Diagnostic Accuracy Study

Medicine

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# Difficulty in the diagnosis of pancreatic cancer based on the initial CT report

## A retrospective study

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**Abstract**

The role of computed tomography (CT) in the initial diagnosis of pancreatic cancer (PC) is well-known. CT reports made by radiologists are important as not all patients with PC are examined by specialists; however, some cases are not identified based on CT reports. Diagnosis via imaging of PC is sometimes difficult, and the diagnostic rate of PC and other pancreatic diseases can vary across radiologists. This study aimed to examine the diagnostic rate of PC in initial CT reports and the details of cases with diagnostic difficulties. This single-centered, retrospective study collected clinical data of 198 patients with histologically diagnosed PC between January 2018 and April 2022. Out of these contrast-enhanced CT was performed in 192 cases. PC was not reported as the main diagnosis in 18 patients (9.4%; 11 men and 7 women). Among these 18 cases, intrapancreatic mass lesions were detected in 3 (1.6%), indirect findings such as bile/pancreatic duct stenosis or dilation were detected in 5 (2.6%), and no PC-related findings were found in 10 (5.2%). The specialists suspected PC in 15 of these 18 cases based on initial CT reports. 17 cases were confirmed by endoscopic ultrasound-fine needle aspiration and one by biopsy after upper gastrointestinal endoscopy. To improve accuracy of its diagnosis, it is important that specialists provide feedback to diagnostic radiologists regarding the findings they did not report. Endoscopic ultrasound-fine needle aspiration should be performed by specialists when there is clinical information which indicates pancreatic disease of any kind.

**Abbreviations:** CT = computed tomography, EUS = endoscopic ultrasound, FNA = fine needle aspiration, PC = pancreatic cancer.

**Keywords:** biopsy, endoscopic ultrasound-fine needle aspiration (EUS-FNA), needle, pancreatic neoplasms

## 1. Introduction

Pancreatic cancer (PC) is sometimes difficult to diagnose and has a poor prognosis.[1] Patients with PC seldom exhibit disease-specific symptoms until late in the disease progression. Therefore, the dismal prognosis for patients with PC is mainly because most patients are diagnosed after the disease has progressed and they have unresectable disease at the time of diagnosis.[2]

The role of computed tomography (CT) in the initial diagnosis of PC is well-known.[3–9] CT reports made by radiologists are important as not all patients with PC are examined by specialists for pancreatic diseases; however, some cases are not identified based on CT reports. Imaging diagnosis of PC is sometimes difficult, and according to a previous report, the diagnostic rate of PC and other pancreatic diseases varied by approximately 20%, depending on radiologists.[2] Therefore, this study aimed to evaluate the accuracy of the CT reports and causes in cases, wherein PC diagnosis was not initially identified.

## 2. Methods

### 2.1. Study design

This retrospective single-centered study assessed the accuracy of CT reports. The study was reviewed and approved by the institutional review board of the Future Medical Research Center

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*All data generated or analyzed during this study are included in this published article [and its supplementary information files].*

*Ethics approval and consent to participate: This retrospective observational study was reviewed and approved by the Future Medical Research Center Committee institutional review board (IRB no. TGE01784-024). Moreover, all procedures have been performed by the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from all individual participants included in the study by the opt-out method of our hospital website and in-hospital posting (as it was a retrospective study using information contained in medical charts and computerized records). The ethics committee approved the study.*

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(IRB no. TGE01784-024). All procedures have been performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

### 2.2. Data collection

Clinical data was collected from patients who were diagnosed with PC between January 2018 and April 2022 in our hospital, and 198 cases were diagnosed with PC histologically. Out of 198 cases, there were 6 cases in which only plain CT was performed, or CT reading was not performed, and these were excluded from the study. Therefore, 192 cases were examined, in which contrast-enhanced or dynamic CT was performed and reported (Fig. 1).

### 2.3. Outcome measures and definitions

This study aimed to clarify the diagnosis rate of PC by CT report and the causes for not being able to directly diagnose PC initially. Furthermore, we conducted a detailed evaluation of cases where the primary diagnosis in the CT report was not PC, including those with any findings associated with PC, those with pancreatic benign lesions or other pancreatic tumors, and those with dilation or stricture of the pancreatic or bile ducts, including suspicion of bile duct carcinoma. The findings of dilation or stricture of the pancreatic or bile ducts without obvious causes of diseases other than PC were defined as indirect findings. However, the finding of a mass lesion in the pancreas, including a lesion suspected of benign disease, was defined as a direct finding. A pancreatic specialist was defined as a specialist who had been practicing as an outpatient pancreatic specialist for at least 5 years. The specialists basically reviewed the CT scans before obtaining a confirmed diagnosis of PC. The diagnosis made by the specialists, which wasn't a reevaluation for this study, was primarily based on the initial clinical diagnosis without prior knowledge of the PC diagnosis.

## 3. Results

### 3.1. Patient characteristics

Out of 198 cases diagnosed with PC histologically, 192 were considered, wherein contrast-enhanced or dynamic CT was performed and reported. These cases consisted of 124 men (64.6%) and 68 women (35.4%) and the median age was 69 years (range 33–87 years).

