



## Methods to increase the diagnostic efficiency of endoscopic ultrasound-guided fine-needle aspiration for solid pancreatic lesions: An updated review

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### Abstract

Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) is a means to procure adequate specimens for histological and cytologic analysis. The ideal EUS-FNA should be safe, accurate, and have a high sample adequacy rate and low adverse events rate. In recent years, many guidelines and trials on EUS-FNA have been published. The purpose of this article is to provide an update on the influence of some of the main factors on the diagnostic efficiency of EUS-FNA as well as a rare but serious complication known as needle tract seeding.

**Key Words:** Endoscopic ultrasound; EUS-FNA; Pancreatic cancer; Diagnostic efficiency

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**Core Tip:** This review evaluates the influencing factors and limitations of endoscopic ultrasound-guided fine-needle aspiration of solid pancreatic lesions. The information presented here highlights multiple factors and the latest results, such as mass size, rapid on-site evaluation, and needle tract seeding for improving diagnostic efficiency. Therefore, this review may be highly beneficial for clinicians focusing on the management of endoscopic ultrasound-guided fine-needle aspiration.

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## INTRODUCTION

Pancreatic cancer is one of the worst solid pancreatic lesions. The incidence of pancreatic cancer is increasing year by year [1], and the 5-year survival rate is no more than 10% [2]. Due to the low early diagnostic rate, approximately 80% of patients are diagnosed when pancreatic cancer has reached an unresectable stage [3]. Therefore, a reliable and widely applicable early assessment of pancreatic cancer is extremely important for personalized therapies [4]. Decades after endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) was designed in the early 1990s by Vilmann *et al* [5], it is considered a recommended method when the diagnosis is unclear in patients with suspected pancreatic cancer following the computed tomography scan pancreatic protocol [6-8]. According to the latest research, genetic testing technology such as whole-exome sequencing and nuclear DNA content assessment can also be used with EUS-FNA [9]. In recent years, many guidelines and trials on EUS-FNA have been published [10,11]. In the past few years, endoscopic ultrasound-guided fine-needle biopsy (EUS-FNB) has become a useful tool. The newer fine-needle biopsy (FNB) needles are equally effective in pancreatic lesions and non-pancreatic lesions, such as subepithelial lesions and abdominal lymph node lesions, which can improve the sample adequacy rate and diagnostic accuracy [12,13]. However, the evidence relating to this is limited and further multiple large sample studies and randomized clinical trials are warranted to improve the diagnostic efficiency of EUS-FNA [14].

## MASS SIZE

With the development of pancreatic cancer diagnosis technology, early detection of small solid pancreatic lesions is increasingly common. In the past, it was believed that there was no relationship between lesion size and EUS-FNA diagnostic yield [15,16]. However, previous related research was conducted with rapid on-site evaluation (ROSE), in which the procedure was repeated until the representative cells were confirmed from the target lesion. Nevertheless, according to a retrospective cohort study by Crinò *et al* [17], the adequacy, accuracy, and sensitivity of EUS-FNA for solid pancreatic lesions without ROSE are related to the size of the mass. This finding indicates that endoscopists need to be more cautious when diagnosing small solid pancreatic lesions without ROSE, especially in patients with lesions less than 20 mm [6].

## NEEDLE SIZE

According to the latest guidelines in United Kingdom, Japan, and China, there is still uncertainty regarding the optimal needle size for EUS-FNA in solid pancreatic lesions supported by high-level evidence. Generally, in terms of needle choice, a 19-gauge needle is used for interventional surgery. A 22-gauge needle is usually used for histologic evaluation, while a 25-gauge needle has been widely used in cytologic assessment with ROSE [18,19].

In recent years, due to their manageability and safety, 22-gauge and 25-gauge needles have gained increasing popularity in clinical trials [20]. According to a meta-analysis which included 7 trials with 689 patients and 732 lesions from 2007 to 2014, there was no significant difference between a 22-gauge needle and a 25-gauge needle on cytologic evaluation in terms of diagnostic sensitivity, specificity, sample adequacy, and adverse events [21]. In addition, a retrospective study of 153 patients with pancreatic ductal adenocarcinoma showed that both 22-gauge and 25-gauge needles both provided equal adequate specimens for immunohistochemical analysis [22].

With regard to the 19-gauge needle, it has advantages over the 22-gauge and 25-gauge needle in terms of the size and quality of tissue samples obtained without ROSE [23]. However, as a result of its stiffness and difficulty in use, the 19-gauge needle often fails when performed *via* the transduodenal approach in a bent position, essentially in pancreatic head or uncinate process tumors [23]. To overcome this problem, a flexible 19-gauge needle with a nitinol shaft (19 G Flex) was introduced. However, according to a randomized study by Laquière *et al* [24], the 19 G Flex needle was inferior to a standard 22-gauge needle in diagnosing pancreatic head cancer and was still difficult to use in the transduodenal approach. Intermediate size needles (20-G or 21-G) are on the way [25,26].

## SUCTION, SLOW-PULL OR NON-SUCTION

Suction is commonly used to obtain adequate samples, but it may damage cellular structures and contaminate the sample with blood, clouding cytologic interpretation [27]. Compared with dry suction, wet suction has better sample adequacy and higher diagnostic accuracy without increasing blood contamination [28,29]. In addition, slow-pull and non-suction sampling are techniques that procure samples of good quality with only slight blood contamination [30-32]. According to a prospective randomized trial by Cheng *et al* [30] and a multicenter randomized trial by Saxena *et al* [32], both suction and slow-pull sampling need 2 passes on average and show equivalent sensitivity, specificity, and accuracy. The combination of these two techniques shows better sampling results than each alone. This study also concluded, in contrast to the study by Mohammad Alizadeh *et al* [33], that suction did not increase blood contamination of the sample compared with slow-pull sampling in solid pancreatic lesions.

## WITH OR WITHOUT STYLET

The use of a stylet during EUS-FNA prolongs the procedure time with an increased risk of unintentional needle stick injury due to repeat passes during reinsertion of the stylet[34]. However, a longer operation time does not mean better diagnostic efficiency. As indicated by prospective studies and meta-analyses, the use of a stylet during EUS-FNA confers no significant difference in terms of technical success, the mean number of needle passes, needle malfunction, complications, adequate sample rate, cellularity, contamination rate, bloodiness, cytological diagnostic accuracy, and histological diagnostic accuracy[35-38].

