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ORIGINAL RESEARCH

# Endoscopic Ultrasound-Guided Fine Needle Biopsy with Stylet and Suction Versus No Stylet No Suction for the Diagnosis of Pancreatic and Non-Pancreatic Lesions

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**Background:** Endoscopic ultrasound (EUS)-guided tissue acquisition is the procedure of choice to obtain samples to diagnose pancreatic and non-pancreatic lesions. Previous randomized trials demonstrated that using stylets during the EUS-fine needle biopsy (FNB) technique does not improve the diagnostic yield. However, little data exists regarding the role of stylet and suction in the core biopsy needle during EUS-guided tissue acquisition.

**Aim of the Study:** This study aims to assess the efficacy and diagnostic yield of samples collected by EUS-FNB with stylet and suction versus no stylet, no suction techniques.

**Patients and Methods:** This prospective study included 167 patients referred to the Gastroenterology Division, Internal Medicine Department, Kasr Al-Aini Hospitals for EUS-guided biopsy from pancreatic or non-pancreatic lesions from May 2021 to January 2024. Each lesion was sampled twice using an EUS-FNB 22-gauge Franseen-tip needle (Acquire; Boston Scientific, USA); one sample was collected with stylet and suction, while the other with no stylet no suction technique. Subsequently, slides were evaluated for cellularity, tissue integrity, degree of blood contamination, and diagnostic ability.

**Results:** A total of 167 patients fulfilled the inclusion criteria, 78 females and 89 males, with a mean age of 61 years. Most lesions were pancreatic (83.2%, n = 139), while the remaining (16.8%, n = 28) were non-pancreatic. No significant differences were observed between stylet and suction versus no stylet, no suction techniques. The diagnostic performance, including sensitivity, specificity, and overall accuracy, was identical (100%) for both methods when evaluating alcohol-fixed smears in conjunction with formalin-preserved tissues collected through FNB.

**Conclusion:** EUS-FNB tissue acquisition with and without stylet and suction provides comparable diagnostic yield and tissue quality for pancreatic and non-pancreatic lesions. The decision to use a stylet and suction should be individualized based on the clinical context and operator experience.

**Keywords:** EUS-FNB, pancreatic lesions, non-pancreatic lesions, stylet, suction, diagnostic yield

## Introduction

Endoscopic ultrasound-guided tissue acquisition (EUS-TA) is an integral procedure for pathological evaluation, diagnosis, and staging of gastrointestinal (GI) and certain non-GI malignancies.[1] Its diagnostic accuracy is reported in 71–98% for pancreatic masses, 85–90% for lymphadenopathy, and 67–92% for gastrointestinal subepithelial tumors.[2]

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Such variations may refer to several variables that affect diagnostic yield, accuracy, and efficacy of the technique. They include the site of lesions, the skill and experience of both the endosonographer and cytopathologist, technical difficulty associated with the procedure, the size and type of needle selected for tissue acquisition, number of needle passes, and the availability of rapid on-site evaluation (ROSE).[3]

Previously published reports emphasized the need for stylet during the EUS-FNA technique, but this remains controversial. They all compared the performance of FNA with and without stylet and reported that the use of stylet did not demonstrate a statistically significant difference in the sample quality and diagnostic accuracy of malignancy.[3,4] Furthermore, most previously reported data regarding stylet use were based on cytological assessment alone, with few done using the core needle biopsy (FNB). The current study aims to compare stylet with suction versus no stylet no suction techniques during EUS-FNB using 22-gauge acquire needles (Acquire; Boston Scientific, USA).

## Patients and Study Design

This single-center prospective study was conducted at the El-Ebrashi Unit of Gastroenterology and Hepatology, Internal Medicine Department, Kasr Al-Aini Hospitals, Cairo University, from May 2021 to January 2024. The participant patients were referred for EUS-guided biopsy of either pancreatic or non-pancreatic lesions. Informed consent was obtained before the procedure. The inclusion criteria were the presence of pancreatic, intra-abdominal, or mediastinal solid lesions (size > 1cm), confirmed by at least one other investigational modality, such as MRI, CT, and ultrasonography. Smaller lesions (<1cm) were excluded due to the increased difficulty in obtaining an adequate tissue sample. Previous studies have shown that sampling smaller lesions is technically challenging and may reduce diagnostic yield.[5] The exclusion criteria were the following:[1] Hemoglobin ≤ 8.0 g/dL,[2] any coagulation disorder,[3] history of taking oral anticoagulation agents in the past week,[4] history of acute pancreatitis in the past 2 weeks,[5] cardiorespiratory dysfunction precluding tolerance of the procedure and[6] inability to provide informed consent. Each enrolled patient underwent EUS-FNB with stylet and suction and another pass with no stylet no suction techniques. Ethical approval was obtained from the hospital's ethical committee.

