PC is clinically suspected in individuals presenting with abnormal pancreatic findings on ultrasound or with unexplained biliary strictures. Preoperative diagnostic strategies frequently rely on CT imaging to assess these cases. However, CT interpretation can become challenging in certain scenarios, such as space-occupying pancreatitis or unclear pancreatic head enlargements without definitive evidence of malignancy [5].

CT imaging has limitations, especially in detecting lymph node metastases due to their small size, as well as in distinguishing tiny liver metastases (<1 cm) from cysts [6]. Most solid pancreatic focal lesions (PFLs) are hypovascular, appearing as low-attenuation areas on contrast-enhanced CT. Furthermore, pancreatic adenocarcinomas often present as iso-attenuated images, complicating their identification on CT scans [7].

Additional indicators, such as dilated pancreatic or common bile ducts, may suggest a compressive mass effect, as seen in neuroendocrine tumors. Localized pancreatic lesions can sometimes be identified during routine imaging as shadowing areas [8,9].

Studies have demonstrated that endoscopic ultrasound (EUS) provides exceptionally high-resolution imaging of

PFLs, allowing for more accurate diagnosis and staging [10-12]. However, distinguishing advanced focal chronic pancreatitis from pancreatic malignancies using EUS B-scan imaging remains challenging. The diagnostic accuracy of EUS in differentiating benign from malignant PFLs is often no higher than 75% in many studies [13–19], largely because the sonographic features of chronic pancreatitis can mimic those of malignancies. EUS-guided fine-needle aspiration (EUS-FNA) or biopsy has proven helpful in many cases, though its success depends on the operator, lesion characteristics, and pathological evaluation.

Benign PFLs include serous pancreatic cystadenomas, acinar cell cystadenomas, papillary cysts, lymphoepithelial cysts, and simple cysts. However, some PFLs have malignant potential or are outright malignant, such as ductal adenocarcinoma, acinar cell carcinoma, cystadenocarcinoma, pancreatoblastoma, solid pseudopapillary neoplasm, and neuroendocrine tumors [20,21].

While treatments such as surgery, chemotherapy, and radiation aim to extend survival, a cure is rare. Surgical removal remains the only definitive curative option [22].

Despite advancements in magnetic resonance imaging (MRI), particularly MR cholangiopancreatography (MRCP), its diagnostic efficacy is comparable to that of CT [23,24].

This study aimed to assess the additional diagnostic value of EUS compared to CT with a pancreatic protocol in evaluating focal pancreatic lesions, focusing on diagnosis, staging, and intervention options.

2. Subjects & Methods

2.1. *Subjects*

This prospective study included patients who visited the endoscopy units at the National Liver Institute and Ahmed Maher Teaching Hospital between December 2021 and May 2022. Among 104 evaluated patients, 50 met the inclusion criteria and agreed to participate in the study.

Inclusion Criteria

- Age >18 years.
- Presence of biliary strictures detected via ERCP or MRCP.
- Presence of focal pancreatic lesions identified on CT.

Exclusion Criteria

- Prior chemotherapy or surgery before the procedure.
- More than 30 days have elapsed since CT imaging.
- Uncontrolled coagulopathy.
- Severe comorbid conditions (e.g., end-organ failure or terminal malignancies).
- Patients deemed unfit for anesthesia.

2.2. *Methods*

All patients underwent demographic data collection, which included age, gender, geographic distribution, occupation, smoking habits, and alcohol consumption. A detailed medical history, including prior illnesses and medication use, was obtained.

Clinical Examination

Each patient underwent a general physical examination, including measurements of:

- Blood pressure
- Temperature
- Pulse rate
- Respiratory rate
- Additionally, general and abdominal examinations were performed on all patients.