### 3.2. Diagnostic rate of PC in initial CT reports

In total, 192 cases were considered in which contrast-enhanced or dynamic CT was performed and reported. In total, 174 cases (90.6%) were diagnosed with PC in initial CT reports and 18 (9.4%) were not directly diagnosed with PC in initial CT reports (Fig. 1). In 10 of the 18 cases, no findings related to PC were detected in the initial CT reports. However, in the remaining 8 cases, pancreatic lesions or indirect findings were noted, but was not diagnosed with PC directly. In the 18 cases, 8 radiologists certified by the Japan Radiological Society were involved, with experience ranging from 12 to 36 years. Regarding the specialists, 3 were involved and diagnosed the CT independently. Among these 18 cases, indirect findings, such as bile duct/pancreatic duct stenosis or dilation, were detected in 5 (27.8%: 5/18) and intrapancreatic mass lesions were detected in 3 (16.7%: 3/18). Specialists for pancreatic diseases were able

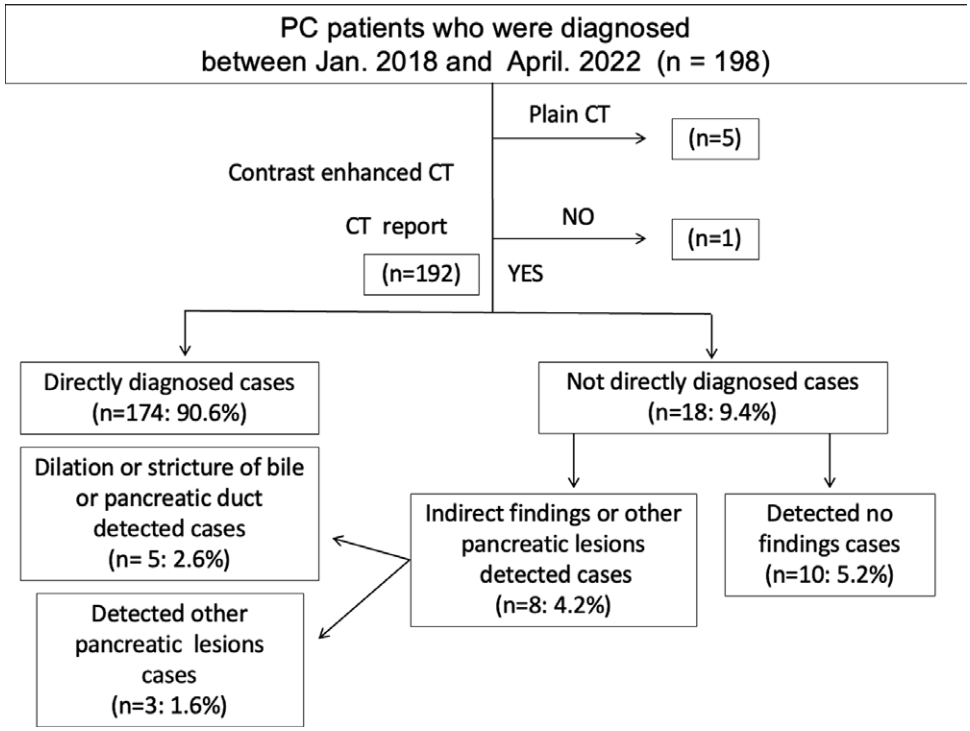



**Figure 1.** Materials and methods. In this study, 198 cases were diagnosed with pancreatic cancer (PC) histologically. Out of 198 cases, 6 cases in which only simple computed tomography (CT) was performed or CT reading was not performed were excluded from the study. Therefore, 192 cases were evaluated, in which contrast-enhanced or dynamic CT was performed and reported. The diagnostic rate of PC based on computed tomography reports and the clinical characteristics of cases that could not be diagnosed were considered. Notably, 174 cases were directly diagnosed with PC in CT reports, and 18 cases were not directly diagnosed with PC in CT reports. Out of 18 cases, 8 cases had pancreatic lesions other than PC or indirect findings, and the other 10 cases presented no findings associated with PC. Among these 8 cases (4.2%), indirect findings such as bile duct/pancreatic duct stenosis or dilation were detected in 5 (2.6%) and other pancreatic lesions such as intrapancreatic mass lesions were detected in 3 cases (1.6%).

to suspect PC in 15 cases initially among these 18 cases. The remaining 3 cases were not suspected of having PC as the main diagnosis from the initial CT even by specialists; however, they were diagnosed by endoscopic ultrasound (EUS)-guided fine needle aspiration (FNA).