### Endoscopic Procedures and Tissue Preparation

EUS-guided tissue sampling was performed by a single experienced endosonographer using a linear echoendoscope (Pentax EG3870UTK) attached to the Hitachi Avius ultrasound machine and under propofol sedation. After localizing the lesion, a 22-gauge FNB Franseen-tip needle (Acquire; Boston Scientific, USA) was introduced. The endoscopist used color Doppler to identify the optimal position for puncture to avoid intervening vessels between the needle and the target lesion. The needle was then inserted into the target tissue under EUS guidance. For the pass made with a stylet, the latter was left inside the needle, slightly retracted from the tip. After puncturing the lesion, the stylet was pushed forward the needle tip and removed. Then, continuous suction was applied using a 20-mL syringe. For the pass made without a stylet, there was no stylet in the needle and no suction throughout the entire pass. For all passes, the needle was inserted into the lesion, followed by approximately 20 backward and forward movements while keeping the needle tip in the lesion.

The sampled material was prepared as follows. Smears were prepared from part of the material and immediately fixed in 95% ethyl alcohol for 20 minutes, then stained with the Papanicolaou stain. Moreover, abundant material (including blood containing cellular aggregates and tissue fragments) was directly fixed in 10% buffered formaldehyde and then routinely processed. Tissue blocks were cut into 4-μm slides. Sections were stained with hematoxylin and eosin.[6]

### Assessment Standards

All samples were analyzed to assess cytological quality (including smear cellularity and blood contamination) and histopathological quality (including tissue integrity and blood contamination), obtained by each technique based on a three-class grading system for each item that was previously reported by Fabbri et al 2015[7] and Alatawi et al 2015.[8] For tissue integrity (Table 1): Grade A: an architecturally intact piece of tissue measuring at least 550 microns in the greatest axis, as the diameter of a high-power microscopic field, characterizes the lesion sufficient for diagnosis; Grade B: tissue fragments present, the tissue does not meet the criteria for architecturally intact histology but can still yield a diagnosis based on cell morphology; Grade C: no lesion tissue found and cannot yield a diagnosis. For smear cellularity: Grade A:

**Table 1** Criteria for Blood Contamination and Tissue Integrity

| Category | Grade A (Good Quality) | Grade B (Moderate Quality) | Grade C (Poor Quality) |
|---|---|---|---|
| Tissue Integrity | Architecturally intact tissue piece ≥550 microns, sufficient for diagnosis | Tissue fragments present, but diagnosis still possible based on cell morphology | No lesion tissue found, insufficient for diagnosis |
| Blood Contamination (Cell Block) | Minimal blood contamination, surface area (SA) <25% of the slide | Medium blood contamination, SA 25–50% of the slide | High blood contamination, SA >50% of the slide |
| Smear Cellularity | Satisfactory: ≥4 clusters, each with ≥10 cells | Adequate: 2–4 clusters, each with ≥10 cells | Unsatisfactory: <2 clusters or no cellular smear |

**Notes**: Grading criteria (A–C) for assessing sample quality in EUS-guided FNB, including tissue integrity, blood contamination, and smear cellularity.

satisfactory, more than four clusters, with a minimum of ten cells in each cluster; Grade B: adequate, approximately two to four clusters, with a minimum of ten cells in each cluster; Grade C: unsatisfactory, fewer than two clusters, or no cellular smear). The assessment of blood cell contamination was graded into Grade A: little blood contamination, minimal surface area (SA) < 25% of the slide; Grade B: medium blood contamination, SA 25–50% of the slide; Grade C: much blood contamination, SA > 50% of the slide) (Table 1).

In cases where immunohistochemistry was needed for diagnosis, the immunostaining was performed on sections prepared from the paraffin blocks using Ventana BenchMark autostainer. For final diagnosis, pancreatic cases were diagnosed and categorized according toThe Papanicolaou Society of Cytopathology System for Reporting Pancreaticobiliary Cytology; standardized terminology and nomenclature for pancreaticobiliary cytology. (Pitman and Layfield, 2014)

The non-pancreatic lesions were diagnosed following five categories, including “unsatisfactory”, “positive for malignancy”, “suspicious for malignancy”, “atypia”, and “negative for malignancy”.[9]

Follow-up was done for all cases for at least 6 months. The positive cases were correlated with CT findings, tumor marker level, and follow-up. The few negative cases (3%, n = 5) were followed up for at least 6 months without an increase in the size of the lesions or new development of metastatic lesions.

## Statistical Methods

Sample size calculations for a paired proportions study with 95% confidence and 80% power suggest a requirement of approximately 150–200 patients. Our study included 167 patients, which falls within this range, ensuring adequate statistical power.[10] The collected data were entered into a computer using Microsoft Office Excel Software Program 2019. Pre-coded data were then transferred and entered the Statistical Package of Social Science (SPSS) Software program, version 26, to be statistically analyzed. For quantitative variables, they were described as mean, standard deviation, median, minimum, and maximum. For qualitative variables, they were described as frequency and percentage and compared using the Chi-square test, where the p-value was considered significant if less than 0.05.

# Results

A total of 167 patients fulfilled the inclusion criteria, 78 females and 89 males, with a mean age of 61 years. Most lesions were pancreatic (83.2%, n = 139), and most of them were in the pancreatic head (95 cases, 68.3%). In comparison, 16.8% (n = 28) were non-pancreatic, including lymph nodes, esophagus, stomach, duodenum, retroperitoneum, and mediastinum. The size of the lesions sampled ranged from 2 cm to 11 cm, with a mean size of 4 cm (SD = 1.391). The baseline characteristics of the patients are summarized in Table 2.

