Title page

High and low negative pressure suction techniques in endoscopic ultrasound-guided fine needle tissue acquisition using 25-gauge needles: A multicenter prospective randomized controlled trial

Running title: High and low negative pressure suction techniques in EUS-guided FNA

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Abstract

Background: Endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) has a high diagnostic accuracy for pancreatic diseases. However, while most reports have typically focused on cytology, histological tissue quality has rarely been investigated. The effectiveness of EUS-FNA combined with high negative pressure (HNP) suction was recently indicated for tissue acquisition, but has not thus far been tested in a prospective, randomized clinical trial.

Objective: To evaluate the adequacy of EUS-FNA with HNP for the histological diagnosis of pancreatic lesions using 25-gauge needles

Design: Prospective, single-blind, randomized, controlled crossover trial

Setting: Seven tertiary referral centers

Patients: Patients referred for EUS-FNA of pancreatic solid lesions. From July 2011 to April 2012, 90 patients underwent EUS-FNA of pancreatic solid masses using normal negative pressure (NNP) and HNP with two respective passes. The order of the passes was randomized, and the sample adequacy, quality, and histology were evaluated by a pathologist.

***Intervention*:** EUS-FNA using NNP and HNP

***Main outcome measurements*:** The adequacy of tissue acquisition and the accuracy of histological diagnoses made using the EUS-FNA technique with HNP

Results: We found that 72.2% (65/90) and 90% (81/90) of the specimens obtained using NNP and HNP, respectively, were adequate for histological diagnosis (P = 0.0003, McNemar's test). For 73.3% (66/90) and 82.2% (74/90) of the specimens obtained using NNP and HNP, respectively, an accurate diagnosis was achieved (P = 0.06, McNemar's test). One patient developed pancreatitis following this procedure, which

subsided with conservative therapy.

***Limitations*:** This was a single-blinded, cross-over study

Conclusion: Biopsy procedures that combine the EUS-FNA with HNP techniques are superior to EUS-FNA with NNP procedures for tissue acquisition. (Clinical trial registration number: UMIN000005939)

Keywords:

Pancreatic tumor

Endoscopic ultrasound-guided fine needle aspiration

High negative suction

Abbreviations:

EUS, endoscopic ultrasound; EUS-FNA, endoscopic ultrasound-guided fine needle aspiration; HNP, high negative pressure; PS, performance status; ASA, American Society of Anesthesiologists; UMIN, University Hospital Medical Information Network; NNP, normal negative pressure; CI, confidence interval

Introduction

Endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) biopsies were first reported by Vilmann et al. in 1992[1] and have a high diagnostic accuracy (ranging from 70% to 98%)[2]. In most cases, a cytological assessment is sufficient for the diagnosis of a pancreatic tumor. However, it is sometimes difficult to make a differential diagnosis by cytological data alone[3]. In such cases, evaluation of tissue architecture and morphology, namely histological diagnosis, is required for an accurate pathological diagnosis.

The success of puncture is important for tissue acquisition, and is thus a crucial factor in EUS-FNA performance. A higher technical success rate is achievable with a 25-gauge needle than with a 22- or 19-gauge needle; however, the specimen obtained with the 25-gauge needle is less adequate for histological diagnosis compared to that obtained with the other needles[4]. Two studies have indicated that EUS-FNA approaches utilizing high negative pressure (HNP) suction to aspirate tissue enable acquisition of adequate tissue[5,6]. However, these studies only used the 22- and 19-gauge needles, and no studies thus far have evaluated the efficacy of 25-gauge needles for EUS-FNA in combination with HNP.

Therefore, we hypothesize that a 25-gauge needle for EUS-FNA with HNP may enable us to obtain sufficient tissue material with a high success rate. In the present report, we conducted a multicenter, prospective randomized trial to determine the accuracy of this hypothesis.

Methods

Patients

Between July 2011 and April 2012, patients with solid pancreatic masses, as detected by ultrasound, computed tomography, or magnetic resonance imaging, were consecutively enrolled in this study. Seven gastrointestinal tertiary referral centers, where more than 100 EUS-FNAs are performed a year, were considered eligible for this study. Patients with the following conditions were excluded: European Cooperative Oncology Group (ECOG) performance status (PS) of 4; serious underlying disorder; American Society of Anesthesiologists (ASA) class III to IV; those on oral anticoagulants; prothrombin time-international normalized ratio > 1.5; platelet count < 50,000/mm^3; pregnancy; gastrointestinal obstruction; and refusal or inability to provide informed consent. The study was approved by the institutional review board appropriate for each institution and was registered with the University Hospital Medical Information Network (UMIN) Clinical Trials Registry (number UMIN000005939).

Procedural technique

Patients were laid in the left lateral decubitus position and provided conscious sedation. A curvilinear echoendoscope (GF-UCT240-AL5; Olympus Medical Systems, Tokyo, Japan) was used, and EUS-FNA was performed using a 25-gauge needle (Echo Tip Ultra; Cook-Japan, Tokyo, Japan). After the needle was advanced into the target lesion, the stylet was withdrawn. A 10-mL syringe with 10-mL negative pressure (normal negative pressure; NNP) or the Alliance II inflation system (Boston Scientific Japan, Tokyo, Japan) employing a 60-mL syringe with 50-mL high negative pressure (HNP) was attached to the proximal end of the needle, as appropriate, for the

