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ABOUT COVER

Editorial Board Member of *World Journal of Gastroenterology*, Dr. Rakesh Kochhar is a Professor in and Head of the Department of Gastroenterology at the Postgraduate Institute of Medical Education and Research, Chandigarh, India. Having completed his MBBS from J N Medical College (Aligarh, India), he performed postgraduate training in Medicine and undertook a fellowship in Gastroenterology at the Postgraduate Institute of Medical Education and Research. He then joined his alma mater as faculty and became a professor in 2003. Widely travelled, he worked as a World Health Organization Fellow at Mayo Clinic (Rochester, USA) and St Bart's Hospital (London, UK). His ongoing research interests include corrosive injuries to the gastrointestinal tract, stricture dilatation, acute pancreatitis, and celiac disease. He has served as President of the Society of Gastrointestinal Endoscopy of India and is currently the President-elect of the Indian Society of Gastroenterology. (L-Editor: Filipodia)

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MINIREVIEWS

Overlooked risk for needle tract seeding following endoscopic ultrasound-guided minimally invasive tissue acquisition

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Abstract

Endoscopic ultrasound-guided minimally invasive tissue acquisition can be performed by two approaches as follows: Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) and endoscopic ultrasound-guided fine-needle biopsy (EUS-FNB). These have been evolved into leading approaches and widely used for the histological diagnosis of tumors in the gastrointestinal tract and adjacent organs. However, the role of EUS-FNA and EUS-FNB in disease diagnosis and evaluation remains controversial. Although the incidence of surgery-associated complications remains low, the consequences of needle tract seeding can be serious or even life-threatening. Recently, increasing case reports of needle tract seeding are emerging, especially caused by EUS-FNA. This complication needs serious consideration. In the present work, we integrated these case reports and the related literature, and summarized the relevant cases and technical characteristics of needle tract seeding caused by EUS-FNA and EUS-FNB. Collectively, our findings provided valuable insights into the prevention and reduction of such serious complication.

Key Words: Endoscopic ultrasound-guided fine-needle aspiration; Endoscopic ultrasound-guided fine-needle biopsy; Needle tract seeding; Gastrointestinal tract; Computed tomography

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Core Tip: This paper integrates for the first time the case reports and related literature of needle tract seeding caused by endoscopic ultrasound-guided fine-needle aspiration or biopsy, and summarizes in detail the case characteristics of needle tract seeding, including the time interval, tumor location, effective detection methods, the relationship between treatment and prognosis, and the risk factors that may lead to needle tract seeding. Our findings provide valuable insights for preventing and reducing such serious complications.

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INTRODUCTION

Endoscopic ultrasound-guided minimally invasive tissue acquisition can be mainly performed by two approaches as follows: Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) and endoscopic ultrasound-guided fine-needle biopsy (EUS-FNB). Such procedures are safe and accurate to acquire tissue in the pancreas, abdomen, subepithelial masses, pelvis, and lymphoma. In EUS-FNA, the puncture needle is penetrated into the target lesion through the digestive tract under the monitoring of endoscopic ultrasound probe to obtain cell or tissue materials in order to determine the nature, origin, and pathological features of the lesion. Since its first introduction in the 1990s, EUS-FNA has become the standard sampling approach for suspected intra-abdominal and intrathoracic lesions (various masses and lymph node tissues) due to its high accuracy[1] and low complication rate[2], which can further provide staging and diagnostic information[3-6]. It has been reported that the incidence of post-EUS-FNA surgical complications, such as infection, acute pancreatitis, bleeding, and duodenal perforation, ranges from 0.98% to 3.4%[7-9]. However, a technology-related limitation of FNA is the scant cellularity and lack of histological structure provided in samples, leading to the difficulty of diagnosis[10,11]. To overcome these shortcomings, EUS-FNB has been developed. It uses a new type of needle with micro-core acquisition technology, which can obtain histological core samples and cytological aspirates at the same time, achieving a diagnostic sensitivity and specificity > 90%[12-15]. Studies have shown that the number of passes, diagnostic accuracy, and histological yield of EUS-FNB are better compared with those of EUS-FNA[16,17]. Both FNA and FNB are considered relatively safe in most cases, and EUS uses a shorter needle track, which may lead to a lower possibility of needle tract seeding[7,18]. The estimated prevalence of needle tract seeding of FNA is 0.003%-0.009%[2]. Recently, increasing case reports of needle tract seeding following EUS-FNA or EUS-FNB are emerging, especially in the diagnosis of pancreatic cancer[19,20]. In the present work, we integrated these case reports and the related literature, and summarized the relevant cases and technical characteristics of needle tract seeding. Collectively, our findings provided valuable insights into the prevention and reduction of such serious complication.