The examination of cell blocks obtained using stylet and suction revealed that 85% (n = 142) of the samples had good tissue integrity (Category A), while 15% (n = 25) of the samples were category B. As regards blood contamination, 40.1% (n = 67) of the samples had minimal blood contamination (Category A), 14.4% (n = 24) had mild contamination (Category B), and 45.5% (n = 76) had significant blood contamination (Category C).

**Table 2** Baseline Characteristics of the Studied Cases

| Characteristic | Studied Cases |
|---|---|
| Age (mean± SD) | 61.38±11.16 |
| Sex (male: female) | 1.14:1 (n= 89:78) |
| Site of lesion | |
| Pancreatic (83.2%, n=139) | Head (68.3%, n=95)Neck (3.6%, n=5)Body (19.42%, n=27)Tail (5%, n=7)Uncinate process (2.15%, n=3) Diffuse (1.43%, n=2) |
| Non-pancreatic (16.8%, n=28) | Stomach (67.85%, n=19)Lymph node (17.85%, n=5)Mediastinum (3.57%, n=1)Esophagus (3.57%, n=1) Duodenum (3.57%, n=1)Retroperitoneum (3.57%, n=1) |
| Size in cm (mean ± SD) | 4.15 ± 1.39 |
| Diagnostic category | |
| Positive | 97% (n=162) |
| Negative | 3% (n=5) |

**Notes**: Demographic and clinical characteristics of all studied cases, including age, sex, lesion site, lesion size, and final diagnostic category.

The examination of the smears obtained using stylet and suction revealed that 98.8% (n = 165) of the samples had adequate cellularity (Category A), while 1.2% (n = 2) were Category B. Regarding blood contamination, 16.2% (n = 27) of the samples had minimal blood contamination (Category A) (Figures 1 and 2), 10.8% (n = 18) had mild contamination (Category B) (Figure 3), and 73.1% (n = 122) had significant contamination (Category C).

The examination of cell blocks obtained using no stylet and no suction illustrated that 79% (n = 132) of the samples had good tissue integrity (Category A), while 21% (n = 35) were Category B. As regards blood contamination, 43.1% (n = 72) of

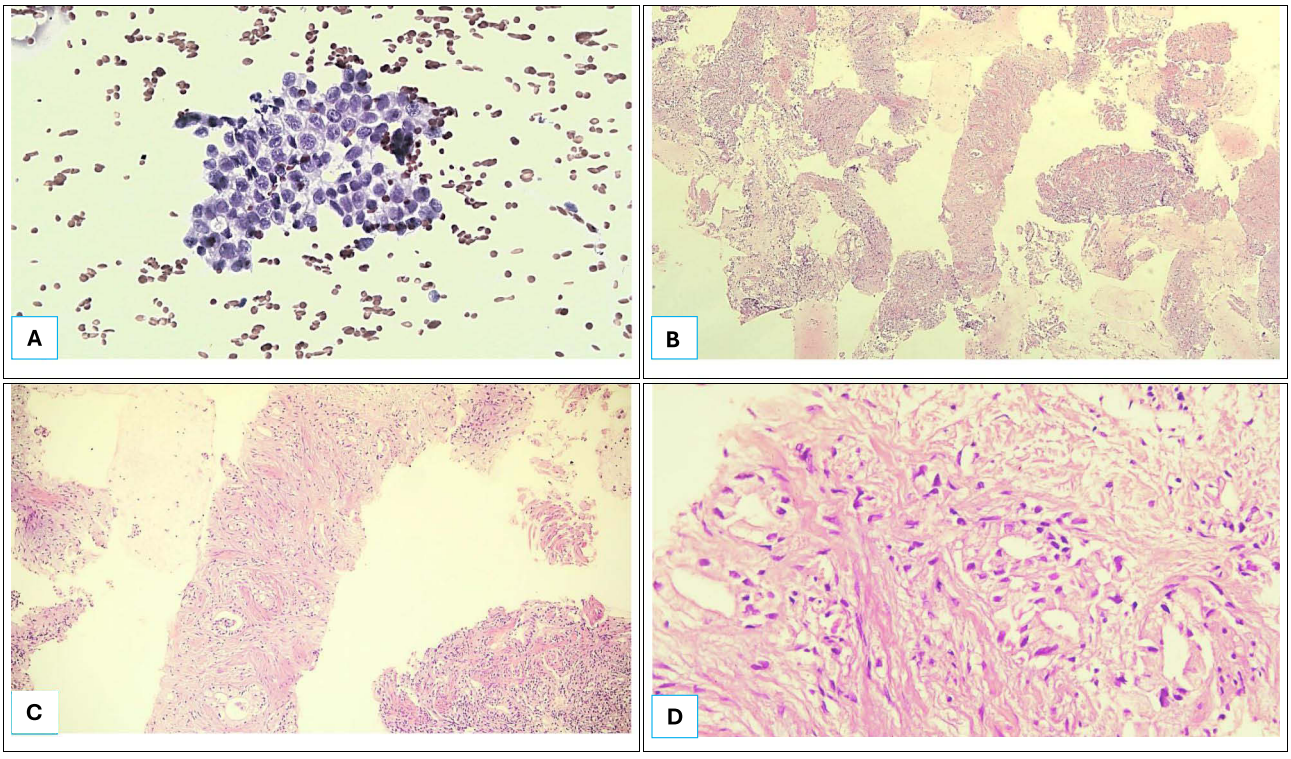


**Figure 1** Case of pancreatic head well differentiated ductal adenocarcinoma; EUS-FNB (22-gauge), with stylet and suction, **(A)** Smear shows sheet of malignant ductal cells displaying loss of polarity, pleomorphism, overlapping high nucleocytoplasmic (N/C) ratio and abnormal chromatin. (Papanicolaou X40). (**B**–**C**) Cell block showing intact tissue fragments of adenocarcinoma, formed of irregular glands separated by fibrotic stroma, grade A tissue integrity and grade A blood contamination. (Hematoxylin & Eosin X4 & X10 & X40, respectively).