## RAPID ON-SITE EVALUATION

In the past, it was believed that ROSE could help the diagnostic accuracy of pancreatic EUS-FNA and reduce the number of needle passes and inadequate samples[39]. However, recent comprehensive data on the impact of ROSE have been conflicting. In a multicenter randomized controlled trial and a meta-analysis, no statistical difference was demonstrated in diagnostic accuracy, adequacy rate, procedure time, and the average number of needle passes between EUS-FNA with and without ROSE[40,41]. However, a study that considered pancreatic, submucosal upper gastrointestinal tract and adjacent lesions indicated that ROSE does improve the adequacy rate and diagnostic accuracy of EUS-FNA, especially in solid pancreatic lesions[42]. The variety of conclusions among different studies may be related to other factors such as the difficulty in implementing blind methods, additional passes when malignant cells are not detected, and the experience of endoscopists and cytopathologists[43]. Therefore, ROSE alone may not be the predominant factor. It could be considered an essential part of the learning period and in hospitals where the diagnostic accuracy rate is lower than 90%[44].

## CONTRAST-ENHANCED HARMONIC ENDOSCOPIC ULTRASOUND AND ELASTOGRAPHY

Contrast-enhanced harmonic endoscopic ultrasound (CEH-EUS) and elastography have been widely used to assist in the diagnosis of pancreatic indeterminate lesions[45]. It can correctly distinguish false negative diagnoses of EUS-FNA, thus improving the diagnostic rate of pancreatic diseases and EUS-FNA[46,47]. CEH-EUS-guided fine-needle aspiration (CEH-EUS-FNA) avoids fibrosis, necrotic areas, and blood vessels in pancreatic lesions, and can locate the sampling site more accurately[48]. Compared with the standard EUS-FNA, it can reduce the number of punctures when obtaining equivalent sufficient samples, thus reducing the incidence of adverse events related to EUS-FNA, such as bleeding, perforation, infection, and pancreatitis *etc*[46,49]. Elastography strain imaging is accessible through EUS, wherein it gauges tissue distortion by the application of a predetermined pressure. The combined utilization of CEH-EUS or elastography appears to enhance the diagnostic capability of EUS[50]. However, a meta-analysis suggested that more studies are needed to assess the combined utilization[51].

## NEEDLE TRACT SEEDING

Apart from common complications such as pancreatitis and bleeding, a rare but serious complication has also received increasing attention since 2003. Cancer recurrence due to needle tract seeding after EUS-FNA was first reported by Hirooka *et al*[52] in a patient with a pancreatic tumor. Since then, relevant studies have been published continuously, discussing the impact of tumor cell seeding *via* the needle tract on short-term prognosis[53]. According to several retrospective studies, although pre-operative EUS-FNA has not been proved to be associated with overall survival or an increased rate of gastric and peritoneal cancer recurrence, its potential long-term prognosis is still non-negligible[54-57]. Furthermore, this phenomenon is unique to tumors in the pancreatic body and tail, considering that the needle tract is not included in the surgical resection of these tumors[58-65]. Therefore, if possible, more attention to the imaging findings of the needle tract in the postoperative follow-up is necessary or including the needle tract during the surgical resection may improve long-term prognosis[66]. In addition, appropriate risk information on needle tract seeding before EUS-FNA is necessary[65].

## EUS-FNB AND MACROSCOPIC ON-SITE EVALUATION

EUS-FNB has become the first choice when multiple immunohistochemical staining is required to assist in the diagnosis of diseases such as autoimmune pancreatitis and pancreatic metastasis[67]. At present, relevant studies have mainly focused on the research and development of puncture needles of different types and shapes. The most common ProCore® biopsy needle improves the adequacy of tissue specimens, and the Acquire® biopsy needle improves the quality of the tissue specimen due to its tip stability and more controllable puncture site[19,67]. However, a study demonstrated that the 22G Acquire® needle achieved better accuracy than the 20G needle due to more pancreatic mass tissue for histologic assay[68].

A trial by Yousri *et al*[69] reported that both FNA and FNB are safe and effective for accurately diagnosing pancreatic and non-pancreatic abnormalities. In comparison to tissue examination alone, FNB demonstrates higher sensitivity and diagnostic accuracy when diagnosing pancreatic lesions. Additionally, FNB can provide a higher quality histological specimen with reduced contamination due to blood. A randomized controlled trial suggested that EUS-FNB without ROSE showed great diagnostic accuracy in solid pancreatic lesions, and ROSE might not be recommended when new FNB needles are used[70]. Although newer FNB needles have the advantage of being self-assisting in diagnosing diseases, standard FNA needles are still very competitive as their high flexibility allows them to puncture difficult target sites and allow for ROSE[25]. A meta-analysis found evidence to suggest that EUS-FNB with ROSE was not significantly better than EUS-FNB with newer end-cutting needles. However, there may still be a potential role for ROSE when reverse bevel needles are utilized[71]. However, ROSE necessitates the presence and expertise of a pathologist, incurs supplementary expenses, and is not accessible in many medical centers. The macroscopic on-site evaluation (MOSE) by an endoscopist was introduced as an alternative to ROSE, and two studies found that MOSE is a complementary technology that reduces the number of needles necessary for sample acquisition and improves diagnostic accuracy in some clinical conditions[71,72] (Table 1).

## DISCUSSION

EUS-FNA plays a pivotal role in the diagnosis and evaluation of solid pancreatic lesions. Although there are still no globally accepted guidelines for the application of EUS-FNA in solid pancreatic lesions, relevant and clinically meaningful studies on techniques are increasing. The ideal EUS-FNA is safe, accurate, and has a high sample adequacy rate and low adverse events rate. Studies are even exploring its use in cancer diagnosis beyond the digestive system[73-75].

Needle size for EUS-FNA has always been a popular research topic. According to a network meta-analysis involving 27 randomized controlled trials and 2711 patients, there was no significant difference in diagnostic accuracy and sample adequacy among 19-gauge, 22-gauge, and 25-gauge needles[76]. This means that endoscopists can choose the needle size based solely on the purpose of the operation, for instance, interventional surgery, histological evaluation, and cytologic assessment. It is also important to note that although the 19-gauge needle has advantages in terms of the quantity and quality of tissue samples obtained without ROSE, it does not perform well *via* the transduodenal approach in a bent position[23]. Modification of a 19-gauge needle, such as material and shape, to make it flexible and easier to use seems warranted.

Inconsistent findings in studies of ROSE may be due to the difficulty of performing the blind method, additional punctures when no malignant cells are detected, and the difference in the experience of endoscopists and cytopathologists[43]. This prevents ROSE itself from being considered as a major factor affecting the diagnostic accuracy of EUS-FNA, at least without sufficient evidence. However, it is almost certain that ROSE plays a role in the effect of mass size on the accuracy of EUS-FNA. Thus, in hospitals without ROSE, endoscopists should be more cautious in patients with small solid pancreatic lesions[17].