METHODS

PubMed, MEDLINE ,and Cochrane Library were searched to identify articles published between June 1996 and January 2020 using the search items as follows: "Endoscopic ultrasound (EUS)", "fine needle aspiration (FNA)", "fine needle biopsy (FNB)", "needle tract seeding", and "seeding". A total of 140 potentially relevant articles were identified from our initial search, 94 of which were excluded after reviewing the abstracts and titles. Finally, 46 articles focusing on EUS-FNA or EUS-FNB related complications met our inclusion criteria, including 34 case reports about

needle tract seeding following EUS-FNA or EUS-FNB.

EUS-FNA- OR EUS-FNB-INDUCED NEEDLE TRACT SEEDING

According to related reports, the incidence of tumor seeding ranges from 0.005% to 0.009% in percutaneous FNA of gastrointestinal tract (GI) and adjacent organic lesions guided by external ultrasound or computed tomography (CT)[21]. Furthermore, a previously published retrospective study consisting of 73 patients submitted to pancreatic mass FNA has reported that the incidence of needle tract seeding is as high as 1.4%[22]. In recent years, studies have shown that the total complication rate of EUS-FNA varies from 0.5% to 3%[13,23,24]. One of the more serious complications following EUS-FNA is tumor seeding, which can lead to the development of peritoneal carcinomatosis and recurrence along the needle tract. Due to the shorter puncture path under the guidance of EUS, the incidence of tumor seeding is considered to be much lower compared with that of the percutaneous FNA[18]. In previous case reports[25-28], the location of the recurrent tumor appearing in the gastric wall is very close to the previous FNA puncture site, supporting the hypothesis that the tumor may spread along the needle track following EUS-FNA. As for EUS-FNB, previous studies have reported that it has a comparable adverse event rate (varied between 0-7.8%) to EUS-FNA[29-33], and the recurrence due to needle tract seeding after EUS-FNB is also considered a rare event. Recently, Kawabata *et al*[34] have reported a case of tumor seeding caused by EUS-FNB.

On the contrary, there are some reports revealing that preoperative EUS-FNA for patients with pancreatic cancer does not affect the postoperative survival, needle tract seeding, or peritoneal recurrence[35-39]. For example, Yane *et al*[40] have assessed whether preoperative EUS-FNA in patients with pancreatic cancer increases the risk of stomach or peritoneal recurrence, and whether it affects the patient's recurrence-free survival and overall survival in a retrospective study. In this retrospective study, there were 301 patients undergoing distal pancreatectomy due to invasive pancreatic cancer from January 2006 to December 2015. A total of 176 patients received preoperative EUS-FNA, and 34 patients had a peritoneal recurrence (including 18 patients in the non-EUS-FNA group and 16 patients in the EUS-FNA group). Multivariate analysis did not find a significant correlation between the preoperative EUS-FNA and recurrence of stomach or peritoneal tumors[40]. To date, similar results have been obtained in the other eight retrospective studies[8,35,36,38,39,41-43]. In these studies, preoperative EUS-FNA has no negative impact on the survival of patients with pancreatic cancer and does not lead to tumor seeding through the needle tract.

However, it has been suggested that the risk of needle tract seeding following EUS-FNA or EUS-FNB is underestimated. First, most studies are single-center studies with a relatively small number of patients. Therefore, it is impossible to accurately estimate the incidence of needle tract seeding. Second, it is generally believed that it is difficult to diagnose low-volume gastric or peritoneal metastases clinically, because not all patients undergo the same strict diagnostic follow-up after surgery. Third, the follow-up period is relatively short, and thus the patients with unresectable tumors die before the clinical evidence of tumor spreading. Fourth, a preoperative biopsy may lead to the deposition of cancer cells outside the surgical resection area, which mistakenly classifies the cancer cell growth as a tumor recurrence or incomplete resection. In summary, these characteristics may lead to a significant reduction in the prediction of the number and location of cancer recurrence.