Laboratory Investigations

Laboratory tests conducted for all participants included:

- Complete blood count (CBC)
- Liver function tests
- Kidney function tests
- Tumor markers: carcinoembryonic antigen (CEA) and carbohydrate antigen 19.9 (CA19.9)

Imaging Studies

All patients underwent a pancreatic protocol CT scan, with the images reviewed by an experienced radiologist. Nonionic contrast (Ultravist) was administered intravenously at a rate of 4–5 mL per second, with a 1–2 mL per kilogram of body weight. Multiphasic CT imaging allowed for the detailed assessment of the pancreas using thin slice thicknesses of 1 mm or less, achieved during a single breath-hold. Based on CT findings, patients were categorized as positive, negative, or indeterminate for pancreatic mass detection.

Endoscopic Ultrasonography (EUS)

EUS examinations were performed using a linear array echoendoscope

(Fuji2U047K030) connected to a Hitachi Avius ultrasound machine. Procedures were conducted under general anesthesia, with patients positioned in the left lateral decubitus position.

2.3. *Statistical Analysis*

Data were collected and analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 20 (SPSS Inc., Chicago, IL). Statistical methods were applied to evaluate the findings systematically.

3. Results

This prospective study involved 50 patients with pancreatic focal lesions who attended the endoscopy units at the National Liver Institute and Ahmed Maher Teaching Hospital.

The average age of the patients examined was 55.28±9.94 years and ranged from 34 to 82 years. The ≥60 years age group was the most commonly presented (42%), followed by the 50–59 years age group (32%), then the 40–49 years (20%), and the <40 years (6%). There were 29 males (58%) and 21 females (42%), with the male-to-female ratio being 1.38:1. Seven (14%) patients had positive HCV Abs. One patient had positive HBV sAg.

Regarding symptoms, 33 (66%) had jaundice, 21 (42%) had weight loss, and 33 (66%) had epigastric pain. As for clinical examination, 5 (10%) had hepatomegaly, 3 (6%) had splenomegaly, 33 (66%) had jaundice, and 30 (60%) had epigastric tenderness.

The mean hemoglobin level was 11.38±1.75 g/dL. The mean platelet count was 249.74±116.31×10^9/10^9/L. In addition, the mean leukocyte counts were 8.66±6.62 × 10^9/L. The mean serum urea was 28.94±12.26 mg/dL, while the mean serum creatinine was 1±0.87 mg/dL. The mean BUN value was 14.18±5.85 mg/dL.

The mean AST and ALT values were 61.42±43.84 U/L and 74.18±86.18 U/L, respectively. Mean direct bilirubin and total bilirubin were 3.26±3.80 mg/dL and 5.15±5.50 mg/dL, respectively. The mean albumin level was 3.49±0.68 g/dL. The

mean serum INR was 1.12±0.13, while the mean PC was 87.30±9.77.

The mean serum CEA was 30.03±35.22 ng/ml while the mean serum CA19-9 level was 1±0.87 U/ml (**Table 1**).

Table 1: Studied patients' characteristics.

Parameters			**Frequency (N=50)**
Gender	Male		29 (58%)
	Female		21 (42%)
Age (years)	Mean± SD		55.28± 9.94
	Median (Min-Max)		56 (34-82)
Age groups	<40 years		3 (6%)
	40-49 years		10 (20%)
	50- 59 years		16 (32%)
	≥ 60 years		21 (42%)
Clinical characteristics	HCV Ab.	Negative	43 (86%)
		Positive	7 (14%)
	HBV S. Ag	Negative	49 (98%)
		Positive	1 (2%)
	Hepatomegaly	No	45 (90%)
		Yes	5 (10%)
	Splenomegaly	No	47 (94%)
		Yes	3 (6%)
	Jaundice	No	17 (34%)
		Yes	33 (66%)
	Jaundice	No	17 (34%)
		Yes	33 (66%)
	Weight Loss	No	29 (58%)
		Yes	21 (42%)
	Epigastric pain	No	17 (34%)
		Yes	33 (66%)
	Epigastric tenderness	No	20 (40%)
		Yes	30 (60%)
Laboratory findings	Hemoglobin (g/ dL)	11.38±1.75	11.8 (7.8-15.6)
	WBCs (10^9/L)	8.66±6.62	7.75 (2.9-51)
	Platelet count (10^9/L)	249.74±116.31	234.5 (109-807)
	Serum urea (mg/dl)	28.94±12.26	26 (5-80)
	Serum creatinine (mg/dl)	1± 0.87	0.9 (0.4-6.7)
	BUN (mg/dL)	14.18±5.85	12 (7-42)
	ALT (U/L)	74.18±86.18	42.5 (9-487)