According to a prospective randomized trial by Cheng *et al*[30], there was no statistically significant difference between slow-pull and suction EUS-FNA techniques in terms of safety, accuracy, and blood contamination. Several slow-pull and suction techniques, for instance, wet suction, have also been modified to enhance tissue acquisition or reduce tissue damage[77]. However, sufficient evidence to prove that one technique is superior to another is still required.

As mentioned above, it would be reasonable not to use a stylet during the EUS-FNA process, which may make the operation easier, reduce labor intensity, take less time and be more cost-effective without affecting the quality of the results.

In recent years, although the incidence of needle tract seeding is low, due to its serious consequences, this complication has received more and more attention from endoscopists. This may also be precisely because of its low incidence that the results of its impact on overall survival rate were not obtained in relevant previous studies and meta-analyses[54-57]. In order to fully clarify the clinical characteristics of EUS-FNA posterior needle tract seeding, further prospective studies are warranted. However, in current clinical practice, it is still recommended that attention is paid to needle tract seeding and appropriate risk information is necessary.

Organoids offer a comprehensive depiction of the intricate diversity inherent in tumors, covering their genetic constitution, transcriptional landscape, metabolic dynamics, cytological intricacies, and histological characteristics. Organoids serve as a synthesized representation of multiple tumoral features *in vivo*, thereby serving as a pivotal conduit between fundamental tumor research and clinical applications, such as drug screening[78]. With the exploration and development of new technologies, tissues obtained by EUS can also be used for organoid culture[79].

Tumor organoids are mainly cultured from surgically resected samples, the inherent difficulty in obtaining viable specimens from advanced-stage tumors, such as pancreatic cancer, poses a significant impediment to this approach. In contrast, EUS-FNA is a versatile methodology, applicable across all disease stages, encompassing preoperative, perioperative, post-therapeutic, and recurrent phases. This methodological flexibility means that EUS-FNA is unconstrained by disease staging, thereby facilitating the establishment of a dynamic organoid that faithfully mirrors the temporal progression of the disease[80]. In contrast to traditional methods, these specimens after ROSE can be used immediately in the laboratory to generate organoid cultures, and samples can be taken as the disease progresses, not just after the lesion requires surgical excision.

Table 1 Characteristics of the study

| Ref.                          | Number of patients | Study design                                | Result (Diagnosis accuracy)                                                            |
|-------------------------------|--------------------|---------------------------------------------|----------------------------------------------------------------------------------------|
| Karsenti <i>et al</i> [68]    | 60                 | Randomized controlled trial                 | 87% with 22G needle and 67% with 20G needle for FNB, $P = 0.02$                        |
| Yousri <i>et al</i> [69]      | 100                | Prospective study                           | 98% with FNA and 90% with FNB only depending on tissue                                 |
| Crinò <i>et al</i> [70]       | 800                | Randomized controlled non-inferiority trial | 96.4% with ROSE and 97.4% without ROSE, $P = 0.396$                                    |
| Facciorusso <i>et al</i> [71] | 2147               | Meta-analysis                               | FNB with ROSE group better than the FNB only group (OR = 2.49, 1.08-5.73; $P = 0.03$ ) |

FNA: Fine-needle aspiration; ROSE: Rapid on-site evaluation; FNB: Fine-needle biopsy.

## CONCLUSION

In conclusion, short-term outcomes of the factors introduced above are necessary for the improvement of EUS-FNA. Multiple large sample studies and prospective randomized trials are still warranted to discuss cytopathologic support, modification of techniques, materials, and long-term consequences.

## FOOTNOTES

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## REFERENCES

- Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin* 2021; **71**: 209-249 [PMID: 33538338 DOI: 10.3322/caac.21660]
- Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer Statistics, 2021. *CA Cancer J Clin* 2021; **71**: 7-33 [PMID: 33433946 DOI: 10.3322/caac.21654]
- Kleeff J, Korc M, Apte M, La Vecchia C, Johnson CD, Biankin AV, Neale RE, Tempero M, Tuveson DA, Hruban RH, Neoptolemos JP. Pancreatic cancer. *Nat Rev Dis Primers* 2016; **2**: 16022 [PMID: 27158978 DOI: 10.1038/nrdp.2016.22]
- Hampton T. New Target for Pancreatic Cancer Treatment Shows Potential. *JAMA* 2019; **322**: 391-392 [PMID: 31386111 DOI: 10.1001/jama.2019.10165]
- Vilman P, Jacobsen GK, Henriksen FW, Hancke S. Endoscopic ultrasonography with guided fine needle aspiration biopsy in pancreatic disease. *Gastrointest Endosc* 1992; **38**: 172-173 [PMID: 1568614 DOI: 10.1016/s0016-5107(92)70385-x]
- Khoury T, Kadah A, Mari A, Sirhan B, Mahamid M, Sbeit W. The Utility of Endoscopic Ultrasound Fine Needle Aspiration in Pancreatic Cystic Lesions Diagnosis. *Diagnostics (Basel)* 2020; **10** [PMID: 32707780 DOI: 10.3390/diagnostics10080507]
- Larghi A, Rimbaş M, Rizzatti G, Quero G, Gasbarrini A, Costamagna G, Alfieri S. Resectable pancreatic solid lesions: Time to move from surgical diagnosis? *Endosc Ultrasound* 2020; **9**: 76-82 [PMID: 32295965 DOI: 10.4103/eus.eus\_67\_19]
- Cazacu IM, Luzuriaga Chavez AA, Mendoza TR, Qiao W, Singh BS, Bokhari RH, Saftoiu A, Lee JH, Weston B, Stroehlein JR, Kim MP, G Katz MH, Maitra A, McAllister F, Bhutani MS. Quality of life impact of EUS in patients at risk for developing pancreatic cancer. *Endosc*