In a prospective study[44], 140 patients underwent lumen fluid aspiration before and after FNA through the suction channel and underwent cytological analysis during EUS. The cytological examination of intraluminal fluid showed that the positive rate of malignant tumors in patients with intraluminal tumor was 48%. This is a normal phenomenon, because cancer cells in the GI may shed. However, what is puzzling is that three (11.5%) patients tested positive for post EUS-FNA luminal fluid cytology in 26 patients with pancreatic cancer (extraluminal cancer). Normally, these three cases of extraluminal cancer should not be positive in cytological examination of intraluminal fluid, because there is no reasonable explanation for the metastatic pathway that allows extraluminal cancer cells into intestinal cavity. Therefore, the post-FNA positive luminal fluid cytology may be related to FNA.

At present, EUS-FNA is performed on intraabdominal and intrathoracic tumors, and surgical resection of these lesions usually does not remove the needle tract site, which may lead to a rare phenomenon of tumor seeding after operation. The incidence of such seeding is significantly low, and published data are only found in case reports

and literature reviews. Due to the deficiency of data, it is not possible to determine whether the tumor seeding is caused by the malignant potential of these tumors or a technical defect. In the future, we need to conduct multi-center, large-scale, prospective studies to fully determine the clinical characteristics of needle tract seeding following EUS-FNA and EUS-FNB.

SUMMARY OF CASES ON NEEDLE TRACT SEEDING

Since the first described case of EUS-FNA-induced needle tract seeding in a patient with intraductal papillary mucinous neoplasm in 2003[45], 33 patients with needle tract seeding following EUS-FNA or EUS-FNB have been reported up to January 2020. Of these cases, 27 were found in pancreatic cancer patients after EUS-FNA[19,20,25,27,28,36,40,46-58], one in a pancreatic cancer patient after EUS-FNB[34] (Table 1), and five in patients with other intra-abdominal and intrathoracic tumors after EUS-FNA[59-63] (Table 2). A total of 29 cases with pancreatic body or pancreatic tail cancer had needle tract seeding caused by diagnostic FNA or FNB. Tumor seeding following FNA or FNB has not been reported in pancreatic head mass. A possible reason is that patients with pancreatic head lesions need to remove both the primary foci and pancreatico-duodenum (including the needle tract). Therefore, seeding is unlikely to be successful. In contrast, FNA or FNB is usually performed for pancreatic body/tail tumors through the transgastric approach without removing the needle tract during pancreatectomy. Therefore, if the surgical procedure fails to remove the needle tract, we should seriously consider the possibility of tumor seeding following FNA or FNB of resectable thoracoabdominal tumors.

This review included 33 patients (16 males, 17 females; mean age 68.2 ± 12.2 years). Regarding the seeding site, 30 cases (90.9%) in the gastric wall, two in the esophageal wall, and one in the gastroesophageal junction were found to have tumor implantation. Only 18 cases have reported the size of the seeding tumor, with a median of 25 mm (range, 4-50 mm). Most seeding tumors were mainly located in the submucosal muscle layer or serous membrane layer of the GI, and thus they mainly appeared as submucosal tumor-like masses.

In terms of the FNA/FNB procedure, 25 (75.8%) cases used 22-G puncture needle during the execution of surgery, and the puncture process in two cases were not described. In most cases, a syringe was used for vacuum suction during the puncture process. The average number of needle pass was 2.8 ± 1.0.

As for the treatment of EUS-FNA or FNB-related needle tract seeding, chemotherapy has been performed in four cases, and the patients died at 10.8 mo, 12 mo, 26 mo, and 2 years, respectively, after chemotherapy. Surgical resection was selected in 21 cases, of which eight were followed for an average of 23.2 mo without tumor recurrence, three died about 20 mo after surgery, and detailed results and follow-up information are not obtained from the other ten cases undergoing surgical resection. In one case of tumor seeding in the esophageal wall, the lesion disappeared at 2 mo after radiation therapy[60]. In one case receiving surgery and chemotherapy at the same time, no tumor recurred after 6 years of follow-up[20]. There are no reports for the treatment methods for the remaining six cases. Additionally, Iida *et al*[26] have reported that a patient with pancreatic cancer had an EUS-FNA-related tumor seeding on the lower posterior gastric wall. At 21 mo after distal gastrectomy, a recurrent lesion was found on the upper posterior gastric wall. The author has suggested that the patient should undergo total gastrectomy rather than simple surgical resection[26]. Based on the above-mentioned results, the long-term prognosis of simple surgical resection of seeding tumors remains unclear. It is possible that radical surgery in combination with chemotherapy can improve the prognosis.