AST (U/L)	61.42±43.84	45 (10-211)
Direct bilirubin (mg/dl)	3.26±3.8	1.9 (0.1-16)
Total bilirubin (mg/dl)	5.15±5.5	3.7 (0.25-23)
Albumin (g/dl)	3.49±0.68	3.6 (1.8-4.7)
INR	1.12±0.13	1.1 (0.9-1.4)
PC	87.3±9.77	90 (52-105)
CEA (ng/ml)	30.03±35.22	17.45 (0.4-150)
CA19-9 (U/ml)	503.35±932.88	120 (2.1-3528)

The most common location of the mass was the pancreatic head, observed in 31 (62%), followed by the pancreatic body in 7 (14%). Other locations included the body and tail, head and body, and the uncinate process, each found in 3 (6%). The majority of masses (76%) were solid, while 7 (14%) had cystic masses, and 4 (8%) had both solid and cystic characteristics. The average mass size was (3.34×3.36) ± (1.6×1.4). Pancreatic duct dilation was noted in 29 (58%). Superior mesenteric artery invasion occurred in 8 (16%), while superior mesenteric vein invasion was seen in 14 (28%). Celiac artery invasion affected 3 (6%), and portal vein invasion was observed in 9 (18%) (**Table 2**).

Table 2: Mass characteristics detected by EUS in the studied patients.

Parameters		**Frequency (N=50)**
Mass site	No mass	1 (2%)
	Ampulla	1 (2%)
	Body	7 (14%)
	Body and tail	3 (6%)
	Head	31 (62%)
	Head and body	3 (6%)
	Neck	1 (2%)
	Uncinate process	3 (6%)
Mass type	No mass	1 (2%)
	Cystic	7 (14%)
	Solid	38 (76%)
	Solid and Cystic	4 (8%)
Mass size	Mean± SD	(3.34*3.36) ± (1.6*1.4)
	Median	(3.0* 3.0)
	Range	(1.0*1.5) – (10.0*8.8)
Pancreatic duct	Normal	21 (42%)
	Dilated	29 (58%)

SMA	No	42 (84%)
	Yes	8 (16%)
SMV	No	36 (72%)
	Yes	14 (28%)
Celiac artery	No	47 (94%)
	Yes	3 (6%)
Portal vein	No	41 (82%)
	Yes	9 (18%)
Distant lymph nodes	No	46 (92%)
	Yes	4 (8%)
Regional lymph nodes	No	21 (42%)
	Yes	29 (58%)
Left suprarenal	No	50 (100%)
	Yes	0 (0%)
Left hepatic lobe	No	50 (100%)
	Yes	0 (0%)
Ascites	No	43 (86%)
	Yes	7 (14%)
EUS- FNA	No	5 (10%)
	Yes	45 (90%)

The most common mass was the pancreatic head (found in 24 (48%) patients). Most masses found (60%) were solid, and 6 (12%) were cystic and soft, in 1 (2%) patient. The mean mass size was (3.34×3.36) ± (1.6×1.4). The pancreatic duct was dilated in 16 (32%) patients. CT detected superior mesenteric artery invasion in 3 (6%) patients and superior mesenteric vein invasion was detected in 7 (14%) patients. No invasion of the celiac artery and portal vein was detected. Regarding metastasis, distant lymph nodes were affected in 9 (18%) patients, regional lymph nodes in 18 (36%) patients, and the left lobe in 1 (2%) patients. No metastasis in the left supra-kidney was detected on CT. Ascites were detected by CT in 6 (12%) patients (**Table 3**).