randomized protocol. The needle was then moved back-and-forth 10 to 20 times while performing suction. We performed EUS-FNA using jabbing movements under continuous suction. We also used the fanning technique during EUS-FNA for pancreatic lesions if the endoscopist was able to perform the maneuver. Four EUS-FNA procedures were performed in the following order in the NNP and HNP group, respectively: NNP-HNP-NNP-HNP and HNP-NNP-HNP-NNP. Obtained samples were categorized according to group (NNP or HNP) and fixed with formalin for histological examination. A portion of each sample, obtained by the first and second punctures, was sent for cytological examination. The remaining tissue was instantly fixed in 10% neutral-buffered formalin solution for histological examination. The EUS-FNA procedure was performed using NNP with a 25-gauge needle or using HNP with a different 25-gauge needle. On-site modified Giemsa staining (Diff-Quik; Kokusai Shiyaku, Kobe, Japan) was performed in all institutions. If an endoscopist considered samples obtained during 4 attempts of EUS-FNA insufficient for pathological diagnosis, an additional puncture was permitted. An additional puncture was performed if: (i) the cytopathologist could not identify any material on the glass slide or (ii) the cytopathologist could not macroscopically identify any whitish material on the glass slide. For additional punctures, any FNA procedure (needle/suction) could be performed.

Method of assignment of NNP and HNP groups

A computer-generated sequence was used to randomize patients into the NNP or HNP group. Randomized groups were stratified by institutions.

Outcome measurements

The primary outcome of this study was to determine the adequacy of tissue acquisition by the EUS-FNA/HNP combined technique and to determine the accuracy of histological diagnoses achievable using this technique. The secondary outcome of this study was to assess the quality and quantity of obtained tissue and the potential for adverse events arising from the use of this procedure.

Pathological assessment of samples obtained in this study

Cytological and histological analyses were performed separately. The cytological analysis was performed in on-site pathology facilities available in each hospital. Cell-block techniques were not performed for all patients in this study. The histological analysis was performed by a single expert pathologist (T.M.) on the basis of hematoxylin and eosin staining. This pathologist evaluated the quantity and quality of each specimen and performed histological diagnosis blinded (to clinical information, cytology, and final diagnoses).

The quantity of samples was assessed by the scoring system described by Gerke et al[6]. This scoring system is as follows: 0 indicates a sample with no material; 1 indicates the sample contains sufficient material for limited cytological interpretation but is probably not representative; 2 indicates the sample contains sufficient material for adequate cytological interpretation but is insufficient for histological information; 3 indicates sufficient material for limited histological interpretation; 4 indicates sufficient material for adequate histological interpretation, but a low quality sample (total material is within 10× power field in length); 5 indicates sufficient material for adequate histological interpretation, and a high quality sample (total material is over 10× power

field in length). **Figure 1** shows representative examples. In our study, a sample with a score of 3 or more was defined as adequate for histological diagnosis. A sample with a score of 2 or less was defined as inadequate for histological diagnosis.

The degree of contamination (e.g., gastrointestinal mucosa) in the specimens was categorized into 4 grades: 0, no contamination; 1, contamination present in <25% of the slide; 2, contamination present in 25–50% of the slide; 3, contamination present in >50% of the slide. The degree of the amount of blood in the specimens was categorized into 3 grades: 0, mild; 1, moderate; 2, significant.

Pancreatic carcinomas, neuroendocrine tumors, lymphomas, and solid pseudopapillary neoplasms were defined as "malignant diseases". Pancreatitis and non-neoplastic pancreatic tissue were defined as "non-malignant diseases". "Malignancy" and "Suspicious for malignancy" were defined as "positive for malignancy". "Atypical cells" and "benign" were defined as "negative for malignancy". As immunohistochemical studies could not be performed for all specimens in this study, the pathologist judged a sample to be malignant or benign by hematoxylin and eosin staining alone. An "accurate" diagnosis was defined as follows: (i) "positive for malignancy," with a final diagnosis of "malignant disease," such as carcinoma, neuroendocrine tumor, or solid pseudopapillary neoplasm (true positive); (ii) "negative for malignancy," with the condition ultimately being diagnosed as a "non-malignant disease," such as pancreatitis and nonneoplastic pancreatic tissue (true negative).

Diagnostic accuracy was defined as the ratio between the sum of true positive and true negative values, divided by the total number of samples. Adequacy rate was calculated by the following formula: number of adequate samples divided by total number of samples.

Clinical diagnostic methodology used for ultimate diagnosis of patients

Malignant disease was ultimately identified in patients by: i) diagnosis upon autopsy after death due to pancreatic cancer; ii) diagnosis based on histopathological analyses of surgically resected specimens; iii) radiological or clinical data indicating evidence of disease progression; iv) diagnosis based on histopathological analyses of nodules in other organs, demonstrating metastatic progression. In this study, benign disease was defined as a decrease or lack of change in pancreatic mass and a lack of change in clinical data obtained for at least 6 months.

Adverse events

An adverse event was defined as any event that required the patient to stay in the hospital for a longer duration than expected, or to undergo other unplanned interventions. For detailed reporting of adverse events, we referred to the Practice Committee of the American Society for Gastrointestinal Endoscopy guidelines[7].

Sample size

The study was designed such that the sample size was large enough to obtain differences in the adequacy of samples needed for histological diagnosis.

It has been reported that a sample acquisition rate of 45.8% can be achieved using a 25-gauge needle in pancreatic tumors[4]. We estimated that 50% and 65% of specimens obtained in the NNP and HNP groups, respectively, would have the adequacy required for histological diagnoses. By using the McNemar's test of equality of paired proportions and assuming 25% discordant pairs and a 10% dropout rate, each subject

was assumed to have one pancreatic lesion. It was evaluated that 90 patients would be required to enable statistical analyses using a two-tailed test with a 5% significance level and 80% statistical power.

