

Endoscopic ultrasound-guided fine needle biopsy analysis of pancreatic lesions at Rizgari Teaching Hospital in Erbil City

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Abstract

Background and objectives: Pancreatic cancer carries a poor prognosis because of delayed diagnosis; early detection and accurate staging are therefore essential for appropriate management. Endoscopic ultrasound-guided fine-needle biopsy (EUS-guided FNB) has demonstrated good diagnostic performance for the detection and differentiation of pancreatic lesions. This study aimed to analyze the usefulness of EUS-guided FNB for the evaluation of pancreatic lesions.

Methods: This prospective cohort study was conducted at the Hawler Gastroenterology and Hepatology Center of Rizgari Teaching Hospital, Erbil, Kurdistan Region, Iraq, from 1 May 2025 to 1 May 2026, on 142 patients with pancreatic lesions detected on imaging. Endoscopic ultrasound characteristics of the lesions and their final histopathological diagnoses were collected. Data were analyzed using SPSS version 27.0, and a P-value of ≤ 0.05 was considered statistically significant.

Results: The median age of the patients was 59 years and most were male (64.1%). Abdominal pain was the most common presentation (91.5%), followed by weight loss (66.9%). On endoscopic ultrasound, most lesions were located in the head of the gland (69.7%), had an irregular border (64.8%) and were hypoechoic (64.1%); a dilated pancreatic duct (≥ 5 mm) was observed in 52.8%. A histopathological diagnosis of pancreatic ductal adenocarcinoma was made in 83 (58.5%) of the lesions sampled by EUS-guided FNB.

Conclusion: EUS-guided FNB of pancreatic lesions contributed to the differentiation and initial histopathological diagnosis of various pancreatic pathologies. Several clinical characteristics and endoscopic ultrasound imaging features were significantly associated with the prevalence of pancreatic ductal adenocarcinoma.

Keywords: Endosonography, Image-Guided Biopsy, Pancreatic Neoplasms.

1. Introduction

Pancreatic cancer is a highly fatal disease with an overall 5-year survival rate below 10%.^{1,2} This poor prognosis is related to delayed initial diagnosis of pancreatic lesions because of the nonspecific clinical presentation of the disease and the late onset of symptoms at an advanced stage.³⁻⁵ Surgical resection can provide curative treatment when the tumor is diagnosed at an early stage; however, only a small proportion of patients are suitable for complete resection at the time of diagnosis.^{4,6} Therefore, early detection and accurate staging of pancreatic cancer are important for planning appropriate management and improving patient survival.^{3,6}

With the increased utilization of imaging modalities, the detection and incidence of both cystic and solid pancreatic lesions have been increasing.⁷ Pancreatic ductal adenocarcinoma (PDAC) is the most common primary malignant neoplasm of the pancreas, accounting for more than 90% of solid malignant tumors.^{8,9} However, several other solid pancreatic lesions, both benign and malignant, can mimic the imaging appearance of PDAC, including pancreatic neuroendocrine tumors, lymphoma, metastasis, inflammatory conditions and other rare tumors.^{9,10} Some cystic pancreatic lesions also carry a potential risk of malignant transformation, particularly intraductal papillary mucinous neoplasms (IPMN) and mucinous cystic neoplasms (MCN).^{7,11} High-quality imaging modalities are therefore essential for distinguishing PDAC from its mimics, for differentiating solid from cystic pancreatic lesions, and for planning adequate follow-up and management of cystic pancreatic lesions.^{7,10,11}

Different non-invasive imaging modalities, including transabdominal ultrasound (TAUS), computed tomography (CT) and magnetic resonance imaging (MRI), have been employed for the evaluation of pancreatic lesions.^{12,13} In addition, endoscopic ultrasound (EUS) is a minimally invasive imaging technique that has been widely used as a reliable tool in the detection and characterization of pancreatic lesions.^{4,14} Unlike other imaging modalities, EUS provides high

spatial resolution imaging with excellent anatomical assessment and has higher accuracy for detecting small pancreatic lesions (< 1 cm in diameter).^{12,14} However, EUS alone has limited specificity in differentiating pancreatic cancer from other pancreatic pathologies.^{4,12} Therefore, to establish an accurate diagnosis and guide treatment in patients with pancreatic lesions, EUS-guided tissue sampling with fine-needle aspiration (FNA) or fine-needle biopsy (FNB) is usually required.^{3,4}