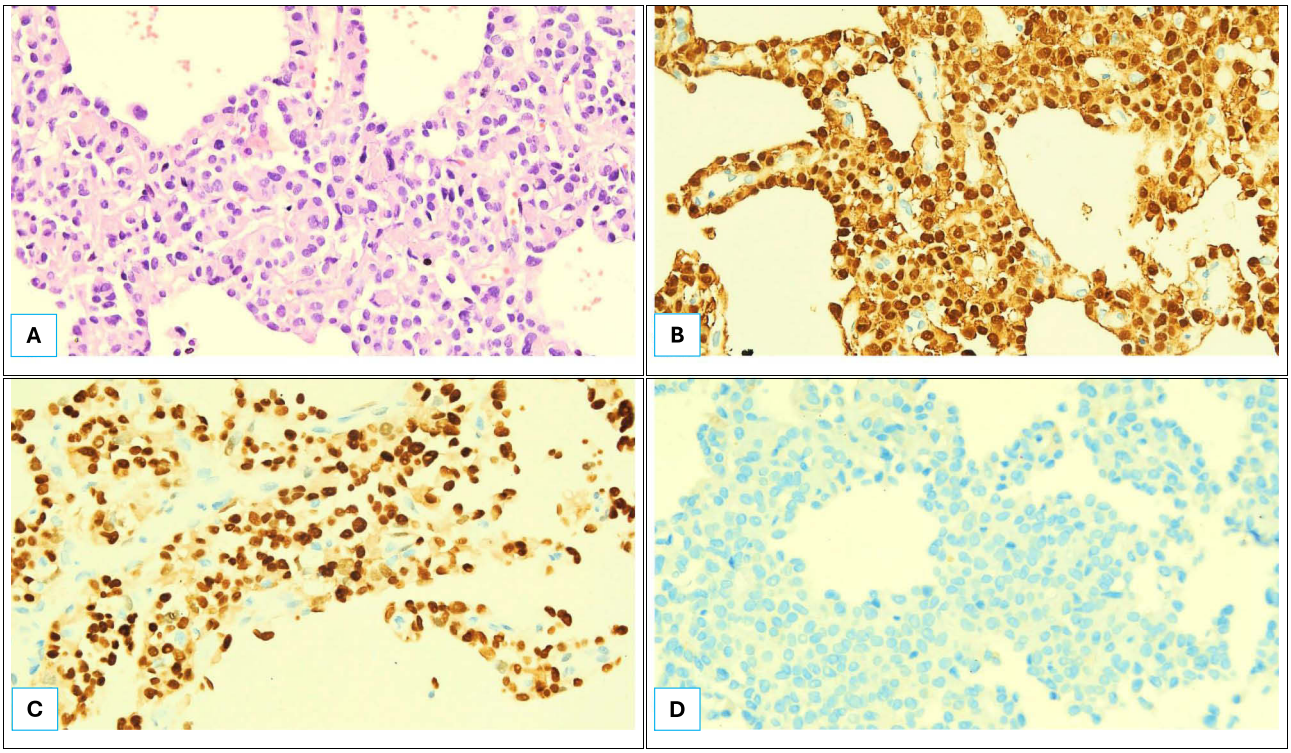


**Figure 2** Case of pancreatic tail solid pseudopapillary neoplasm of the pancreas; EUS-FNB (22-gauge), with stylet and suction, **(A)** Cell block showing intact tissue fragments of tumor formed of rather monomorphic round cells separate by delicate vascular stroma, grade A tissue integrity and grade A blood contamination (Hematoxylin & Eosin X40). **(B)** Tumor cells show positive reaction to Beta-Catenin (X40). **(C)** Tumor cells show positive reaction to progesterone receptor (PR) (**D)** Tumor cells show negative reaction to Chromogranin (X40).