Statistical analysis

All statistical tests were performed using dedicated software (JMP software version 8; SAS Institute, Cary, NC, USA). McNemar's test was applied to adequacy, accuracy, and quality data gathered from tissue samples. A P value <0.05 was considered statistically significant.

Results

During the study period, 52 men and 38 women (90 patients) were enrolled in this study. The median age of patients was 67 years. All lesions were visible by EUS. Thirty-four patients had a lesion in the pancreas head (10 patients had lesions in the uncinate process), 40 patients in the body, and 16 patients in the tail. Fifty-six successful EUS-FNA procedures were performed through the gastric wall, while the remaining 34 procedures were performed through the duodenal wall. The median size of lesions was 28.2 mm (range, 7.2–63.9) (**Table 1**).

All EUS-FNA procedures were performed with on-site cytopathology evaluation. In this study, additional punctures were performed. Among these 5 patients, 2 underwent EUS-FNA with NNP using a 22-gauge needle, 2 underwent EUS-FNA with NNP using a 19-gauge needle, and 1 underwent EUS-FNA with HNP using a 25-gauge needle. The definitive diagnostic procedures for a pancreatic lesion were as follows: 25 lesions were diagnosed based on pathological findings in resected specimens and 65 lesions were

diagnosed by clinical course.

Adequacy score of specimen

The adequacy scores of obtained tissues for histological diagnosis are shown in **Table 2** and **Figure 2**. The numbers of adequate and inadequate samples in the NNP and HNP groups are displayed in **Table 3**.

It was determined that 72.2% (65/90) (95% confidence interval [CI]: 62.2–80.4%) of samples obtained from the NNP group were adequate for histological diagnosis. In comparison, 90% (81/90) (95% CI: 82.0–94.6%) of samples obtained from the HNP group were adequate for histological diagnosis. A concordance rate of 77.8% (70/90) (63 adequate and 7 inadequate for histological diagnosis) and a discordance rate of 22.2% (20/90) was determined. The samples obtained for histopathological diagnosis using HNP were significantly superior to those obtained using NNP (P = 0.0003, McNemar's test) (**Table 3**). In 18 of these 20 patients, samples obtained by HNP were adequate for histological diagnosis, while samples obtained by NNP were inadequate. In the remaining 2 cases, adequate samples for histological diagnosis were obtained by NNP, but not by HNP. Therefore, it was determined that samples obtained by HNP were significantly superior to those obtained by NNP for histopathological diagnosis (P = 0.0003, McNemar's test) (**Table 3**).

Accuracy

The final clinical diagnoses are outlined in **Table 4**. Seventy-one patients were ultimately diagnosed with pancreatic ductal adenocarcinoma, 1 with an acinar cell carcinoma, 1 with an undifferentiated carcinoma with osteoclast-like cells, and 4 with

carcinomas with histological types that could not be classified. Four patients were diagnosed with neuroendocrine tumors, 1 with a solid-pseudopapillary neoplasm, and 1 with a secondary tumor. Seven patients were diagnosed with pancreatitis.

Cytological diagnosis was categorized into "malignancy" or "no malignancy." Malignancies were detected with a sensitivity of 89.2% (74/83) (95% CI: 80.7–94.1%) and a specificity of 100% (7/7) (95% CI: 64.4–100%).

Among the 90 samples obtained by NNP, 76 were diagnosed using cytological and/or histological techniques. Sensitivity and specificity were 86.1% (62/72) (95% CI: 76.3–92.3%) and 100% (4/4) (95%CI: 51.0–100%), respectively. Total accuracy rate was 73.3% (66/90) (95% CI: 63.3–81.3%).

Among the 90 samples obtained by HNP, 85 were diagnosed using cytological and/or histological techniques. Sensitivity and specificity were 88.5% (69/78) (95% CI: 79.5–93.8%) and 71.4% (5/7) (95%CI: 35.8–91.8%), respectively. Total accuracy rate was 82.2% (74/90) (95% CI: 73.1–88.8%).

The accuracy of diagnoses based on the analysis of samples obtained using EUS-FNA/HNP and EUS-FNA/NNP was equivalent (P = 0.06, McNemar's test). It should be noted that, of the 24 lesions that were not accurately diagnosed using samples obtained via EUS-FNA/NNP, a specimen adequate for histological diagnosis was obtained in only 10 lesions. Of these 24 cases, 16 lesions were accurately diagnosed with adequate specimens obtained using the EUS-FNA/HNP technique. In contrast, 16 lesions that were not accurately diagnosed using samples obtained via EUS-FNA/HNP, 8 lesions were accurately diagnosed using samples obtained via the EUS-FNA/NNP technique. As such, the combined EUS-FNA/HNP technique is superior to the EUS-FNA/NNP technique for pathological diagnosis.

We analyzed the relationship between adequacy and accuracy for all specimens obtained in this study. Specimens deemed adequate for histological diagnosis had significantly higher diagnostic accuracy than specimens deemed inadequate for histological diagnosis ($P < 0.001$, Chi-square test) (**Table 5**).

Tissue quality

The samples obtained by HNP contained more blood than those obtained by NNP ($P = 0.0042$, McNemar's test). On the other hand, the degrees of contamination were not significantly different between the samples obtained using either technique ($P = 0.0795$, McNemar's test) (**Table 6**).