Table 3: Mass characteristics detected by CT in the studied patients.

Parameters		**Frequency (N=50)**
Mass site	No lesion	13 (26%)

	Ampulla	1 (2%)
	Body	2 (4%)
	Body and tail	1 (2%)
	Head	24 (48%)
	Head and body	1 (2%)
	Head and neck	1 (2%)
	Head and uncinate process	1 (2%)
	Neck	1 (2%)
	Neck and body	2 (4%)
	Tail	1 (2%)
	Uncinate process	2 (4%)
Mass type	No lesion	13 (26%)
	Cystic	6 (12%)
	Solid	30 (60%)
	Soft	1 (2%)
Mass size	Mean± SD	(3.34*3.36) ± (1.6*1.4)
	Median	(3.0* 3.0)
	Range	(1.0*1.5) – (10.0*8.8)
Pancreatic duct	Normal	14 (28%)
	Not mentioned	20 (40%)
	Dilated	16 (32%)
SMA	No	24 (48%)
	Not mentioned	23 (46%)
	Yes	3 (6%)
SMV	No	20 (40%)
	Not mentioned	23 (46%)
	Yes	7 (14%)
Celiac artery	No	27 (54%)
	Not mentioned	23 (46%)
Portal vein	No	30 (60%)
	Not mentioned	20 (40%)
Distant lymph nodes	No	41 (82%)
	Yes	9 (18%)
Regional lymph nodes	No	32 (64%)
	Yes	18 (36%)
Left suprarenal	No	50 (100%)
	Yes	0 (0%)
Left hepatic lobe	No	48 (98%)
	Yes	1 (2%)
Ascites	No	44 (88%)
	Yes	6 (12%)

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of EUS for detecting pancreatic lesions were 95.2%, 100%, 100%, and 95.5%, respectively, with an overall accuracy of 97.6%. In comparison, CT demonstrated a sensitivity of 61.9%, specificity of 82.8%, PPV of 78.2%, NPV of 68.5%, and an overall accuracy of 72.3% (**Table 4**).

Table 4: Sensitivity, specificity, positive predictive and, negative predictive value and overall accuracy of EUS and CT in detecting pancreatic lesions

Parameters	EUS	CT
Sensitivity	95.2%	61.9%
Specificity	100%	82.8%
PPV	100.%	78.2%
NPV	95.5%	68.5%
Accuracy	97.6%	72.3%

4. Discussion

In this study, we found that malignant pancreatic focal lesions (PFLs) were more prevalent with increasing age, particularly in patients aged ≥60 years, and were more common in men than women, consistent with previous research [25–27]. The majority of patients presented with jaundice (66%), pain (42%), and weight loss (33%). Laboratory findings revealed elevated transaminases and serum bilirubin levels, with normal renal function tests in all but one case. These results aligned with earlier studies, except for one [26] reporting elevated mean serum urea, potentially due to dehydration in their patient cohort.

Tumor markers were significantly elevated in our patients, in agreement with other studies [26–28], reflecting their association with gastrointestinal tumors like PFLs. EUS identified the pancreatic head as the most common site of PFLs, followed by the pancreatic body, and was more accurate than CT in localizing lesions. The pancreatic head was the predominant mass site, observed in 24 patients (48%), consistent with prior studies [26–29]. While both imaging modalities demonstrated similar accuracy in assessing tumor size, EUS outperformed CT in detecting small tumors (<3 cm) [27].