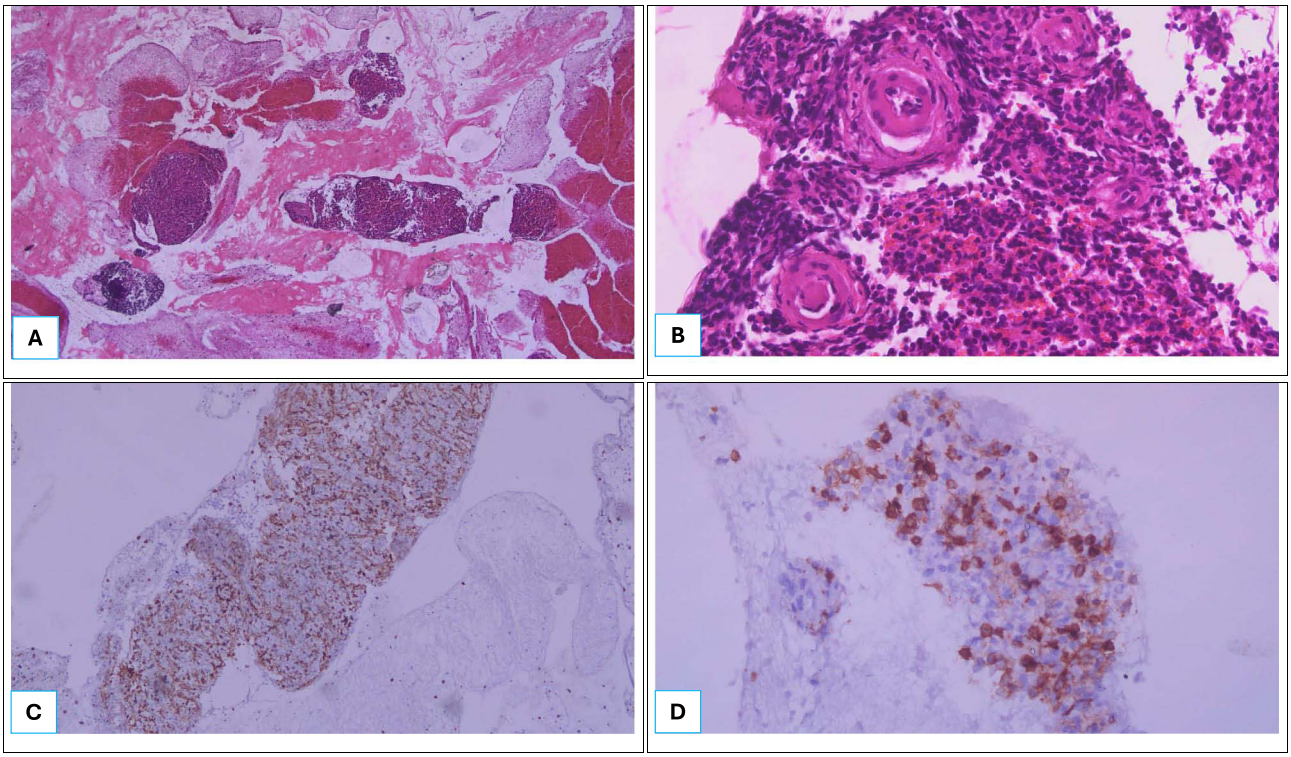


**Figure 3** Case of pancreatic tail accessory spleen; EUS-FNB (22 Gauge), with stylet and suction (**A**) low power view showing grade A tissue integrity and grade B blood contamination. (Hematoxylin & Eosin X10). (**B**) High power of the same section showing ectopic splenic tissue. (Hematoxylin & Eosin X10 & X40, respectively). (**C** and **D**) CD8 immunostain highlight the endothelium of thin-walled blood vessels. (X10 & X40, respectively).


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the samples had minimal blood contamination (Category A), 16.2% (n = 27) had mild contamination (Category B), and 40.7% (n = 68) had significant contamination (Category C).

The examination of the smears obtained using no stylet and no suction showed that 98.2% (n = 164) of the samples had adequate cellularity (Category A), while 1.8% (n = 3) were Category B. As regards blood contamination, 14.4% (n = 24) of the samples had no blood contamination (Category A) (Figures 4 and 5), 12.6% (n = 21) had mild contamination (Category B), and 73.1% (n = 122) had significant contamination (Category C).

Obtaining an intact tissue core (Grade A tissue integrity) was higher in the samples acquired by stylet and suction with a statistically significant p-value (142 cases vs 132 cases). Both procedures were successful in acquiring an intact tissue fragment in all cases, with no failure recorded (absence of Grade C tissue integrity). Blood contamination was higher in cell blocks sampled using stylet and suction, with a significant statistical difference. In contrast, blood contamination of the smears was higher with no stylet and no suction. In terms of smear cellularity, there was no significant statistical difference between the two techniques. Sampling outcomes are presented in Table 3.

Most cases (97%, n = 162) were positive for malignancy, while (3%, n = 5) were negative. Most positive cases (84.6%, n= 137) were pancreatic, and the other 15.4% (n = 25) were non-pancreatic. The negative cases included 2 pancreatic and 3 non-pancreatic lesions. Among 139 pancreatic lesions and adenocarcinoma, the ductal type was the dominant encountered diagnosis (131 cases). Various diagnoses for both pancreatic and non-pancreatic lesions are demonstrated in Table 4 and Table 5. Immunocytochemistry was done to confirm the diagnoses in 15.6% (n = 26) of cases. The final diagnoses include neuroendocrine tumors, solid pseudopapillary neoplasm of the pancreas, gastrointestinal stromal tumor (GIST), mesothelioma, and lymphoma. The sensitivity, specificity, positive predictive value, and negative predictive value of EUS-guided tissue sampling were 100% for both