Adverse events

Among the enrolled 90 patients, 1 patient developed pancreatitis after the EUS-FNA procedure was performed. He recovered following conservative therapy. The rate of adverse events was therefore 1.1% (1/90).

Discussion

Our data indicate that the use of a procedure that combines EUS-FNA with HNP provides significantly more specimens adequate for histological diagnosis than a procedure that combine EUS-FNA with NNP. EUS-FNA with HNP allows more cells to be acquired and preserves tissue architecture in specimens.

A previous study has shown that 25-gauge needles have a higher technical success rate, whereas more specimens adequate for histological diagnoses are obtained using a 22- or 19-gauge needle[4]. A 25-gauge needle is therefore recommended to

puncture the head of the pancreas[4]. Several studies have compared the performance characteristics of a 22-gauge needle with those of a 25-gauge FNA needle for sampling pancreatic masses, but most have failed to demonstrate superiority of either needle[8-22]. A recent systematic review and meta-analysis of EUS-FNA for solid pancreatic masses, including a large cohort of patients, revealed that a 25-gauge needle was more sensitive than a 22-gauge needle[23]. In our study, EUS-FNA using a 25-gauge needle was successfully performed in all of the pancreatic lesions, not just lesions in the pancreatic head.

The need for suction during EUS-FNA has been evaluated by previous reports, but is still controversial[5, 24, 25]. The European Society of Gastrointestinal Endoscopy technical guideline advocates the use of suction for EUS-FNA of solid masses/cystic lesions but does not recommend the use of suction for EUS-FNA of lymph nodes[26]. However, previous reports have only focused on cytological examinations, not histology. The results of our study reveal that EUS-FNA with HNP enables the acquisition of more specimens adequate and sufficient for histological diagnosis than what is achievable with EUS-FNA with NNP. Further study is required for the evaluation of EUS-FNA with and without HNP suction to determine whether suction is required during EUS-FNA for the purpose of histological diagnosis.

Pancreatic ductal adenocarcinoma accounts for the majority of pancreatic tumors, and can be diagnosed by cell morphology and the degree of atypia. However, larger specimens are sometimes required for the histological diagnosis of other pancreatic tumors[27, 28]. In fact, 90% of specimens obtained using a 25-gauge needle and HNP were adequate for histological diagnosis. This is higher than previous reports describing the use of a 25-gauge needle[4]. Furthermore, greater diagnostic accuracy was

achieved when specimens were adequate (**Table 6**), indicating that adequate specimens, optimal for histological diagnosis, can be obtained using a 25-gauge needle. As such, the use of a 25-gauge needle with HNP improves technical performance of EUS-FNA, and is the most appropriate method for pancreatic head lesions.

Diagnostic accuracy was not significantly different between the NNP and HNP groups. The majority of the enrolled patients in this study had ductal adenocarcinoma, which could be diagnosed by cell atypia alone. Our findings, however, are not limited to ductal adenocarcinoma. Pancreatic tumors with low-grade dysplasia or tumors with chronic pancreatitis, which are difficult to diagnose by only cell atypia, were also accurately diagnosed[29]. However, diagnostic accuracy was different between groups with adequate and inadequate specimens. This fact reveals that histological assessment aids the diagnosis of materials using EUS-FNA. Suction is recommended when only a small amount of aspirate is obtained without suction[30]. One problem we identified with the use of EUS-FNA with HNP was that the specimen obtained contained more blood. However, there was no difference between HNP and NNP in terms of diagnostic accuracy. It therefore appears that amount of blood of samples does not compromise histological diagnosis; blood is rarely considered in the histological diagnosis of pancreatic tumors. Even if a sample contains blood, blood and cell components are visualized separately in the histological preparation. There were some limitations in this study protocol. One limitation of this study is the non-double-blinded clinical setting. Most patients presented with adenocarcinoma, and only a few had benign tumors or other types of malignancies. In particular, only few patients had hypervascular tumors (n = 4, neuroendocrine tumors). This was a cross-over study. In addition, our study could not compare the rates of adverse events between the two techniques

(EUS-FNA/HNP and EUS-FHA/NNP) as the rate of adverse events was low at 1.1%, and similar to the results of previous systematic review[31]. While this evidence suggests that EUS-FNA with HNP is feasible, additional study is required to resolve these issues.

Conclusion

Biopsy procedures with the EUS-FNA/HNP technique are superior to the EUS-FNA/NNP procedures in terms of tissue acquisition. This method is feasible and effective for collecting specimens for the histological diagnosis of pancreatic tumors.

Table 1. Characteristics of the enrolled patients

Characteristic		
Median age (y, range)		67 (27–87)
Gender (male/female)		52/38
ECOG Performance status	0	81
	1	8
	2	1
ASA score	1	86
	2	4
Site of lesion	Pancreatic head	34
	Pancreatic body	40
	Pancreatic tail	16
Puncture route	Transgastric	56
	Transduodenal	34
Median size of lesion (mm, range)		28.2 (7.2–63.9)
Size of lesion (mm)	0-20	22
	21–40	58
	41–60	8
	60-	2

ECOG, European Cooperative Oncology Group; ASA, American Society of Anesthesiologists

Table 2. Scores assigned to describe the adequacy of tissue obtained by EUS-FNA for histological diagnosis

		NNP						
	Score	0	1	2	3	4	5	Total
HNP	0	2	0	0	0	0	0	2
	1	0	0	2	1	0	0	3
	2	0	1	2	1	0	0	4
	3	2	1	4	11	8	1	27
	4	5	0	4	14	13	3	39
	5	2	0	0	3	3	7	15
	Total	11	2	12	30	24	11	90