EUS-guided FNA has been primarily used for the evaluation of pancreatic lesions, with diagnostic accuracy ranging from 80% to 95%.¹⁵ However, this technique has the limitation of providing only cytological specimens, which are of limited value for the differentiation of certain pancreatic pathologies.^{3,16} To overcome this, FNB has been developed and has shown greater diagnostic performance by providing adequate tissue samples while preserving tissue architecture. This allows complete histopathological analysis, which is necessary for distinguishing pancreatic cancer from cases of chronic pancreatitis associated with severe inflammation and fibrosis leading to obscure cellular changes. In addition, adequate tissue is obtained for immunohistochemistry, flow cytometry and molecular analysis, which are essential for the diagnosis of certain pancreatic conditions, including pancreatic neuroendocrine tumors and autoimmune pancreatitis.¹⁶⁻¹⁸

Various studies have reported the diagnostic accuracy of EUS-guided FNB in the differentiation of pancreatic lesions, with only a few studies conducted in our region.^{6,17,18} The aim of this study was to assess the utility of EUS-guided FNB for the histopathological diagnosis of pancreatic lesions at the Gastroenterology and Hepatology Center of Rizgari Teaching Hospital, and to identify the variables associated with pancreatic ductal adenocarcinoma.

2. Material and Methods

2.1. Study design, setting and period

This was a prospective cohort study conducted at the Hawler Gastroenterology and Hepatology Center of Rizgari Teaching Hospital in Erbil city, Kurdistan Region, Iraq, from 1 May 2025 to 1 May 2026.

2.2. Sample size and study population

The sample size was estimated using the Buderer formula for sensitivity. The calculation assumed an expected sensitivity of 90% based on prior studies, a 95% confidence level ($Z = 1.96$) and a margin of error of 5%. Based on these assumptions, the minimum required sample size was approximately 139 participants. Patients aged 18 years or older with radiological evidence of pancreatic lesions on transabdominal ultrasound, computed tomography or magnetic resonance imaging, and who required further assessment with EUS-guided tissue sampling, were included in the study. Patients with anemia, uncorrected coagulopathy or cardiorespiratory dysfunction were excluded, as were those who could not be followed up until the final diagnosis.

2.3. EUS-guided FNB technique and data collection

FNB was performed using a 22-gauge Franseen needle, with three passes in all lesions. Data were recorded on a prearranged data collection form that included the demographic and clinical data of the patients, presenting symptoms, EUS findings, histopathological findings of the lesions and the effect on patient management. The recorded data were entered into a Microsoft Excel spreadsheet.

2.4. Statistical analysis

Data were analyzed using SPSS version 27.0 (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA). Descriptive statistics were used, with the mean and standard deviation reported for normally distributed continuous variables, the median and interquartile range (IQR) for non-normally distributed continuous variables, and frequencies and percentages for categorical variables. Categorical variables were compared using the chi-square test, normally distributed continuous variables using the independent-samples t-test, and non-normally distributed continuous variables using the Mann-Whitney U test. A P-value ≤ 0.05 was considered statistically significant.

3. Results

The sample consisted of 142 participants. The median age was 59 (IQR: 50.0-70.0) years, with most patients falling into the age category of 50-59 years (28.2%). Most of these patients were male (64.1%). Diabetes mellitus (DM) was

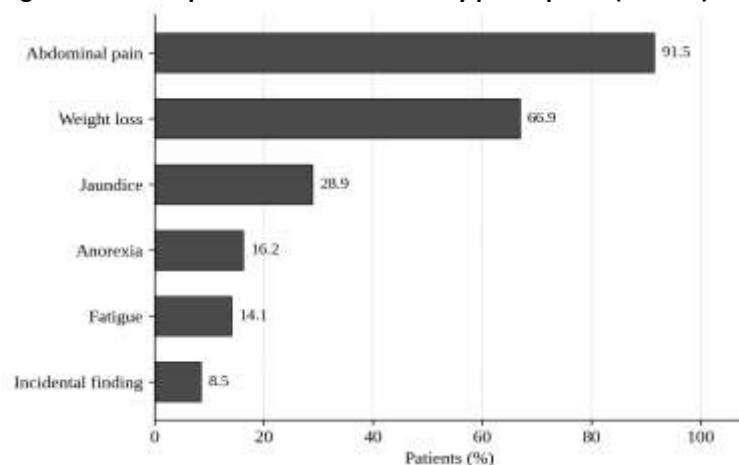
the most common comorbidity (51.4%). Ninety-two (64.8%) of the participants smoked and 4 (2.8%) patients drank alcohol. A positive family history was reported in 4.2% of patients. These findings are summarized in Table 1.