EUS detected pancreatic duct dilation in 29 patients (58%), compared to only 16 patients (32%) identified by CT. Regarding metastases, EUS revealed distant lymph node involvement in 4 patients (8%), regional lymph node involvement in 29 (58%), and ascites in 7 (14%). In comparison, CT detected distant lymph node involvement in 9 patients (18%), regional lymph node involvement in 18 (36%), and ascites in 6 (12%).

Histopathological analysis identified pancreatic adenocarcinoma as the most common diagnosis, found in 36 patients (72%). This finding corroborates the results of El-Deeb et al. [27], who reported ductal adenocarcinoma in 63.6% of cases. EUS demonstrated exceptional diagnostic performance with sensitivity, specificity, PPV, NPV, and overall accuracy of 95.2%, 100%, 100%, 95.5%, and 97.6%, respectively. Furthermore, EUS surpassed CT in evaluating tumor size, vascular involvement, and lymph node metastases [29, 30].

Endosonographic biopsy proved effective in distinguishing benign from malignant PFLs and was performed in 90% of cases. However, factors such as lesion size, location, and proximity to major vessels, as well as chronic pancreatitis, influenced biopsy accuracy. Sensitivity was notably lower in patients with chronic pancreatitis [19, 36]. Advanced biopsy techniques, including true-cut needles and EUS elastography, are being investigated to enhance outcomes [37–42].

EUS was particularly effective for detecting small pancreatic tumors (≤2 cm), with a pooled sensitivity of approximately 95% [44]. With ongoing advancements in artificial intelligence, the diagnostic potential of EUS is expected to improve, positioning it as a leading modality for PFL diagnosis. However, in cases with distant metastases, CT remains superior [45].

This study underscores the superior diagnostic value of EUS over CT in the evaluation of pancreatic focal lesions, particularly in detecting small lesions and assessing locoregional involvement. By demonstrating its high sensitivity, specificity, and overall accuracy, our findings reinforce EUS as a pivotal tool in modern diagnostic pathways. Additionally, this study highlights the unique role of EUS

in complementing CT imaging, providing further insights into its application in challenging cases, such as those involving chronic pancreatitis or small lesions. These findings contribute to the growing body of evidence advocating for the expanded use of EUS in pancreatic lesion evaluation and pave the way for future research on cost-effectiveness and diagnostic optimization strategies.

This study has several limitations. First, the sample size was relatively small, which may limit the generalizability of the findings. A larger cohort would provide more robust statistical power and enhance the reliability of the results. Second, the study was conducted at only two centers, which might introduce selection bias or limit the diversity of patient populations. Third, the absence of a standardized diagnostic scoring system reduces the ability to directly compare results with other studies or clinical guidelines. Finally, cost analysis comparing the use of CT-first versus EUS-first approaches was not conducted, which could be valuable for informing clinical decision-making and healthcare policies. Future studies should address these limitations and explore additional aspects such as long-term outcomes and the integration of artificial intelligence in EUS diagnostics.

5. Conclusion

EUS is highly effective in detecting localized pancreatic lesions smaller than 3 cm in diameter, particularly when CT findings are inconclusive. By facilitating the early diagnosis of pancreatic cancer (PC), EUS plays a critical role in reducing morbidity and mortality. EUS-FNA offers precise tumor characterization with minimal complications, making it an essential tool for differential diagnosis. While both EUS and CT are valuable for detecting PC, EUS outperforms CT in identifying distant pancreatic metastases. Consequently, CT should primarily be reserved for patients requiring a metastatic workup.

Acknowledgement: The authors acknowledge the team of the endoscopy unit in the National Liver Institute.

Ethical approval and consent to participate: The study was approved by the Ethics Committee of Menoufia University. Detailed

information about the study was provided to all participants, who gave written informed consent before enrollment. Ethical guidelines were followed, adhering to the World Medical Association's Declaration of Helsinki.

Funding: The authors do not have any financial sources to disclose for this manuscript.

Conflicts of Interest: All authors declare they have no conflicts of interest.

AI declaration: Non-declared.

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