NHP, Normal negative pressure; HNP, High negative pressure

Table 3. A contingency table formulated to describe the adequacy of samples obtained for histological diagnosis based on the suction technique employed (HNP or NNP)

		NNP		
		Adequate	Inadequate	Total
HNP	Adequate	63	18	81
	Inadequate	2	7	9
	Total	65	25	90

NNP, Normal negative pressure; HNP, High negative pressure

Table 4. Final diagnosis independently of tissue biopsies (EUS-FNA)

	Final diagnosis
Ductal adenocarcinoma	71
Acinar cell carcinoma	1
Undifferentiated carcinoma with osteoclast-like cells	1
Carcinoma (unclassified)	4
Secondary tumors of the pancreas (adenocarcinoma)	1
Solid-pseudopapillary neoplasm	1
Neuroendocrine tumor	4
No evidence of malignancy	7
Total	90

Table 5. The relationship between adequacy of samples obtained for histological diagnosis and accuracy of diagnoses

		Accuracy		
		Accurate	Inaccurate	Total
Adequacy	Adequate	130	16	146
	Inadequate	10	24	34
	Total	140	40	180

$P < 0.001$ (by Chi-square test)

Table 6. Quality of samples obtained using the HNP/EUS-FNA and NNP/EUS-FNA techniques assessed based on the degree of contamination present and the amount of blood in the sample

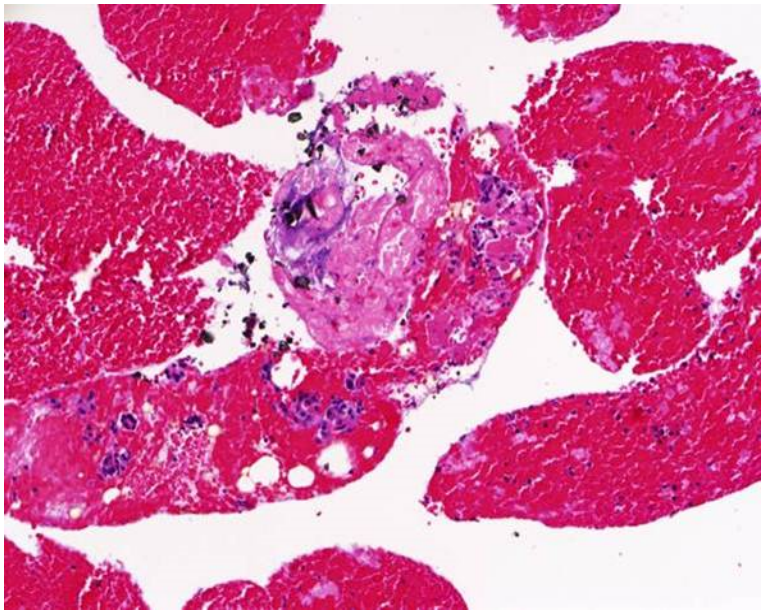
Contamination		HNP	NNP
0	No contamination seen	70	68
1	Contamination present in <25% of the slide	19	10
2	Contamination present in 25–50% of the slide	1	10
3	Contamination present in >50% of the slide	0	2

Amount of blood		HNP	NNP
0	Minimal	16	28
1	Moderate	41	43
2	Significant	33	19

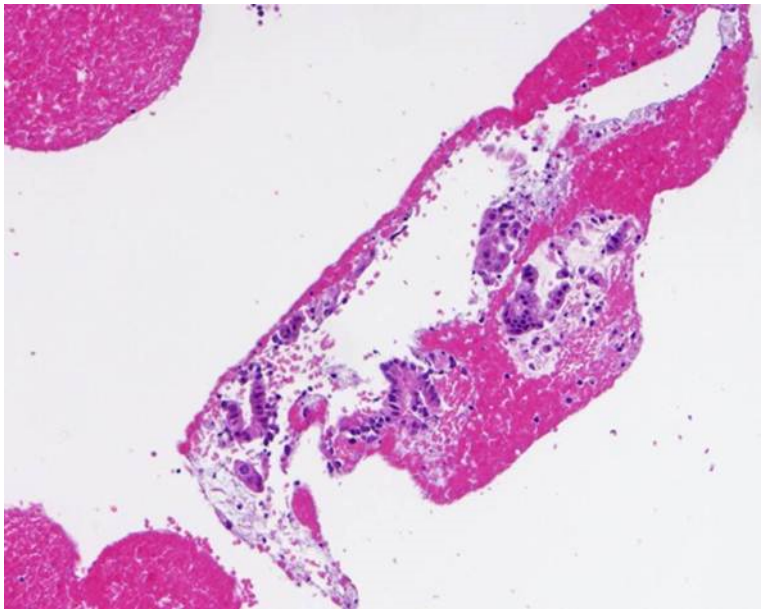
HNP, High negative pressure; NNP, Normal negative pressure

Figure 1.