Table 1: Demographic and clinical characteristics of the study participants (n = 142).

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
< 40	18	12.7
40-49	15	10.6
50-59	40	28.2
60-69	28	19.7
≥ 70	41	28.9
Gender		
Male	91	64.1
Female	51	35.9
Comorbidities and risk factors		
Diabetes mellitus	73	51.4
Hypertension	29	20.4
Ischemic heart disease	4	2.8
Smoking	92	64.8
Alcohol drinking	4	2.8
Positive family history	6	4.2

Abdominal pain was the most common clinical presentation among these patients (91.5%), followed by weight loss (66.9%) and jaundice (28.9%). In 8.5% of patients, the pancreatic lesion was an incidental finding. This is shown in Fig. 1.

Figure 1: Clinical presentation of the study participants (n = 142).



EUS imaging showed that most of the pancreatic lesions were located in the head of the gland (69.7%), followed by the neck (27.5%), body (19.7%), and only 7.0% were located in the tail. The majority of the lesions showed an irregular border (64.8%), and a dilated pancreatic duct (≥ 5 mm) was detected in more than half of the lesions

(52.8%). Regarding echogenicity, the majority of the lesions were hypoechoic (64.1%), followed by mixed echogenicity (18.3%), hyperechoic (9.9%), and 7.7% were anechoic. These findings are shown in Table 2.

Table 2: Endoscopic ultrasound characteristics of the pancreatic lesions (n = 142).

Characteristic	Frequency (n)	Percentage (%)
Lesion site*		
Head	99	69.7
Neck	39	27.5
Body	28	19.7
Tail	10	7.0
Border regularity		
Regular	50	35.2
Irregular	92	64.8
Echogenicity		
Anechoic	11	7.7
Hypoechoic	91	64.1
Hyperechoic	14	9.9
Mixed echogenicity	26	18.3
Dilated pancreatic duct (≥ 5 mm)		
No	67	47.2
Yes	75	52.8

* Some of the pancreatic lesions involved more than one site; therefore, the total exceeds 142.

A histopathological diagnosis of PDAC was made in 83 (58.5%) of the patients, benign neoplasm in 4 (2.8%) patients, autoimmune pancreatitis in 10 (7.0%) patients and chronic pancreatitis in 6 (4.2%) patients. Less common pancreatic tumors, including pancreatic neuroendocrine tumor and solid pseudopapillary tumor, were observed in 10 (7.0%) and 4 (2.8%) of the patients, respectively. Cystic pancreatic lesions were detected in 4 (2.8%) patients. Other diagnoses included benign pancreatic tissue in 8 (5.6%) patients, necroinflammatory debris in 10 (7.0%) patients and inadequate tissue sample in 3 (2.1%) patients. These findings are shown in Table 3.

Table 3: Histopathological diagnosis of EUS-guided FNB of pancreatic lesions (n = 142).

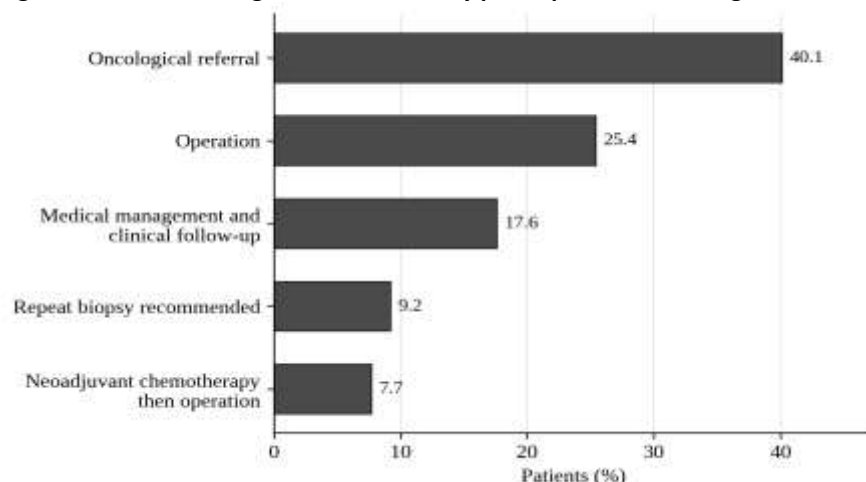
Histopathological diagnosis	Frequency (n)	Percentage (%)
Pancreatic ductal adenocarcinoma	83	58.5
Benign neoplasm	4	2.8
Benign pancreatic tissue	8	5.6
Pancreatic neuroendocrine tumor	10	7.0
Autoimmune pancreatitis	10	7.0
Necroinflammatory debris	10	7.0
Chronic pancreatitis	6	4.2
Intraductal papillary mucinous neoplasm	3	2.1
Solid pseudopapillary tumor	4	2.8
Mucinous cystic neoplasm	1	0.7
Inadequate tissue sample	3	2.1