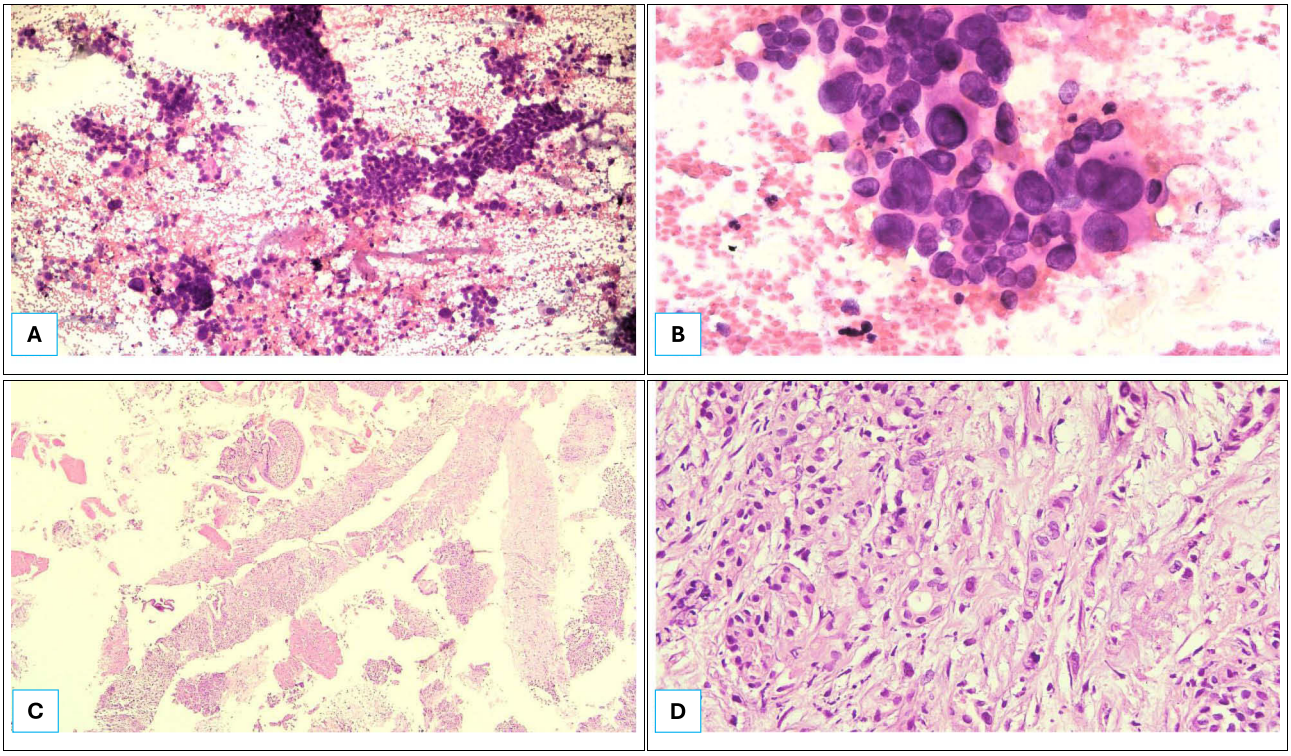


**Figure 4** Case of pancreatic head poorly differentiated ductal adenocarcinoma; EUS-FNB (22-gauge), no stylet no suction, (**A** and **B**) Smear shows groups and sheets of malignant ductal cells displaying loss of polarity, pleomorphism, overlapping high nucleocytoplasmic (N/C) ratio and abnormal chromatin. (Papanicolaou, X10 & X40, respectively). (**C** and **D**) Cell block showing intact tissue fragments of adenocarcinoma, formed of irregular solid groups with focal glandular formations, separated by fibrotic stroma, grade A tissue integrity and grade A blood contamination. (Hematoxylin & Eosin X4 & X10 & X40, respectively).