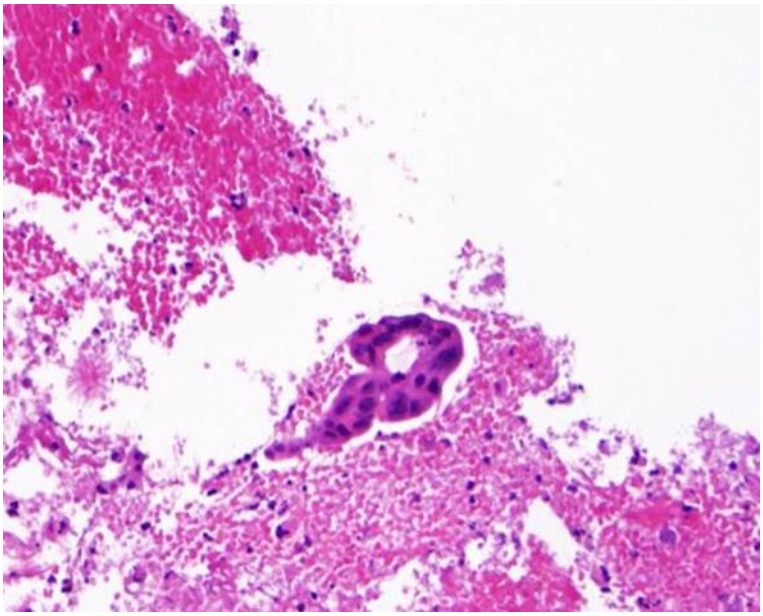
(a)



(b)



(c)



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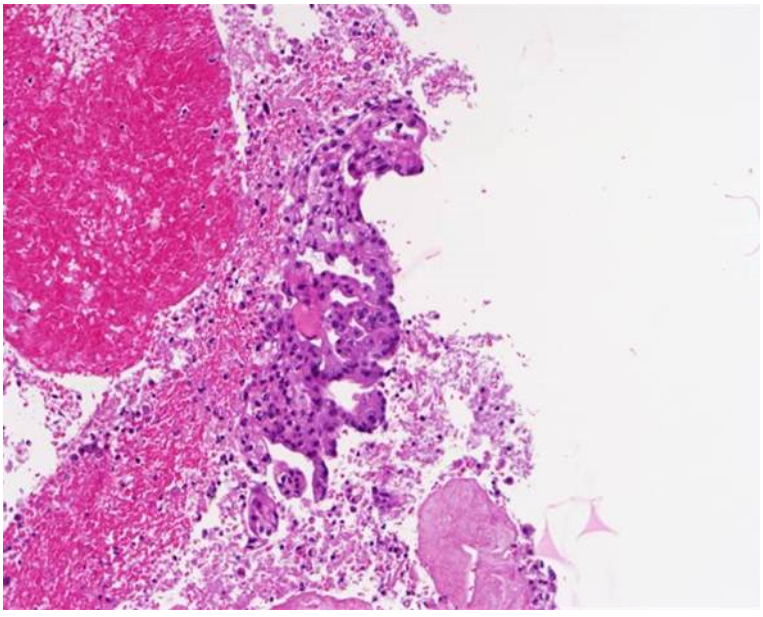


(e)

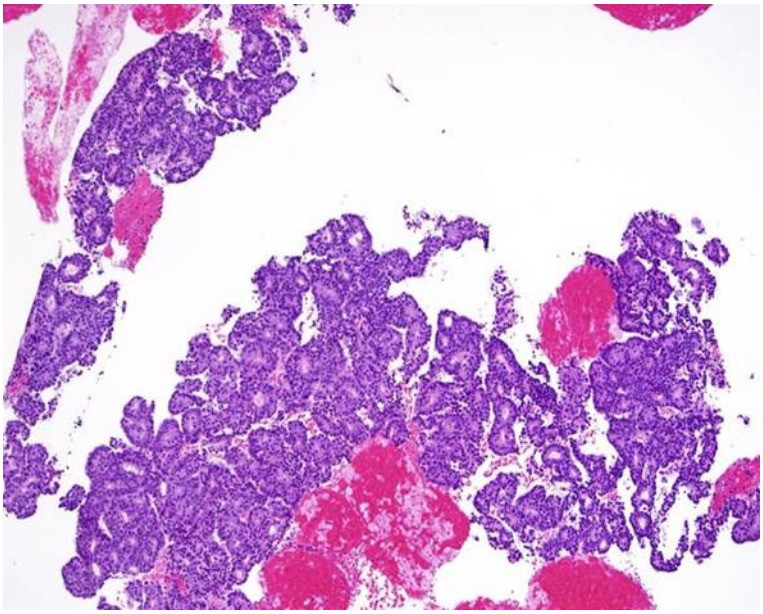
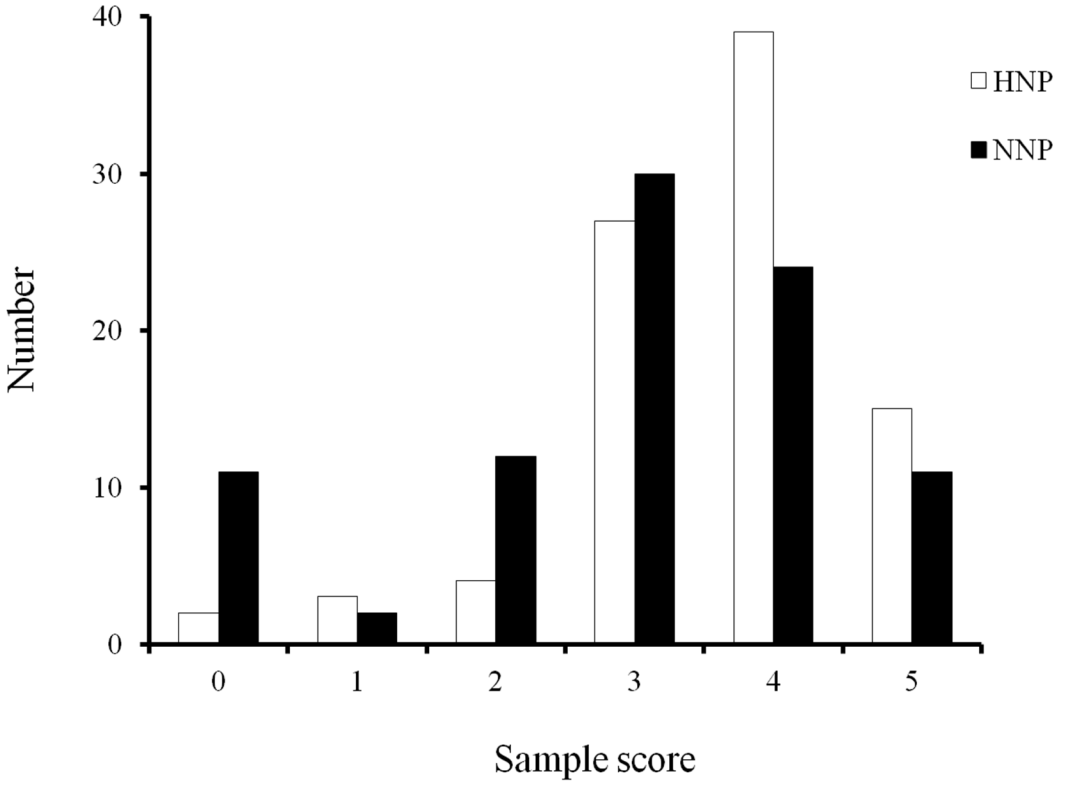