Histopathological diagnosis	Frequency (n)	Percentage (%)
Total	142	100.0

EUS-guided FNB: endoscopic ultrasound-guided fine-needle biopsy.

Regarding the impact of EUS-guided FNB results on further management of the study participants, oncological referral was the most common management plan (40.1% of patients), followed by operation (25.4%). Medical management with clinical follow-up was recommended for 17.6% of patients and repeat biopsy for 9.2%, while 7.7% of the patients were recommended neoadjuvant chemotherapy followed by operation. This is shown in Fig. 2.

Figure 2: Further management of the study participants after EUS-guided FNB (n = 142).



Diabetes mellitus was significantly associated with the presence of PDAC on biopsy results, with 71.2% of the diabetic patients having PDAC compared with 44.9% of non-diabetic patients ($P = 0.001$). Regarding the social history of patients, smokers showed a significantly higher prevalence of PDAC (75.0%), whereas none of the alcohol drinkers did ($P < 0.001$). PDAC was more common among patients with a positive family history (83.3%) than among those with a negative family history; however, this finding was not significant ($P = 0.206$). According to EUS imaging features, lesions with an irregular border were significantly associated with PDAC (79.3%) compared with lesions with a regular border (20.0%) ($P < 0.001$). Echogenicity assessment on EUS was significantly associated with PDAC ($P < 0.001$): hypoechoic lesions showed the highest prevalence of PDAC (81.3%), whereas none of the anechoic lesions, 7.1% of the hyperechoic lesions and 30.8% of mixed echogenicity lesions were associated with PDAC. PDAC was significantly more prevalent among lesions with vascular invasion (88.0%) and lymph node involvement (88.6%) than among those without these features ($P < 0.001$). Lesions with a dilated pancreatic duct (≥ 5 mm) were significantly associated with PDAC (77.3%) compared with those without duct dilatation (37.3%) ($P < 0.001$). This is shown in Table 4.

Table 4. radiographic characteristics of the patients.

Characteristic	Pancreatic ductal adenocarcinoma		P-value
	No, n (%)	Yes, n (%)	
Diabetes mellitus			0.001
No	38 (55.1)	31 (44.9)	
Yes	21 (28.8)	52 (71.2)	
Social history			< 0.001
None	32 (69.6)	14 (30.4)	
Smoker	23 (25.0)	69 (75.0)	

Drinker	4 (100.0)	0 (0.0)	0.206
Family history			
No	58 (42.6)	78 (57.4)	
Yes	1 (16.7)	5 (83.3)	< 0.001
Irregular border			
No	40 (80.0)	10 (20.0)	
Yes	19 (20.7)	73 (79.3)	< 0.001
Echogenicity			
Anechoic	11 (100.0)	0 (0.0)	< 0.001
Hypoechoic	17 (18.7)	74 (81.3)	
Hyperechoic	13 (92.9)	1 (7.1)	
Mixed echogenicity	18 (69.2)	8 (30.8)	< 0.001
Vascular invasion			
No	50 (74.6)	17 (25.4)	< 0.001
Yes	9 (12.0)	66 (88.0)	
Lymph node involvement			
No	51 (70.8)	21 (29.2)	< 0.001
Yes	8 (11.4)	62 (88.6)	
Dilated pancreatic duct (≥ 5 mm)			
No	42 (62.7)	25 (37.3)	< 0.001
Yes	17 (22.7)	58 (77.3)	

Values are presented as n (%). P-values were calculated using the chi-square test; $P \leq 0.05$ was considered statistically significant.