- Ultrasound* 2020; **9**: 53-58 [PMID: [31552914](#) DOI: [10.4103/eus.eus\\_56\\_19](#)]
- 9 **Plougmann JI**, Klausen P, Toxvaerd A, Abedi AA, Kovacevic B, Karstensen JG, Poulsen TS, Kalaitzakis E, Høgdall E, Vilmann P. DNA sequencing of cytopathologically inconclusive EUS-FNA from solid pancreatic lesions suspicious for malignancy confirms EUS diagnosis. *Endosc Ultrasound* 2020; **9**: 37-44 [PMID: [31552911](#) DOI: [10.4103/eus.eus\\_36\\_19](#)]
- 10 **Guo J**, Sahai AV, Teoh A, Arcidiacono PG, Larghi A, Saftoiu A, Siddiqui AA, Arturo Arias BL, Jenssen C, Adler DG, Lakhtakia S, Seo DW, Itokawa F, Giovannini M, Mishra G, Sabbagh L, Irisawa A, Iglesias-Garcia J, Poley JW, Vila JJ, Jesse L, Kubota K, Kalaitzakis E, Kida M, El-Nady M, Mukai SU, Ogura T, Fusaroli P, Vilmann P, Rai P, Nguyen NQ, Ponnudurai R, Achanta CR, Baron TH, Yasuda I, Wang HP, Hu J, Duan B, Bhutani MS, Sun S. An international, multi-institution survey on performing EUS-FNA and fine needle biopsy. *Endosc Ultrasound* 2020; **9**: 319-328 [PMID: [32883921](#) DOI: [10.4103/eus.eus\\_56\\_20](#)]
- 11 **Dietrich CF**. Controversies in EUS. *Endosc Ultrasound* 2021; **10**: 1-2 [PMID: [33586695](#) DOI: [10.4103/EUS-D-21-00024](#)]
- 12 **Facciorusso A**, Crinò SF, Muscatiello N, Gkolafakis P, Samanta J, Londoño Castillo J, Cotsoglou C, Ramai D. Endoscopic Ultrasound Fine-Needle Biopsy versus Fine-Needle Aspiration for Tissue Sampling of Abdominal Lymph Nodes: A Propensity Score Matched Multicenter Comparative Study. *Cancers (Basel)* 2021; **13** [PMID: [34503112](#) DOI: [10.3390/cancers13174298](#)]
- 13 **Facciorusso A**, Sunny SP, Del Prete V, Antonino M, Muscatiello N. Comparison between fine-needle biopsy and fine-needle aspiration for EUS-guided sampling of subepithelial lesions: a meta-analysis. *Gastrointest Endosc* 2020; **91**: 14-22.e2 [PMID: [31374187](#) DOI: [10.1016/j.gie.2019.07.018](#)]
- 14 **Arya N**, Wyse JM, Jayaraman S, Ball CG, Lam E, Paquin SC, Lightfoot P, Sahai AV. A proposal for the ideal algorithm for the diagnosis, staging, and treatment of pancreas masses suspicious for pancreatic adenocarcinoma: Results of a working group of the Canadian Society for Endoscopic Ultrasound. *Endosc Ultrasound* 2020; **9**: 154-161 [PMID: [32584310](#) DOI: [10.4103/eus.eus\\_28\\_20](#)]
- 15 **Ramesh J**, Kim H, Reddy K, Eltoum IE. Performance characteristic of endoscopic ultrasound-guided fine needle aspiration is unaffected by pancreatic mass size. *Endosc Int Open* 2016; **4**: E434-E438 [PMID: [27092323](#) DOI: [10.1055/s-0035-1569969](#)]
- 16 **Uehara H**, Ikezawa K, Kawada N, Fukutake N, Katayama K, Takakura R, Takano Y, Ishikawa O, Takenaka A. 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**: 1256-1261 [PMID: [21501226](#) DOI: [10.1111/j.1440-1746.2011.06747.x](#)]
- 17 **Crinò SF**, Conti Bellocchi MC, Bernardoni L, Manfrin E, Parisi A, Amodio A, De Pretis N, Frulloni L, Gabbriellini A. Diagnostic yield of EUS-FNA of small ( $\leq 15$  mm) solid pancreatic lesions using a 25-gauge needle. *Hepatobiliary Pancreat Dis Int* 2018; **17**: 70-74 [PMID: [29428108](#) DOI: [10.1016/j.hbpd.2018.01.010](#)]
- 18 **Ge N**, Zhang S, Jin Z, Sun S, Yang A, Wang B, Wang G, Xu G, Hao J, Zhong L, Zhong N, Li P, Zhu Q, Nian W, Li W, Zhang X, Zhou X, Yang X, Cui Y, Ding Z. Clinical use of endoscopic ultrasound-guided fine-needle aspiration: Guidelines and recommendations from Chinese Society of Digestive Endoscopy. *Endosc Ultrasound* 2017; **6**: 75-82 [PMID: [28440232](#) DOI: [10.4103/eus.eus\\_20\\_17](#)]
- 19 **Facciorusso A**, Bajwa HS, Menon K, Buccino VR, Muscatiello N. Comparison between 22G aspiration and 22G biopsy needles for EUS-guided sampling of pancreatic lesions: A meta-analysis. *Endosc Ultrasound* 2020; **9**: 167-174 [PMID: [31031330](#) DOI: [10.4103/eus.eus\\_4\\_19](#)]
- 20 **Madhoun MF**, Wani SB, Rastogi A, Early D, Gaddam S, Tierney WM, Maple JT. 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 [PMID: [23307148](#) DOI: [10.1055/s-0032-1325992](#)]