Figure 2.



HNP, High negative pressure; NNP, Normal negative pressure

Figure Legends

Figure 1.

Representative images of specimens obtained using EUS-FNA reveal differences between samples in terms of adequacy for histological diagnosis. (a) In this sample with a score of 1, only a few cells are recognizable (hematoxylin and eosin stain, magnification ×200). This sample is inadequate for histological or cytological diagnosis. (b) This is a sample that received a score of 2. This sample is inadequate for histological diagnosis, but might possibly be suitable for cytological diagnosis. (c) This specimen (score 3) is recognizable as a small tissue cluster. Evaluation of a part of tissue architecture and limited histological interpretation is possible. (d) In this sample (score 4), there is sufficient material for adequate histological diagnosis, and tissue architecture can be evaluated. The area of tissue on the prepared slide is within 10× power field in length. (e) In this sample (score 5), there is sufficient material for adequate histological diagnosis and tissue architecture can be evaluated. The area of tissue on the prepared slide is over 10× power field in length.

Figure 2.

Scores of 0–5 were assigned to specimens to describe the adequacy of these samples for histological diagnosis. More samples with a score of 3–5 were obtained using the HNP suction technique than NNP.

Take-home message

- ✓ The use of the high negative pressure suction technique is superior to normal negative pressure suction in terms of the amount of sufficient material for histological diagnosis obtained via EUS-FNA

- ✓ A high diagnostic accuracy is achievable using a 25-gauge needle and high negative pressure suction when performing EUS-FNA on pancreatic lesions.

References

[1] Vilmann P, Jacobsen GK, Henriksen FW, et al. Endoscopic ultrasonography with guided fine needle aspiration biopsy in pancreatic disease. Gastrointest Endosc. 1992; **38**: 172-3.

[2] Wani S, Early D, Kunkel J, et al. Diagnostic yield of malignancy during EUS-guided FNA of solid lesions with and without a stylet: a prospective, single blind, randomized, controlled trial. Gastrointest Endosc. 2012; **76**: 328-35.

[3] Levy MJ, Wiersema MJ. EUS-guided Trucut biopsy. Gastrointest Endosc. 2005; **62**: 417-26.

[4] Sakamoto H, Kitano M, Komaki T, et al. Prospective comparative study of the EUS guided 25-gauge FNA needle with the 19-gauge Trucut needle and 22-gauge FNA needle in patients with solid pancreatic masses. J Gastroenterol Hepatol. 2009; **24**: 384-90.

[5] Larghi A, Noffsinger A, Dye CE, et al. EUS-guided fine needle tissue acquisition by using high negative pressure suction for the evaluation of solid masses: a pilot study. Gastrointest Endosc. 2005; **62**: 768-74.

[6] Gerke H, Rizk MK, Vanderheyden AD, et al. Randomized study comparing endoscopic ultrasound-guided Trucut biopsy and fine needle aspiration with high suction. Cytopathology. 2010; **21**: 44-51.

[7] Cotton PB, Eisen GM, Aabakken L, et al. A lexicon for endoscopic adverse events: report of an ASGE workshop. Gastrointest Endosc. 2010; **71**: 446-54.

[8] Imazu H, Uchiyama Y, Kakutani H, et al. A prospective comparison of EUS-guided FNA using 25-gauge and 22-gauge needles. Gastroenterol Res Pract. 2009; **2009**: 546390.

[9] Lee JH, Stewart J, Ross WA, et al. Blinded prospective comparison of the performance of 22-gauge and 25-gauge needles in endoscopic ultrasound-guided fine needle aspiration of the pancreas and peri-pancreatic lesions. Dig Dis Sci. 2009; **54**: 2274-81.

[10] Siddiqui UD, Rossi F, Rosenthal LS, et al. EUS-guided FNA of solid pancreatic masses: a prospective, randomized trial comparing 22-gauge and 25-gauge needles. Gastrointest Endosc. 2009; **70**: 1093-7.