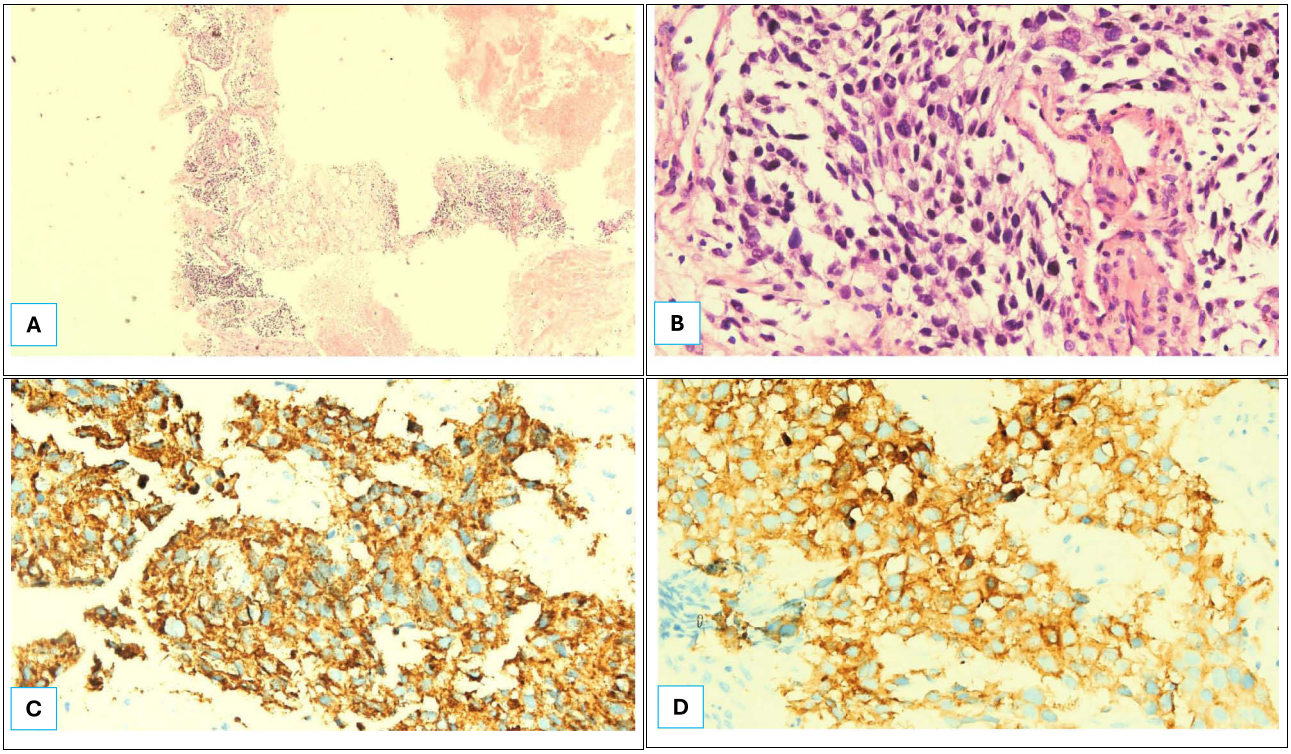


**Figure 5** Case of pancreatic neck neuroendocrine tumor grade 3; EUS-FNB (22-gauge), no stylet no suction (**A**) and (**B**) Cell block section showing intact tissue fragment (Grade A), and little blood contamination (Grade A). (Hematoxylin & Eosin X10 & X40, respectively). (**C**) Tumor cells showing positive reaction for chromogranin. (X40). (**D**) Tumor cells showing positive reaction for Synaptophysin. (X40).

techniques. These results were obtained by combining smears and tissues for diagnosis, thanks to the experience of the cytopathologist in making a conclusive diagnosis based on the examination of smears in addition to the formalin-preserved tissues.

**Table 3** Sampling Outcome of FNB with and without Stylet and Suction

| Characteristic | FNB with Stylet & Suction | FNB without Stylet & without Suction | p-value |
|---|---|---|---|
| Tissue integrity | | | 0.000 |
| A | 142 (85%) | 132 (79%) | 0.000 |
| B | 25 (15%) | 35 (21%) | 0.000 |
| C | 0 | 0 | 0.000 |
| Tissue blood contamination | | | 0.000 |
| A | 67 (40.1%) | 72 (43.1%) | 0.000 |
| B | 24 (14.4%) | 27 (16.2%) | 0.000 |
| C | 76 (45.5%) | 68 (40.7%) | 0.000 |
| Cellularity | | | 0.847 |
| A | 165 (98.8%) | 164 (98.2%) | 0.847 |
| B | 2 (1.2%) | 3 (1.2%) | 0.847 |
| C | 0 | 0 | 0.847 |
| Smear blood contamination | | | 0.000 |
| A | 27 (16.2%) | 21 (14.4%) | 0.000 |
| B | 18 (10.8%) | 21 (12.6%) | 0.000 |
| C | 122 (73.1%) | 122 (73.1%) | 0.000 |

**Notes**: Comparative analysis of sample quality outcomes—tissue integrity, blood contamination, and cellularity—between FNB performed with stylet and suction versus without.


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**Table 4** Different Diagnoses of Pancreatic Lesions

| Diagnostic Category | Total |
|---|---|
| Adenocarcinoma, ductal type | 131 (94.24%) |
| Neuroendocrine tumor | 4 (2.87%) |
| Solid pseudopapillary neoplasm | 2 (1.43%) |
| Pancreatitis | 1 (0.7%) |
| Pancreatic tail accessory spleen | 1(0.7%) |
| Total | 139 |

**Notes**: Final histopathological diagnoses in patients with pancreatic lesions, with frequency and proportion of each tumor type.

**Table 5** Different Diagnoses of Non-Pancreatic Lesions

| Diagnostic Category | Total |
|---|---|
| Adenocarcinoma | 4 (14.28%) |
| Signet ring carcinoma | 4 (14.28%) |
| Squamous cell carcinoma | 1 (3.57%) |
| Dedifferentiated liposarcoma | 1 (3.57%) |
| Diffuse large B cell non-Hodgkin lymphoma | 2 (7.14%) |
| Gastro-intestinal stromal tumor | 12 (42.85%) |
| Mesothelioma | 1 (3.57%) |
| Granulomatous lymphadenitis | 3 (10.71%) |
| Total | 28 |

**Notes**: Final histopathological diagnoses in patients with non-pancreatic lesions, including both malignant and benign pathologies with detailed breakdown.