- 21 **Facciorusso A**, Stasi E, Di Maso M, Serviddio G, Ali Hussein MS, Muscatiello N. Endoscopic ultrasound-guided fine needle aspiration of pancreatic lesions with 22 versus 25 Gauge needles: A meta-analysis. *United European Gastroenterol J* 2017; **5**: 846-853 [PMID: [29026598](#) DOI: [10.1177/2050640616680972](#)]
- 22 **Yoshizawa N**, Yamada R, Sakuno T, Inoue H, Miura H, Takeuchi T, Nakamura M, Hamada Y, Katsurahara M, Tanaka K, Horiki N, Takei Y. Comparison of endoscopic ultrasound-guided fine-needle aspiration and biopsy with 22-gauge and 25-gauge needles for the "precision medicine" of pancreatic cancer: A retrospective study. *Medicine (Baltimore)* 2018; **97**: e11096 [PMID: [29901627](#) DOI: [10.1097/MD.00000000000011096](#)]
- 23 **Song TJ**, Kim JH, Lee SS, Eum JB, Moon SH, Park DY, Seo DW, Lee SK, Jang SJ, Yun SC, Kim MH. The prospective randomized, controlled trial of endoscopic ultrasound-guided fine-needle aspiration using 22G and 19G aspiration needles for solid pancreatic or peripancreatic masses. *Am J Gastroenterol* 2010; **105**: 1739-1745 [PMID: [20216532](#) DOI: [10.1038/ajg.2010.108](#)]
- 24 **Laquière A**, Lefort C, Maire F, Aubert A, Gincul R, Prat F, Grandval P, Croizet O, Boulant J, Vanbiervliet G, Pénaranda G, Lecomte L, Napoléon B, Boustière C. 19 G nitinol needle versus 22 G needle for transduodenal endoscopic ultrasound-guided sampling of pancreatic solid masses: a randomized study. *Endoscopy* 2019; **51**: 436-443 [PMID: [30453379](#) DOI: [10.1055/a-0757-7714](#)]
- 25 **van Riet PA**, Giorgio Arcidiacono P, Petrone M, Quoc Nguyen N, Kitano M, Chang K, Larghi A, Iglesias-Garcia J, Giovannini M, van der Merwe S, Santo E, Baldaque-Silva F, Bucobo JC, Bruno MJ, Aslanian HR, Cahen DL, Farrell J. Combined versus single use 20 G fine-needle biopsy and 25 G fine-needle aspiration for endoscopic ultrasound-guided tissue sampling of solid gastrointestinal lesions. *Endoscopy* 2020; **52**: 37-44 [PMID: [31330556](#) DOI: [10.1055/a-0966-8755](#)]
- 26 **van Riet PA**, Cahen DL, Biermann K, Hansen B, Larghi A, Rindi G, Fellegara G, Arcidiacono P, Doglioni C, Liberta Decarli N, Iglesias-Garcia J, Abdulkader I, Lazare Iglesias H, Kitano M, Chikugo T, Yasukawa S, van der Valk H, Nguyen NQ, Ruszkiewicz A, Giovannini M, Poizat F, van der Merwe S, Roskams T, Santo E, Marmor S, Chang K, Lin F, Farrell J, Robert M, Bucobo JC, Heimann A, Baldaque-Silva F, Fernández Moro C, Bruno MJ. Agreement on endoscopic ultrasonography-guided tissue specimens: Comparing a 20-G fine-needle biopsy to a 25-G fine-needle aspiration needle among academic and non-academic pathologists. *Dig Endosc* 2019; **31**: 690-697 [PMID: [31290176](#) DOI: [10.1111/den.13424](#)]
- 27 **Ramai D**, Singh J, Kani T, Barakat M, Chandan S, Brooks OW, Ofofu A, Khan SR, Dhindsa B, Dhaliwal A, Quintero EJ, Cheung D, Facciorusso A, McDonough S, Adler DG. Wet- versus dry-suction techniques for EUS-FNA of solid lesions: A systematic review and meta-analysis. *Endosc Ultrasound* 2021; **10**: 319-324 [PMID: [34259217](#) DOI: [10.4103/EUS-D-20-00198](#)]
- 28 **Wang Y**, Wang RH, Ding Z, Tan SY, Chen Q, Duan YQ, Zhu LR, Cao JW, Wang J, Shi G, Wu XL, Wang JL, Zhao YC, Tang SJ, Cheng B. Wet- versus dry-suction techniques for endoscopic ultrasound-guided fine-needle aspiration of solid lesions: a multicenter randomized controlled trial. *Endoscopy* 2020; **52**: 995-1003 [PMID: [32413915](#) DOI: [10.1055/a-1167-2214](#)]
- 29 **Mok SRS**, Diehl DL, Johal AS, Khara HS, Confer BD, Mudireddy PR, Kirchner HL, Chen ZE. A prospective pilot comparison of wet and dry heparinized suction for EUS-guided liver biopsy (with videos). *Gastrointest Endosc* 2018; **88**: 919-925 [PMID: [30120956](#) DOI: [10.1016/j.gie.2018.07.036](#)]
- 30 **Cheng S**, Brunaldi VO, Minata MK, Chacon DA, da Silveira EB, de Moura DT, Dos Santos ME, Matuguma SE, Chaves DM, França RF, Jacomo AL, Artifon E. Suction versus slow-pull for endoscopic ultrasound-guided fine-needle aspiration of pancreatic tumors: a prospective