[11] Yusuf TE, Ho S, Pavey DA, et al. Retrospective analysis of the utility of endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) in pancreatic masses, using a 22-gauge or 25-gauge needle system: a multicenter experience. Endoscopy. 2009; **41**: 445-8.

[12] Siddiqui AA, Lyles T, Avula H, et al. Endoscopic ultrasound-guided fine needle aspiration of pancreatic masses in a veteran population: comparison of results with 22- and 25-gauge needles. Pancreas. 2010; **39**: 685-6.

[13] Camellini L, Carlinfante G, Azzolini F et al. A randomized clinical trial comparing 22G and 25G needles in endoscopic ultrasound-guided fine-needle aspiration of solid lesions. Endoscopy. 2011; **43**: 709-15.

[14] Uehara H, Ikezawa K, Kawada N et al. Diagnostic accuracy of endoscopic ultrasound-guided fine needle aspiration for suspected pancreatic malignancy in relation to the size of lesions. J Gastroenterol Hepatol. 2011; **26**: 1256-61.

[15] Fabbri C, Polifemo AM, Luigiano C et al. Endoscopic ultrasound-guided fine needle aspiration with 22- and 25-gauge needles in solid pancreatic masses: a prospective comparative study with randomisation of needle sequence. Dig Liver Dis. 2011; **43**: 647-52.

[16] Lee JK, Lee KT, Choi ER, et al. A prospective, randomized trial comparing 25-gauge and 22-gauge needles for endoscopic ultrasound-guided fine needle aspiration of pancreatic masses. Scand J Gastroenterol. 2013; **48**: 752-7.

[17] Vilmann P, Săftoiu A, Hollerbach S, et al. Multicenter randomized controlled trial comparing the performance of 22 gauge versus 25 gauge EUS-FNA needles in solid masses. Scand J Gastroenterol. 2013; **48**: 877-83.

[18] Madhoun MF, Wani SB, Rastogi A, et al. The diagnostic accuracy of 22-gauge and 25-gauge needles in endoscopic ultrasound-guided fine needle aspiration of solid pancreatic lesions: a meta-analysis. Endoscopy. 2013; **45**: 86-92.

[19] Iglesias-Garcia J, Dominguez-Munoz E, Lozano-Leon A, et al. Impact of endoscopic ultrasound-guided fine needle biopsy for diagnosis of pancreatic masses. World J Gastroenterol. 2007; **13**: 289-93.

[20] Iglesias-Garcia J, Poley JW, Larghi A, et al. Feasibility and yield of a new EUS histology needle: results from a multicenter, pooled, cohort study. Gastrointest Endosc. 2011; **73**: 1189-96.

[21] Puri R, Vilmann P, Săftoiu A, et al. Randomized controlled trial of endoscopic ultrasound-guided fine-needle sampling with or without suction for better cytological diagnosis. Scand J Gastroenterol. 2009; **44**: 499-504.

[22] Wallace MB, Kennedy T, Durkalski V, et al. Randomized controlled trial of EUS-guided fine needle aspiration techniques for the detection of malignant lymphadenopathy. Gastrointest Endosc. 2001; **54**: 441-7.

[23] Polkowski M, Larghi A, Weynand B, et al. Learning, techniques, and complications of endoscopic ultrasound (EUS)-guided sampling in gastroenterology: European Society of Gastrointestinal Endoscopy (ESGE) Technical Guideline.

Endoscopy. 2012; **44**: 190-206.

[24] Haba S, Yamao K, Bhatia V, et al. Diagnostic ability and factors affecting accuracy of endoscopic ultrasound-guided fine needle aspiration for pancreatic solid lesions: Japanese large single center experience. J Gastroenterol 2012; **48**: 973-81.

[25] Wang KX, Ben QW, Jin ZD, et al. Assessment of morbidity and mortality associated with EUS-guided FNA: a systematic review. Gastrointest Endosc. 2011; **73**: 283-90.

[26] Puri R, Vilmann P, Săftoiu A, et al. Randomized controlled trial of endoscopic ultrasound-guided fine-needle sampling with or without suction for better cytological diagnosis. Scand J Gastroenterol. 2009; **44**: 499-504.

[27] Wallace MB, Kennedy T, Durkalski V, et al. Randomized controlled trial of EUS-guided fine needle aspiration techniques for the detection of malignant lymphadenopathy. Gastrointest Endosc. 2001; **54**: 441-7.

[28] Polkowski M, Larghi A, Weynand B, et al. Learning, techniques, and complications of endoscopic ultrasound (EUS)-guided sampling in gastroenterology: European Society of Gastrointestinal Endoscopy (ESGE) Technical Guideline. Endoscopy. 2012; **44**: 190-206.

[29] Haba S, Yamao K, Bhatia V, et al. Diagnostic ability and factors affecting accuracy of endoscopic ultrasound-guided fine needle aspiration for pancreatic solid lesions: Japanese large single center experience. J Gastroenterol 2012; **48**: 973-81.

[30] Varadarajulu S, Fockens P, Hawes RH. Best practices in endoscopic ultrasound-guided fine-needle aspiration. Clin Gastroenterol Hepatol. 2012; **10**: 697-703.

[31] Wang KX, Ben QW, Jin ZD, et al. Assessment of morbidity and mortality

associated with EUS-guided FNA: a systematic review. Gastrointest Endosc. 2011; **73**: 283-90.

Conflict of interest statement

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Appendix

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