Patients with PDAC were significantly older, with a median age of 65 years, compared with a median age of 52 years in those without PDAC ($P < 0.001$). The median lesion width, length and area were significantly greater in the patient subgroup with PDAC (30.0 mm, 39.0 mm and 12.2 cm², respectively) than in the subgroup without PDAC (23.0 mm, 25.0 mm and 6.0 cm², respectively) ($P < 0.001$). The median common bile duct diameter was significantly greater in patients with PDAC (7.0 mm) than in those without PDAC (6.0 mm) ($P < 0.001$). This is shown in Table 5.

Table 5: Comparison of median values between patients with and without pancreatic ductal adenocarcinoma.

Characteristic	Patient subgroup	Median (IQR)	P-value
Age (years)	Pancreatic ductal adenocarcinoma	65.0 (53.0-72.0)	< 0.001
	No pancreatic ductal adenocarcinoma	52.0 (40.0-59.0)	
Lesion width (mm)	Pancreatic ductal adenocarcinoma	30.0 (28.0-35.0)	< 0.001
	No pancreatic ductal adenocarcinoma	23.0 (20.0-30.0)	
Lesion length (mm)	Pancreatic ductal adenocarcinoma	39.0 (25.0-50.0)	< 0.001

Characteristic	Patient subgroup	Median (IQR)	P-value
Lesion area (cm ²)	No pancreatic ductal adenocarcinoma	25.0 (20.0-32.0)	< 0.001
	Pancreatic ductal adenocarcinoma	12.2 (6.0-15.7)	
	No pancreatic ductal adenocarcinoma	6.0 (4.0-8.2)	
	Pancreatic ductal adenocarcinoma	7.0 (6.0-10.0)	
Common bile duct diameter (mm)	No pancreatic ductal adenocarcinoma	6.0 (6.0-7.0)	< 0.001
	Pancreatic ductal adenocarcinoma	6.0 (6.0-7.0)	

IQR: interquartile range. P-values were calculated using the Mann-Whitney U test; $P \leq 0.05$ was considered statistically significant.

4. Discussion

Pancreatic lesions include a variety of cystic and solid lesions, which can be further classified as benign or malignant. Since the management and prognosis of patients with pancreatic lesions depend on early detection and differentiation between benign and malignant lesions, obtaining an accurate histopathological diagnosis is essential.^{18,19} The most common clinical presentation among our patients was abdominal pain, followed by weight loss and jaundice. This is consistent with previous studies reporting these symptoms as common clinical presentations, although the frequencies varied across studies.^{18,20} This may be explained by differences in the study population, with the inclusion of both benign and malignant pancreatic lesions in our study. On the other hand, this study showed that only a small proportion of pancreatic lesions were detected incidentally, which may indicate that many patients with pancreatic lesions seek medical attention only after developing symptoms. In this study, most of the pancreatic lesions were located in the head of the gland, in line with other studies reporting that lesions in the head were more common.^{20,21} This predominance may be explained by the anatomical distribution of pancreatic cancer, particularly PDAC, which most commonly arises in the head of the pancreas.^{21,22} This is further supported by the findings of the present study, in which PDAC was the most common histopathological diagnosis, accounting for 58.5% of the lesions.

In addition to PDAC, the initial histopathological examination of tissue samples obtained by EUS-guided FNB in this study identified several other pancreatic pathologies. These included less common malignant solid tumors, benign tumors, cystic tumors, inflammatory conditions such as autoimmune and chronic pancreatitis, and a variety of other diagnoses. These findings highlight the importance of EUS-guided FNB in the evaluation and differentiation of pancreatic lesions, which may have similar or overlapping clinical and radiological appearances, thereby guiding appropriate subsequent patient management and avoiding unnecessary operation or radiation therapy.^{18,23,24} Inadequate tissue samples and inconclusive results of necroinflammatory debris were reported in a small proportion of our cases, and this may have contributed to the recommendation of repeat biopsy as further management in 9.2% of the patients. Previous studies have demonstrated that repeat EUS-guided FNB can be helpful in reaching a definitive histopathological diagnosis in patients with initially inconclusive diagnostic results.^{25,26}