- randomized trial. *HPB (Oxford)* 2020; **22**: 779-786 [PMID: 31677985 DOI: 10.1016/j.hpb.2019.10.007]
- 31 **Li SY**, Shi L, Yao J, Zhou W, Wang ZJ, Jiang YP, Wang XW, Zhou CH, Gao L, Jiang H, Chen Y, Li ZS, Jin ZD, Wang KX. Optimal sampling technique for EUS-guided fine-needle biopsy of solid pancreatic lesions using a 25-gauge ProCore needle: A multicenter randomized crossover superiority study. *Endosc Ultrasound* 2022; **11**: 466-477 [PMID: 36537384 DOI: 10.4103/EUS-D-21-00256]
  - 32 **Saxena P**, El Zein M, Stevens T, Abdelgelil A, Besharati S, Messallam A, Kumbhari V, Azola A, Brainard J, Shin EJ, Lennon AM, Canto MI, Singh VK, Khashab MA. Stylet slow-pull versus standard suction for endoscopic ultrasound-guided fine-needle aspiration of solid pancreatic lesions: a multicenter randomized trial. *Endoscopy* 2018; **50**: 497-504 [PMID: 29272906 DOI: 10.1055/s-0043-122381]
  - 33 **Mohammad Alizadeh AH**, Hadizadeh M, Padashi M, Shahbaazi S, Molaee M, Shariatpanahi ZV. Comparison of two techniques for endoscopic ultrasonography fine-needle aspiration in solid pancreatic mass. *Endosc Ultrasound* 2014; **3**: 174-178 [PMID: 25184124 DOI: 10.4103/2303-9027.138790]
  - 34 **Rastogi A**, Wani S, Gupta N, Singh V, Gaddam S, Reddymasu S, Ullasac O, Fan F, Romanas M, Dennis KL, Sharma P, Bansal A, Oropeza-Vail M, Olyae M. A prospective, single-blind, randomized, controlled trial of EUS-guided FNA with and without a stylet. *Gastrointest Endosc* 2011; **74**: 58-64 [PMID: 21514932 DOI: 10.1016/j.gie.2011.02.015]
  - 35 **Abe Y**, Kawakami H, Oba K, Hayashi T, Yasuda I, Mukai T, Isayama H, Ishiwatari H, Doi S, Nakashima M, Yamamoto N, Kuwatani M, Mitsuhashi T, Hasegawa T, Hirose Y, Yamada T, Tanaka M, Sakamoto N; Japan EUS-FNA Stylet Study Group. Effect of a stylet on a histological specimen in EUS-guided fine-needle tissue acquisition by using 22-gauge needles: a multicenter, prospective, randomized, controlled trial. *Gastrointest Endosc* 2015; **82**: 837-844.e1 [PMID: 25936452 DOI: 10.1016/j.gie.2015.03.1898]
  - 36 **Lai A**, Davis-Yadley A, Lipka S, Lalama M, Rabbani R, Bromberg D, Nehaul R, Kumar A, Kulkarni P. The Use of a Stylet in Endoscopic Ultrasound With Fine-Needle Aspiration: A Systematic Review and Meta-Analysis. *J Clin Gastroenterol* 2019; **53**: 1-8 [PMID: 28644309 DOI: 10.1097/MCG.0000000000000867]
  - 37 **Kim JH**, Park SW, Kim MK, Lee J, Kae SH, Jang HJ, Koh DH, Choi MH. Meta-Analysis for Cyto-Pathological Outcomes in Endoscopic Ultrasonography-Guided Fine-Needle Aspiration With and Without the Stylet. *Dig Dis Sci* 2016; **61**: 2175-2184 [PMID: 27010546 DOI: 10.1007/s10620-016-4130-5]
  - 38 **Yang MJ**, Hwang JC, Yoo BM, Kim JH, Lee D, Lim H, Kim YB. A prospective randomized trial of EUS-guided tissue acquisition using a 25-gauge core biopsy needle with and without a stylet. *Surg Endosc* 2018; **32**: 3777-3782 [PMID: 29572629 DOI: 10.1007/s00464-018-6166-4]
  - 39 **Iglesias-Garcia J**, Dominguez-Munoz JE, Abdulkader I, Larino-Noia J, Eugenyeva E, Lozano-Leon A, Forteza-Vila J. Influence of on-site cytopathology evaluation on the diagnostic accuracy of endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) of solid pancreatic masses. *Am J Gastroenterol* 2011; **106**: 1705-1710 [PMID: 21483464 DOI: 10.1038/ajg.2011.119]
  - 40 **Wani S**, Mullady D, Early DS, Rastogi A, Collins B, Wang JF, Marshall C, Sams SB, Yen R, Rizeq M, Romanas M, Ullasac O, Brauer B, Attwell A, Gaddam S, Hollander TG, Hosford L, Johnson S, Kushnir V, Amateau SK, Kohlmeier C, Azar RR, Vargo J, Fukami N, Shah RJ, Das A, Edmundowicz SA. The clinical impact of immediate on-site cytopathology evaluation during endoscopic ultrasound-guided fine needle aspiration of pancreatic masses: a prospective multicenter randomized controlled trial. *Am J Gastroenterol* 2015; **110**: 1429-1439 [PMID: 26346868 DOI: 10.1038/ajg.2015.262]
  - 41 **Kong F**, Zhu J, Kong X, Sun T, Deng X, Du Y, Li Z. Rapid On-Site Evaluation Does Not Improve Endoscopic Ultrasound-Guided Fine Needle Aspiration Adequacy in Pancreatic Masses: A Meta-Analysis and Systematic Review. *PLoS One* 2016; **11**: e0163056 [PMID: 27657529 DOI: 10.1371/journal.pone.0163056]
  - 42 **Khoury T**, Kadah A, Farraj M, Barhoum M, Livoff A, Mari A, Mahamid M, Sbeit W. The role of rapid on-site evaluation on diagnostic accuracy of endoscopic ultrasound fine needle aspiration for pancreatic, submucosal upper gastrointestinal tract and adjacent lesions. *Cytopathology* 2019; **30**: 499-503 [PMID: 31034112 DOI: 10.1111/cyt.12712]
  - 43 **Koul A**, Baxi AC, Shang R, Meng X, Li L, Keilin SA, Willingham FF, Cai Q. The efficacy of rapid on-site evaluation during endoscopic ultrasound-guided fine needle aspiration of pancreatic masses. *Gastroenterol Rep (Oxf)* 2018; **6**: 45-48 [PMID: 29479442 DOI: 10.1093/gastro/gox017]
  - 44 **Iglesias-Garcia J**, Lariño-Noia J, Abdulkader I, Domínguez-Muñoz JE. Rapid on-site evaluation of endoscopic-ultrasound-guided fine-needle aspiration diagnosis of pancreatic masses. *World J Gastroenterol* 2014; **20**: 9451-9457 [PMID: 25071339 DOI: 10.3748/wjg.v20.i28.9451]
  - 45 **Tamura T**, Yamashita Y, Itonaga M, Ashida R, Kitano M. Usefulness of EUS-FNA with contrast-enhanced harmonic imaging for diagnosis of gallbladder tumor. *Endosc Ultrasound* 2021; **10**: 224-226 [PMID: 33586687 DOI: 10.4103/EUS-D-20-00112]
  - 46 **Oh D**, Seo DW, Hong SM, Jun JH, Song TJ, Park DH, Son BK, Lee SS, Lee SK, Kim MH. The usefulness of contrast-enhanced harmonic EUS-guided fine-needle aspiration for evaluation of hepatic lesions (with video). *Gastrointest Endosc* 2018; **88**: 495-501 [PMID: 29859228 DOI: 10.1016/j.gie.2018.05.019]
  - 47 **Seicean A**, Samarghitan A, Bolboacă SD, Pojoga C, Rusu I, Rusu D, Sparchez Z, Gheorghiu M, Al Hajjar N, Seicean R. Contrast-enhanced harmonic versus standard endoscopic ultrasound-guided fine-needle aspiration in solid pancreatic lesions: a single-center prospective randomized trial. *Endoscopy* 2020; **52**: 1084-1090 [PMID: 32650346 DOI: 10.1055/a-1193-4954]
  - 48 **Facciorusso A**, Cotsoglou C, Chierici A, Mare R, Crinò SF, Muscatiello N. Contrast-Enhanced Harmonic Endoscopic Ultrasound-Guided Fine-Needle Aspiration versus Standard Fine-Needle Aspiration in Pancreatic Masses: A Propensity Score Analysis. *Diagnostics (Basel)* 2020; **10** [PMID: 33036222 DOI: 10.3390/diagnostics10100792]
  - 49 **Itonaga M**, Kitano M, Kojima F, Hatamaru K, Yamashita Y, Tamura T, Nuta J, Kawaji Y, Shimokawa T, Tanioka K, Murata SI. The usefulness of EUS-FNA with contrast-enhanced harmonic imaging of solid pancreatic lesions: A prospective study. *J Gastroenterol Hepatol* 2020; **35**: 2273-2280 [PMID: 32529685 DOI: 10.1111/jgh.15144]
  - 50 **Goto O**, Kaise M, Iwakiri K. Advancements in the Diagnosis of Gastric Subepithelial Tumors. *Gut Liver* 2022; **16**: 321-330 [PMID: 34456187 DOI: 10.5009/gnl210242]
  - 51 **Shin CM**, Villa E. The efficiency of contrast-enhanced endoscopic ultrasound (EUS) combined with EUS elastography for pancreatic cancer diagnosis: a systematic review and meta-analysis. *Ultrasonography* 2023; **42**: 20-30 [PMID: 36588180 DOI: 10.14366/usg.22103]
  - 52 **Hirooka Y**, Goto H, Itoh A, Hashimoto S, Niwa K, Ishikawa H, Okada N, Itoh T, Kawashima H. Case of intraductal papillary mucinous tumor in which endosonography-guided fine-needle aspiration biopsy caused dissemination. *J Gastroenterol Hepatol* 2003; **18**: 1323-1324 [PMID: 14535994 DOI: 10.1046/j.1440-1746.2003.03040.x]
  - 53 **Nakatsubo R**, Yamamoto K, Itoi T, Sofuni A, Tsuchiya T, Ishii K, Tanaka R, Tonozuka R, Mukai S, Nagai K, Yamaguchi H, Nagakawa Y. Histopathological evaluation of needle tract seeding caused by EUS-fine-needle biopsy based on resected specimens from patients with solid pancreatic masses: An analysis of 73 consecutive cases. *Endosc Ultrasound* 2021; **10**: 207-213 [PMID: 33586689 DOI: 10.4103/EUS-D-20-00174]