In these 33 case reports, the discovering process of seeding tumors also greatly varies. A total of 13 (39.3%) cases had abnormalities detected during regular CT/positron emission tomography-computed tomography (PET-CT) examinations, seven (21.2%) had clinical symptoms and received further examination, four (12.1%) showed a submucosal mass by regular esophagogastroduodenoscopy examination, six (18.2%) were found to have elevated CA19-9 levels and underwent further examination, and three (9.1%) were accidentally discovered during the operation. In addition, the interval time from EUS-FNA or EUS-FNB to detection of needle tract seeding greatly varies, with a median interval of 22 mo (range, 1-67 mo).

Since most seeding tumors are located in the gastric submucosal layer, it may be difficult to detect these early lesions by gastroscopy unless they are large enough to form a raised mass that can be visualized *via* gastroscopy. Paquin *et al*[46] have reported

Table 1 Characteristics of reported needle tract seeding of pancreatic cancer

Ref.	Age	Sex	Pathological diagnosis	Staging	Location	Size, mm	Initial treatment	Frequency of puncture	Needle gauge	Time interval	Details of needle tract seeding				
											Discovery	Location	Maximum diameter (mm)	Treatment	Outcome
Paquin *et al*[46] 2005	65	Male	Adenocarcinoma	T1N0M0	Pt	22	DP	5	22G	21 mo	Symptom/CT/EUS/CA19-9	Posterior gastric wall	50	CHE	Died 12 mo after CHE
Chong *et al*[47] 2011	55	Female	Adenocarcinoma	T2N0M0	Pt	27	DP	2	22G	26 mo	CA19-9/PET-CT/EUS/EGD	Posterior gastric wall	40	Unknown, incurable	Unknown
Ahmed *et al*[48] 2011	79	Male	Adenocarcinoma	T2N0M0	Pb	Unknown	Central pancreatectomy	Several times	Unknown	39 mo	PET-CT/EUS/CT	Gastric wall	45	Total gastrectomy	Died with widely metastatic melanoma
Katanuma *et al*[27] 2012	68	Female	Adenocarcinoma	T2N0M0	Pb	20	DP	4	22G	22 mo	EGD/CT	Posterior gastric wall	Unknown	Surgery	Unknown
Ngamruengphong *et al*[36] 2013	66	Male	Adenocarcinoma	Unknown	Pb/Pt	Unknown	Subtotal pancreatectomy and Chemoradiation	3	22G and 19G	27 mo	Symptom/EGD/EUS-FNA	Gastric wall	Unknown	Unknown	Unknown
Ngamruengphong *et al*[36] 2013	77	Female	Adenocarcinoma	Unknown	Pt	40	DP and PG	3	19G	26 mo	Symptom/EGD	Gastric wall	Unknown	Unknown	Unknown
Sakurada *et al*[49] 2015	87	Female	Adenosquamous carcinoma	T2N0M0	Pb	25	DP	Unknown	22G	19 mo	CA19-9/CT/EUS	Posterior gastric wall	20	PG	Unknown
Tomonari *et al*[25] 2015	78	Male	Pancreatic adenocarcinoma	T3N0M0	Pb	20	DP and CHE	2	22G	28 mo	CA19-9/EGD	Gastric wall	32	Subtotal gastrectomy	Unknown
Minaga *et al*[50] 2015	64	Female	Moderately differentiated tubular adenocarcinoma	T3N0M0	Pb	20	DP	3	22G	8 mo	CA19-9//EGD	Posterior gastric wall	12	PG	No recurrence after 27 mo of follow-up
Yamabe *et al*[51] 2016	75	Male	Intraductal papillary mucinous carcinoma	Unknown	Unknown	30	CHE	Unknown	25G	3 mo	CT/EGD/EUS-FNA	Posterior gastric wall	24	Palliative CHE	Died 26 mo after CHE
Minaga *et al*[52], 2016	72	Female	Well-differentiated tubular	T1N0M0	Pb	10	DP	3	22G	24 mo	EGD	Posterior gastric wall	30	Gastrectomy	No recurrence after 18 mo of follow-up