In the present study, the median age of patients with PDAC was greater, consistent with a previous study showing that the incidence of pancreatic cancer increases with age, with the median age of patients with pancreatic cancer in the United States reported to be 71 years.²⁷ The majority of patients with diabetes had PDAC, which is consistent with previous studies that have identified DM as an important risk factor associated with pancreatic cancer.^{20,22,28} However, this association between pancreatic cancer and DM has been shown to be complex and bidirectional, as long-standing DM may contribute to pancreatic cancer through mechanisms of hyperinsulinemia, insulin resistance and chronic inflammation, while the tumor itself may cause new-onset DM through its effect on pancreatic endocrine function.^{28,29}

Studies have shown smoking and alcohol consumption to be modifiable risk factors for pancreatic cancer.^{22,30} Likewise, our study showed that smokers had a significantly higher prevalence of PDAC, but, in contrast, none of the

alcohol drinkers had PDAC. This may be attributed to the very small number of drinkers in this study. A positive family history of pancreatic cancer has similarly been reported to be associated with an increased risk of developing pancreatic cancer, particularly among first-degree relatives.²² However, this association was not significant in our study, possibly because only six patients had a positive family history.

The EUS imaging features significantly associated with a higher prevalence of PDAC in this study included an irregular lesion border, hypoechoic echogenicity and, to a lesser extent, heterogeneous echogenicity, vascular invasion, lymph node involvement and pancreatic duct dilatation (≥ 5 mm). Furthermore, the median lesion width and length, as well as the common bile duct diameter, were significantly greater in PDAC lesions. An irregular lesion border and pancreatic duct dilatation have similarly been reported in other studies as the EUS features most strongly indicative of PDAC.^{31,32} The association between tumor size and the differentiation of pancreatic lesions has also been assessed in another study, which generally concluded that the mean size of malignant lesions was larger compared with benign ones.³³ Although hypoechoic echogenicity is significantly associated with PDAC, it is a common imaging feature among other solid pancreatic lesions, including pancreatic neuroendocrine tumors. However, these tumors usually present as homogeneous hypoechoic lesions compared with the heterogeneous echogenicity pattern observed in PDAC lesions.^{31,34} Therefore, while several clinical and EUS imaging features showed significant associations with PDAC in this study, these findings are not specific and should be interpreted together with the histopathological analysis.

4.1. Limitations of the study

This study had some limitations. It was conducted at a single gastroenterology center in Erbil city, which may limit the generalizability of the findings to other healthcare settings. It included a relatively small sample size with limited representation of certain clinical characteristics, which may have affected the statistical power of the analysis. The diagnostic performance of EUS-guided FNB could not be assessed because of the lack of a definitive reference diagnosis such as surgical biopsy results or outcomes from clinical follow-up. The FNB technique, needle type and number of needle passes used to obtain tissue samples were standardized across patients, and rapid on-site evaluation was not available, which limited evaluation of the influence of procedure-related factors on the diagnostic yield of FNB.

5. Conclusion

EUS-guided FNB of pancreatic lesions contributed to the differentiation and initial histopathological diagnosis of various pancreatic pathologies. PDAC was the most common diagnosis in this study, and several clinical characteristics and EUS imaging features were significantly associated with the prevalence of PDAC. However, these findings should be interpreted together with the histopathological analysis for a definitive diagnosis.

Author Contribution Statement

Conceptualization, A.A.S.; methodology, A.A.S.; software, A.A.S.; validation, A.S.I. and A.M.S.; formal analysis, A.A.S.; investigation, A.A.S., A.S.I. and A.M.S.; resources, A.A.S.; data curation, A.A.S.; writing—original draft preparation, A.A.S.; writing—review and editing, A.S.I. and A.M.S.; visualization, A.A.S.; supervision, A.S.I. and A.M.S.; project administration, A.A.S.; funding acquisition, A.A.S. All authors have read and agreed to the published version of the manuscript.

Ethical Statement

Ethical approval for this study was obtained from the Research Protocol Ethics Committee of the Kurdistan Higher Council of Medical Specialties (approval reference number: [INSERT APPROVAL NUMBER AND DATE]). Informed written consent was obtained from all participants prior to their enrollment in the study. The study was conducted in accordance with the Declaration of Helsinki.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author(s) did not use any generative AI or AI-assisted tools. The author(s) thoroughly reviewed, verified and edited the content as needed, and take full responsibility for the content of the publication.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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