- 54 **Yane K**, Kuwatani M, Yoshida M, Goto T, Matsumoto R, Ihara H, Okuda T, Taya Y, Ehira N, Kudo T, Adachi T, Eto K, Onodera M, Sano I, Nojima M, Katanuma A. Non-negligible rate of needle tract seeding after endoscopic ultrasound-guided fine-needle aspiration for patients undergoing distal pancreatectomy for pancreatic cancer. *Dig Endosc* 2020; **32**: 801-811 [PMID: 31876309 DOI: 10.1111/den.13615]
- 55 **Kanno A**, Yasuda I, Irisawa A, Hara K, Ashida R, Iwashita T, Takenaka M, Katanuma A, Takikawa T, Kubota K, Kato H, Nakai Y, Ryozaawa S, Kitano M, Isayama H, Kamada H, Okabe Y, Hanada K, Ohtsubo K, Doi S, Hisai H, Shibukawa G, Imazu H, Masamune A; Collaborators. Adverse events of endoscopic ultrasound-guided fine-needle aspiration for histologic diagnosis in Japanese tertiary centers: Multicenter retrospective study. *Dig Endosc* 2021; **33**: 1146-1157 [PMID: 33284491 DOI: 10.1111/den.13912]
- 56 **Hatamaru K**, Kitano M. Can early diagnosis of EUS-FNA needle tract seeding for pancreatic cancer improve patient prognosis? *Dig Endosc* 2020; **32**: 742-744 [PMID: 32410368 DOI: 10.1111/den.13719]
- 57 **Ngamruengphong S**, Xu C, Woodward TA, Raimondo M, Stauffer JA, Asbun HJ, Wallace MB. Risk of gastric or peritoneal recurrence, and long-term outcomes, following pancreatic cancer resection with preoperative endosonographically guided fine needle aspiration. *Endoscopy* 2013; **45**: 619-626 [PMID: 23881804 DOI: 10.1055/s-0033-1344216]
- 58 **Sato N**, Takano S, Yoshitomi H, Furukawa K, Takayashiki T, Kuboki S, Suzuki D, Sakai N, Kagawa S, Mishima T, Nakada E, Mikata R, Kato N, Ohtsuka M. Needle tract seeding recurrence of pancreatic cancer in the gastric wall with paragastric lymph node metastasis after endoscopic ultrasound-guided fine needle aspiration followed by pancreatectomy: a case report and literature review. *BMC Gastroenterol* 2020; **20**: 13 [PMID: 31941458 DOI: 10.1186/s12876-020-1159-x]
- 59 **Rothermel LD**, Strosberg C, Centeno BA, Malafa MP. Case Report of Isolated Gastric Metastasis of Pancreatic Cancer From a Diagnostic Biopsy: Management of a Rare Oncologic Entity. *Cancer Control* 2020; **27**: 1073274820904042 [PMID: 32107943 DOI: 10.1177/1073274820904042]
- 60 **Matsui T**, Nishikawa K, Yukimoto H, Katsuta K, Nakamura Y, Tanaka S, Oiwa M, Nakahashi H, Shomi Y, Haruki Y, Taniguchi K, Shimomura M, Isaji S. Needle tract seeding following endoscopic ultrasound-guided fine-needle aspiration for pancreatic cancer: a report of two cases. *World J Surg Oncol* 2019; **17**: 134 [PMID: 31382964 DOI: 10.1186/s12957-019-1681-x]
- 61 **Chong A**, Venugopal K, Segarajasingam D, Lisewski D. Tumor seeding after EUS-guided FNA of pancreatic tail neoplasia. *Gastrointest Endosc* 2011; **74**: 933-935 [PMID: 21951481 DOI: 10.1016/j.gie.2010.10.020]
- 62 **Paquin SC**, Gariépy G, Lepanto L, Bourdages R, Raymond G, Sahai AV. A first report of tumor seeding because of EUS-guided FNA of a pancreatic adenocarcinoma. *Gastrointest Endosc* 2005; **61**: 610-611 [PMID: 15812422 DOI: 10.1016/s0016-5107(05)00082-9]
- 63 **Sakamoto U**, Fukuba N, Ishihara S, Sumi S, Okada M, Sonoyama H, Ohshima N, Moriyama I, Kawashima K, Kinoshita Y. Postoperative recurrence from tract seeding after use of EUS-FNA for preoperative diagnosis of cancer in pancreatic tail. *Clin J Gastroenterol* 2018; **11**: 200-205 [PMID: 29392646 DOI: 10.1007/s12328-018-0822-z]
- 64 **Matsumoto K**, Kato H, Tanaka N, Okada H. Preoperative Detection of Tumor Seeding after Endoscopic Ultrasonography-guided Fine Needle Aspiration for Pancreatic Cancer. *Intern Med* 2018; **57**: 1797-1798 [PMID: 29434140 DOI: 10.2169/internalmedicine.0321-17]
- 65 **Yokoyama K**, Ushio J, Numao N, Tamada K, Fukushima N, Kawarai Lefor A, Yamamoto H. Esophageal seeding after endoscopic ultrasound-guided fine-needle aspiration of a mediastinal tumor. *Endosc Int Open* 2017; **5**: E913-E917 [PMID: 28924599 DOI: 10.1055/s-0043-114662]
- 66 **Yamaguchi H**, Morisaka H, Sano K, Nagata K, Ryozaawa S, Okamoto K, Ichikawa T. Seeding of a Tumor in the Gastric Wall after Endoscopic Ultrasound-guided Fine-needle Aspiration of Solid Pseudopapillary Neoplasm of the Pancreas. *Intern Med* 2020; **59**: 779-782 [PMID: 31787691 DOI: 10.2169/internalmedicine.3244-19]
- 67 **Crinò SF**, Ammendola S, Meneghetti A, Bernardoni L, Conti Bellocchi MC, Gabbrielli A, Landoni L, Paiella S, Pin F, Parisi A, Mastrosimini MG, Amodio A, Frulloni L, Facciorusso A, Larghi A, Manfrin E. Comparison between EUS-guided fine-needle aspiration cytology and EUS-guided fine-needle biopsy histology for the evaluation of pancreatic neuroendocrine tumors. *Pancreatol* 2021; **21**: 443-450 [PMID: 33390343 DOI: 10.1016/j.pan.2020.12.015]
- 68 **Karsenti D**, Palazzo L, Perrot B, Zago J, Lemaistre AI, Cros J, Napoléon B. 22G Acquire vs. 20G Procore needle for endoscopic ultrasound-guided biopsy of pancreatic masses: a randomized study comparing histologic sample quantity and diagnostic accuracy. *Endoscopy* 2020; **52**: 747-753 [PMID: 32408361 DOI: 10.1055/a-1160-5485]
- 69 **Yousri M**, Abusinna E, Tahoun N, Okasha HH, El-Habashi AH. A Comparative Study of the Diagnostic Utility of Endoscopic Ultrasound-Guided Fine Needle Aspiration Cytology (EUS-FNA) versus Endoscopic Ultrasound-Guided Fine Needle Biopsy (EUS-FNB) in Pancreatic and Non-Pancreatic Lesions. *Asian Pac J Cancer Prev* 2022; **23**: 2151-2158 [PMID: 35763660 DOI: 10.31557/APJCP.2022.23.6.2151]
- 70 **Crinò SF**, Di Mitri R, Nguyen NQ, Tarantino I, de Nucci G, Deprez PH, Carrara S, Kitano M, Shami VM, Fernández-Esparrach G, Poley JW, Baldaque-Silva F, Itoi T, Manfrin E, Bernardoni L, Gabbrielli A, Conte E, Unti E, Naidu J, Ruszkiewicz A, Amata M, Liotta R, Manes G, Di Nuovo F, Borbath I, Komuta M, Lamonaca L, Rahal D, Hatamaru K, Itonaga M, Rizzatti G, Costamagna G, Inzani F, Curatolo M, Strand DS, Wang AY, Ginès A, Sendino O, Signoretti M, van Driel LMJW, Dolapiesiev K, Matsunami Y, van der Merwe S, van Malenstein H, Locatelli F, Correale L, Scarpa A, Larghi A. Endoscopic Ultrasound-guided Fine-needle Biopsy With or Without Rapid On-site Evaluation for Diagnosis of Solid Pancreatic Lesions: A Randomized Controlled Non-Inferiority Trial. *Gastroenterology* 2021; **161**: 899-909.e5 [PMID: 34116031 DOI: 10.1053/j.gastro.2021.06.005]
- 71 **Facciorusso A**, Gkolafakis P, Tziatzios G, Ramai D, Papanikolaou IS, Triantafyllou K, Lisotti A, Fusaroli P, Mangiavillano B, Chandan S, Mohan BP, Crinò SF. Comparison between EUS-guided fine-needle biopsy with or without rapid on-site evaluation for tissue sampling of solid pancreatic lesions: A systematic review and meta-analysis. *Endosc Ultrasound* 2022; **11**: 458-465 [PMID: 36537383 DOI: 10.4103/EUS-D-22-00026]
- 72 **Schmoldt A**, Benthe HF, Haberland G. Digitoxin metabolism by rat liver microsomes. *Biochem Pharmacol* 1975; **24**: 1639-1641 [PMID: 10]
- 73 **Solonitsyn EG**, Danilov IN, Poddymova AV, Ivaniha EV, Mitrofanova LB. EUS-FNA biopsy of parathyroid gland. *Endosc Ultrasound* 2021; **10**: 315-316 [PMID: 33666184 DOI: 10.4103/EUS-D-20-00215]
- 74 **Shi L**, Zhou T, Deng M, Lü M. Extramedullary plasmacytoma of the pancreas diagnosed by EUS-guided fine-needle biopsy (with videos). *Endosc Ultrasound* 2021; **10**: 143-144 [PMID: 33473045 DOI: 10.4103/eus.eus\_76\_20]
- 75 **Cold KM**, Clementsen PF. Diagnosis and staging of lung cancer using transesophageal ultrasound: Training and assessment. *Endosc Ultrasound* 2022; **11**: 92-94 [PMID: 35488620 DOI: 10.4103/EUS-D-21-00129]
- 76 **Facciorusso A**, Wani S, Triantafyllou K, Tziatzios G, Cannizzaro R, Muscatiello N, Singh S. Comparative accuracy of needle sizes and designs for EUS tissue sampling of solid pancreatic masses: a network meta-analysis. *Gastrointest Endosc* 2019; **90**: 893-903.e7 [PMID: 31310744 DOI: 10.1016/j.gie.2019.07.009]
- 77 **Wang Y**, Chen Q, Wang J, Wu X, Duan Y, Yin P, Guo Q, Hou W, Cheng B. Comparison of modified wet suction technique and dry suction