			adenocarcinoma												
Iida *et al*[53] 2016	78	Female	Infiltrating pancreatic duct cancer	T3N0M0	Unknown	Unknown	DP	3	22G	6 mo	PET-CT/EGD/EUS	Posterior gastric wall	18	DG	No recurrence after 10 mo of follow-up
Kita *et al*[54] 2016	68	Female	Adenocarcinoma	Unknown	Pb/Pt	Unknown	Radiation	2	22G	7 mo	PET-CT/EGD	Posterior gastric wall	Unknown	Unknown	Unknown
Sakamoto *et al*[55] 2018	50	Male	Invasive ductal carcinoma	T4N1M0	Pt	38	DP and CHE	2	22G	24 mo	EGD/EUS	Posterior gastric wall	20	PG	Unknown
Matsumoto *et al*[56] 2018	50	Male	Adenocarcinoma	Unknown	Pb	35	CHE	3	21G	8 mo	CT/EUS	Gastric wall	Unknown	DP and PG	Unknown
Yasumoto *et al*[57] 2018	78	Female	Well-differentiated tubular adenocarcinoma	T3N0M0	Pb	10	DP and CHE	3	25G	22 mo	Symptom/EGD	Posterior gastric wall	Unknown	PG	Unknown
Matsui *et al*[58] 2019	68	Female	Invasive ductal carcinoma	T1N1M0	Pb	15	DP and PG	4	22 G, 19 G, 20 G	25 d	Operative finding/CA19-9	Posterior gastric wall	Micro	PG	Died 18 mo after treatment due to peritoneal dissemination
Matsui *et al*[58] 2019	70	Male	Invasive ductal carcinoma	T3N0M1	Pb	34	DP and PG	1	22G	4 mo	Operative finding	Posterior gastric wall	Micro	PG	Stabled 18 mo after treatment
Yane *et al*[40]2019	66	Female	Well differentiated invasive adenocarcinoma	T3N0M0	Pt	Unknown	DP	4	22G	19 mo	CT/EGD	Posterior gastric wall	Unknown	CHE	Died 10.8 mo after diagnosis
Yane *et al*[40] 2019	78	Male	Poorly differentiated invasive adenocarcinoma	T3N0M0	Pt	Unknown	DP	2	22G	27 mo	CT/EGD	Posterior gastric wall	Unknown	PG	Died 24.9 mo after diagnosis
Yane *et al*[40] 2019	86	Female	Poorly differentiated invasive adenocarcinoma	T2N0M0	Pb	Unknown	DP	3	22G	19 mo	CT/EGD	Posterior gastric wall	Unknown	PG	Alive 62.4 mo after diagnosis
Yane *et al*[40] 2019	47	Male	Moderately differentiated invasive adenocarcinoma	T2N0M0	Pb	Unknown	DP	4	22G	28 mo	CT/EGD	Posterior gastric wall	Unknown	PG	Died 17.4 mo after diagnosis
Yane *et al*[40] 2019	79	Female	Poorly differentiated invasive	T1N0M0	Pb	Unknown	DP	3	22G	6 mo	CT/EGD	Posterior gastric wall	Unknown	PG	Alive 40.5 mo after diagnosis

			adenocarcinoma											
Yane *et al*[40] 2019	78	Female	Moderately differentiated invasive adenocarcinoma	T1N0M0	Pb	Unknown	DP	4	22G	35 mo	CT/EGD	Posterior gastric wall	Unknown	PG	Alive 4.6 mo after diagnosis
Yamaguchi *et al*[28] 2020	78	Male	Solid pseudopapillary neoplasm	Unknown	Pb	60	Surgical resection	4	22G	67 mo	Symptom/EGD/PET-CT	Posterior gastric wall	40	DG	Unknown
Sato *et al*[19] 2020	83	Female	Invasive ductal carcinoma	T2N2M0	Pb	25	DP and CHE	2	22G	25 mo	CA19-9/MDCT/EUS	Posterior gastric wall	25	PG and lymph node resection	No recurrence after 5 mo of follow-up
Rothermel *et al*[20] 2020	61	Male	Invasive well differentiated pancreatic ductal adenocarcinoma	T3N0M0	Pb	37	DP and CHE	3	25G	3.5 yr	CA19-9/PET-CT/EGD	Posterior gastric wall	25	PG and CHE	No recurrence after 6 yr of follow-up
Kawabata *et al*[34] 2019	78	Female	Invasive moderately differentiated ductal adenocarcinoma	T1N0M0	Pb	10.8	DP	Unknown	22G	3 yr	CT	Posterior gastric wall	25	PG	Unknown