## Discussion

EUS-FNB is increasingly used to diagnose and stage GI and non-GI malignancies. Recently, many EUS-guided tissue acquisition protocols have recommended the use of a stylet during the procedure. It was believed that the use of a stylet provides stiffness to the FNA device and improves the quality and diagnostic yield of samples by preventing clogging of the lumen of the needle by GI wall tissue. Several prior studies evaluated the usage of the stylet during the EUS-FNA procedure, but none reported any benefit of using it.[8–11] Another meta-analysis study (including five RCTs and two retrospective studies with a total of 5491 specimens) demonstrated no significant difference in the rate of sample adequacy, cellularity, and blood contamination between the stylet and non-stylet groups.[12] Moreover, several disadvantages of using the stylet during EUS tissue acquisition have been reported. It is time-consuming and tedious and may increase the risk of accidental needle stick injury. In addition, the reinsertion of the stylet within the needle in each pass can be difficult, especially if there is a kink in the needle sheath. To our knowledge, there are limited data assessing the role of stylet during EUS-FNB. Theoretically, this is because the newer generation of biopsy needles has a reverse-bevel-sided hole to acquire specimens for histological assessment, unlike FNA needles.[3] We conducted this study to further assess the role of the stylet during the FNB technique. Our study compared the diagnostic yield and tissue quality of EUS-FNB with stylet and suction versus no stylet and no suction. Both methods demonstrated the same diagnostic yields of 100%, indicating that the presence of a stylet and the use of suction do not significantly impact the diagnostic accuracy of EUS-FNB. This finding aligns with previous studies that have shown similar diagnostic yields for different EUS-FNB techniques.[13]

The results showed that 85% of samples obtained with stylet and suction had good tissue integrity (Category A), compared to 79% without stylet and suction. Although there was a significant statistical difference, it was not clinically significant. Blood contamination in cell blocks was higher in the stylet and suction group (45.5%) compared to the no

stylet and no suction group (40.7%). These findings suggest that while the use of a stylet and suction may marginally improve tissue integrity, it increases blood contamination. However, the differences are minimal and may not justify the additional procedural complexity.[14]

Both methods provided adequate cellularity in all samples, with and without using stylet and suction. The smear blood contamination was higher in no stylet no suction samples. This result suggested that the cellularity of the samples was not significantly affected using a stylet and suction, supporting the notion that both techniques are equally effective in obtaining sufficient cellular material for diagnosis.[15]

Our findings are consistent with previous studies that have evaluated the efficacy of different EUS-FNB techniques. For instance, Xu et al[16] compared dry suction and wet suction techniques and found no significant difference in diagnostic accuracy. Similarly, Ishikawa et al[14] highlighted that advancements in needle design and sampling methods have improved diagnostic performance. Still, the choice of technique often depends on operator preference and specific clinical scenarios.

Combining the examination of both alcohol-fixed smears and formalin-preserved tissues obtained by FNB is crucial for enhancing sensitivity and diagnostic accuracy. Smears provide immediate cytological evaluation, while tissue samples offer histological context, which is particularly valuable in complex cases. Additionally, this combined method helps mitigate the variability in diagnostic outcomes due to the experience level of the cytopathologist. By integrating both cytological and histological examination, the diagnostic process becomes more robust and reliable, ultimately leading to better patient outcomes.[17]

Based on the obtained smear and cell block, the present study showed no statistically significant difference between both procedures regarding the diagnostic accuracy of malignancy. The results agree with the results of the previously reported prospective randomized trial conducted by[18] that suggested that the use of a stylet does not confer any advantage regarding diagnostic yield or procedure time in EUS-guided tissue acquisition with a 25-gauge core biopsy needle. Finally, our study may have some limitations, as we used only a 22-gauge needle, and the results may not apply to other needle sizes (25, 20, or 19-gauge).

Clinical implications: The choice of using a stylet and suction during EUS-FNB should be individualized based on the clinical context and operator experience. Given the minimal differences in tissue integrity and blood contamination, the decision to use these techniques can be guided by factors such as ease of use, patient comfort, and procedural efficiency. Our study supports the flexibility in choosing either method without compromising diagnostic accuracy. Limitations: This study has some limitations. For instance, the single-center setting may limit the generalizability of the findings. Additionally, the sample size, while adequate, may not capture all potential variations in outcomes. Another limitation of this study is the absence of randomization in the first pass technique, as the stylet and suction method was always performed first. Future prospective multicenter studies are needed to validate these results and provide more robust evidence.

Future Research: Further research should focus on optimizing EUS-FNB techniques to enhance diagnostic yield and tissue quality. Prospective studies comparing different needle designs, suction techniques, and the number of passes required for optimal sampling are warranted. Additionally, the integration of advanced technologies, such as artificial intelligence for real-time specimen evaluation, could further improve the accuracy and efficiency of EUS-FNB.[19]

## Conclusion

In conclusion, EUS-FNB-guided tissue acquisition using stylet and suction does not increase either cytologic or histologic diagnosis of malignancy. It shows comparable results with the technique of no stylet and suction for both pancreatic and non-pancreatic lesions. Combining both cytological examinations of alcohol-fixed slides and histological examination of formalin-preserved tissue significantly increases the diagnostic yield, making the diagnostic process more robust and reliable, ultimately leading to better patient outcomes.

## Ethical Clearance

The study protocol was conducted following the Helsinki Declaration and approved by the ethical committee board of the Faculty of Medicine, South Valley University, Egypt, with the reference number: SVUMEDMED0181029.

## Disclosure

The authors report no conflicts of interest in this work.

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