technique in endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) for solid lesions: study protocol for a randomized controlled trial. *Trials* 2018; **19**: 45 [PMID: [29343303](#) DOI: [10.1186/s13063-017-2380-y](#)]

- 78 **Grützmeier SE**, Kovacevic B, Vilmann P, Rift CV, Melchior LC, Holmström MO, Brink L, Hassan H, Karstensen JG, Grossjohann H, Chiranth D, Toxvaerd A, Hansen CP, Høgdall E, Hasselby JP, Klausen P. Validation of a Novel EUS-FNB-Derived Organoid Co-Culture System for Drug Screening in Patients with Pancreatic Cancer. *Cancers (Basel)* 2023; **15** [PMID: [37509338](#) DOI: [10.3390/cancers15143677](#)]
- 79 **Yang F**, Wang S, Guo J, Liu X, Ge N, Wang G, Sun S. EUS-guided fine-needle technique facilitates the establishment of organoid biobanks. *Endosc Ultrasound* 2020; **9**: 355-360 [PMID: [33318374](#) DOI: [10.4103/eus.eus\\_79\\_20](#)]
- 80 **Kovacevic B**, Vilmann P. EUS tissue acquisition: From A to B. *Endosc Ultrasound* 2020; **9**: 225-231 [PMID: [32655082](#) DOI: [10.4103/eus.eus\\_21\\_20](#)]



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