DP: Distal pancreatectomy; CHE: Chemotherapy; PG: Partial gastrectomy; EGD: Esophagogastroduodenocopy; Pb: Pancreatic body; Pt: Pancreatic tail; CT: Computed tomography; MDCT: Multidetector computed tomography; DG: Distal gastrectomy.

that a 3 cm mass was found on the stomach wall by EUS. However, endoscopy revealed a normal gastric mucosa without ulcers or other abnormalities[46]. If tumor seeding is suspected in the GI, EUS may be useful in the early detection of these lesions, while the predicted probability may be too low to be cost-effective in most cases. Since EUS-FNA or EUS-FNB is more commonly used in the diagnosis of pancreatic diseases, most cases of tumor seeding are related to pancreatic tumors. Early detection is significantly crucial for needle tract seeding by surgical procedures. Of the 28 pancreatic cancer patients included in this review, 23 (82.2%) had no clinical symptoms at the time of recurrence. On the contrary, ten of these patients underwent CA19-9 testing, and eight (80.0%) exhibited increased CA19-9 levels. Therefore, during postoperative follow-up, CA19-9 may be helpful for the early detection of seeding recurrence. In addition, research shows that changes in the levels of CA19-9 are frequently more than 6 mo earlier than radiological recurrence in patients with pancreatic cancer[64]. In addition, PET-CT represents a more sensitive approach compared with the traditional imaging methods (CT and magnetic resonance imaging [MRI]), and it is also used for the early detection of tumor recurrence after pancreatic cancer surgery[65,66]. Six (100%) cases receiving PET showed that the seeding tumors increased the uptake of fluorodeoxyglucose. However, PET/CT examinations are

Table 2 Characteristics of reported needle tract seeding of other tumors

Ref.	Age	Sex	Pathological diagnosis	Staging	Location	Size, mm	Initial treatment	Frequency of puncture	Needle gauge	Time interval	Details of needle tract seeding				
											Discovery	Location	Maximum diameter (mm)	Treatment	Outcome
Shah *et al*[59] 2004	39	Female	Metastatic melanoma	Unknown	Perigastric lymph node	24	Surgical resection, chemotherapy	Transgastric/1	22G	6 mo	Operative finding	Posterior gastric wall	30	Surgery	Unkonwn
Doi *et al*[60] 2008	70	Male	Metastatic adenocarcinoma	Unknown	Mediastinal lymph node	30	Chemotherapyand distal gastrectomy	Transesophageal/1	19G	22 mo	EGDS/EUS-FNA	Esophageal wall	4	Radiation	Lesion resolved after 2 mo
Anderson *et al*[61] 2013	51	Male	Adenocarcinoma	Unknown	Celiac lymph node	6	Chemoradiation therapy	Transgastric/ unknown	Unknown	Unknown	Symptom/EGDS/EUS-FNA	Gastroesophageal junction	10	Unknown	Unknown
Yokoyama *et al*[62] 2017	53	Male	Mediastinal embryonal adenocarcinoma	Unknown	Mediastinum	60	Unknown	Transesophageal/3	22G	1 mo	CT	Esophageal wall	Unknown	Chemotherapy	Died less than 2 yr after Chemotherapy
Goel *et al*[63] 2017	57	Male	Squamous cell carcinoma	Unknown	Coeliac space	52	Unknown	Transgastric /2	19G	11 mo	Symptom/EGDS	Posterior gastric wall	50	Unsuitable for proximal gastrectomy	Unkonwn

EGDS: Elective esophago-gastro-duodenoscopy; EUS-FNA: Endoscopic ultrasound-guided fine-needle aspiration; CT: Computed tomography.

usually just to clarify the unclear manifestations of CT and MRI.

According to this review, the best treatment method and detection strategy for needle tract seeding have not yet been clarified at present. Among these cases, some patients achieved a good prognosis after surgery[50,52]. However, some reports have shown that the delayed discovery of needle tract seeding has caused metastases in both the stomach wall and lymph nodes[48]. In addition, it has been reported that re-recurrence occurred after partial gastrectomy due to gastric wall metastasis caused by needle tract seeding[26]. Therefore, early diagnosis and surgical resection of these lesions are an effective method for patients with needle tract seeding after EUS-FNA or EUS-FNB to achieve a long-term survival. Moreover, the examination of CA19-9, endoscopy, and imaging modalities (especially PET-CT) may be of great significance for the early detection of tumor recurrence along needle tract.

RISK FACTORS AND PREVENTION STRATEGIES FOR NEEDLE TRACT SEEDING

It has been previously thought that several factors, such as the number of punctures, needle size, needle movement, and tumor characteristics (cystic tumors or poorly differentiated tumors) may affect the development of seeding[50,60,62]. However, due to the small number of reported cases of tumor seeding, it remains unknown whether tumor factors or FNA/FNB procedures are significantly correlated with the occurrence of needle tract seeding. Sakamoto *et al*[55] have conducted an experiment using an agar model, and they considered that the slow-pull technique and the use of puncture needle with a side hole may result in needle tract seeding. Although these results may not reflect the actual clinical situations, it also gives us a warning.

As a rare but serious complication, needle tract seeding following EUS-FNA or EUS-FNB may worsen the prognosis of patients. Therefore, several strategies have been proposed to reduce the tumor seeding. Yane *et al*[40] have reported that EUS-FNA should only be used in patients requiring a pathological diagnosis to develop more accurate treatment strategies (for example, patients with pancreatic cancer who are scheduled to undergo preoperative neoadjuvant therapy or difficult to diagnose by imaging). In addition, the distance between the endoscope and the target site should be as short as possible[67]. Tomonari *et al*[25] has suggested that if the surgical resection does not include puncture needle tract or puncture results cannot change treatment options, EUS-FNA should be avoided or the number of puncture should be limited[25,67]. Therefore, we can consider replacing EUS-FNA with EUS-FNB to diagnose suspected intra-abdominal and intrathoracic lesions. Because some studies have shown that the FNB needle can produce more accurate diagnoses, a better histological yield, and a lower number of passes compared with the FNA needle[17,68]. This is probably a change which will impact also the already low rate of seeding. Moreover, only one case of needle tract seeding following FNB has been reported so far. Tyagi and Dey believed that a puncture needle with a covering sleeve should be used to avoid the needle tract seeding[69].

As the needle site is not within the scope of surgical resection, we should carefully consider the risk-benefit ratio of EUS-FNA or EUS-FNB. If we perform puncture and early radical resection in this situation, regular detection of blood tumor markers, imaging, and endoscopy are essential. Moreover, it has been suggested that neoadjuvant chemotherapy can provide survival benefits for patients with resectable pancreatic cancer[70].

CONCLUSION

More than 25 years after its introduction, endoscopic ultrasound-guided minimally invasive tissue acquisition has replaced percutaneous FNA guided by external ultrasound or CT. Due to its higher effectiveness and lower complications, it has achieved a crucial role in the diagnosis of GI and adjacent organic lesions. Although needle tract seeding following EUS-FNA or EUS-FNB is a rare and easily ignored complication, it can bring serious consequences to patients. Endosonographers should determine the indications for surgery according to the characteristics of different cases. If the location of the needle tract is not within the scope of surgical resection, we should be aware of the risk of tumor metastasis along the needle tract following EUS-FNA or EUS-FNB. We should also pay attention to several aspects, such as shortening the puncture path, limiting the number of puncture, paying attention to the procedure method, and adding seeding needle sleeve. For example, EUS-FNB has greatly improved the diagnostic efficacy of EUS guided tissue acquisition with fewer passes so that we may consider replacing EUS-FNA with EUS-FNB to diagnose suspected intra-abdominal and intrathoracic lesions. In addition, regular detection of blood tumor markers, imaging, and endoscopy are required to diagnose tumor seeding at an early stage. Furthermore, it is necessary to accumulate more cases of needle tract seeding and conduct a large-scale prospective cohort study to confirm its detailed clinical characteristics in order to actively prevent or early detect the risk of needle tract seeding.

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