### 3.3. Clinical features of cases not diagnosed with PC in initial CT reports

The 18 cases not directly diagnosed with PC in initial CT reports were reviewed in detail. The results are shown in Table 1. These 18 cases comprised of 11 men and 7 women, with a median age of 69 years (range 45–84 years). Their clinical features included the following; 13 patients had symptoms, including 5 patients with abdominal pain, 4 patients with jaundice, 3 patients with vomiting, 2 patients with fever, and 1 patient with back pain (with duplication). The remaining 5 cases were asymptomatic, among which 2 were detected during follow-up of pancreatic diseases, 2 were detected during follow-up of other diseases, and one was detected owing to a pancreatic tumor in magnetic resonance cholangiopancreatography.

The CT imaging methods were contrast-enhanced in 10 cases and dynamic in 8 cases. The tumor size was: 0 to 10 mm in 2 cases, 10 to 20 mm in 12 cases, and 20 to 30 mm in 4 cases; the median tumor size in these cases was 18 mm (9.2–28.9 mm). According to the general rules for the study of PC by the Japan Pancreatic Society published in September 2020, the stage of the disease was: IA in 4 cases, IB in 4 cases, IIA in 4 cases, IIB in 1 case, III in 1 case, and IV in 4 cases (Table 1).[10]

The tumor occupied the head, body, and tail in 12, 3, and 3 cases, respectively. The treatments administered were surgery in 13 cases, chemotherapy in 1 case, conversion surgery in 1 case, and best supportive care in 3 cases (Table 1).

**Table 1**

**Clinical features of pancreatic cancer cases which were not directly detected in CT reports.**

| Clinical features of pancreatic cancer cases in which pancreatic cancer was not directly detected in CT reports | |
|---|---|
| **January 2018 to April 2022: n = 18 patients** | |
| **Age** | **Median age: 69 yr (range 45–84 yr)** |
| Sex | Men: 11<br>Women: 7 |
| Enhanced CT methods | Dynamic: 8<br>Non-dynamic: 10 |
| Findings in CT reports (diagnosis) | Indirect findings: 5<br>Dilation or stricture of bile or pancreatic duct: 5<br>Direct findings: 3<br>Bile duct cancer: 2<br>Accessory spleen: 1<br>No findings related to pancreatic cancer: 10 |
| Tumor size (mm) | 0–10: 2<br>10–20: 11<br>20–30: 5 |
| Stage of pancreatic cancer | IA: 4<br>IB: 4<br>IIA: 4<br>IIB: 1<br>III: 1<br>IV: 4 |
| Tumor occupation | Head: 12<br>Body: 3<br>Tail: 3 |
| Treatment | Surgery: 12<br>Conversion surgery: 1<br>Chemotherapy: 1<br>Best supportive care: 4 |
| Symptoms | |
| Symptomatic (n = 13) with duplication | Abdominal pain: 5<br>Jaundice: 4<br>Vomiting: 2<br>Fever: 2<br>Back pain: 1 |
| Asymptomatic (n = 5) | Follow-up pancreatic diseases: 2<br>Follow-up other symptoms: 2<br>Abdominal ultrasonography in health check: 1 |
| Median time from the initial CT report to diagnosis | 16.9 d (range 2–73 d) |

CT = computed tomography, IPMN = intraductal papillary mucinous neoplasm.

### 3.4. Details of initial CT reports in cases not diagnosed with PC

Out of 18 cases, 10 cases (55.6%: 10/18) were not noted any findings associated with PC (Table 1). Figure 2 shows a representative case of those without any findings associated with PC. In this case, no finding associated with PC was identified in the report, even though the specialist noted a tumor extending outside the pancreas.

In 5 cases (27.8%: 5/18), dilation or stricture of the bile duct or dilation or stricture of the caudal pancreatic duct was detected. Among these cases, the initial CT reports suspected benign pancreatic lesion in 1 case, bile duct cancer in 3 cases, and malignant lymphoma in 1 case. Figure 3 shows a representative case in which only indirect findings were noted. In this case, even though the dilation of the bile duct and pancreatic duct was reported in the CT report, these were not diagnosed with PC directly. However, the specialists suspected PC from the beginning and performed EUS, leading to PC diagnosis.

Three cases (16.7%: 3/18) were found to have pancreatic mass lesions. Among these cases, the initial CT reports suspected accessory spleen and bile duct cancers in 1 and 2 patients, respectively. Pancreatic lesions were noted, and additional tests were considered necessary, but a direct diagnosis of PC could not be made. A representative case in which a pancreatic mass was noted but not diagnosed was suspected as accessory spleen because of the regularity of the surface and internal homogeneity of the lesion (Fig. 4).

### 3.5. How the cases with other pancreatic lesions or indirect findings in the CT reports lead to the diagnosis

Eight cases (4.2%) were detected in the CT reports other pancreatic lesions or indirect findings in the CT reports but not diagnosed with PC. Among 5 cases with detected dilation or stricture of the bile duct or dilation or stricture of the caudal pancreatic duct, specialists found the pancreatic tumor and suspected PC first in 4, and one was diagnosed with acute pancreatitis. Among the 3 cases with detected pancreatic mass lesions, specialists observed the pancreatic tumor and suspected PC first in 2 cases; one was diagnosed with accessory spleen. However, EUS showed a pancreatic mass in these 2 cases, which were diagnosed with PC by EUS-FNA.

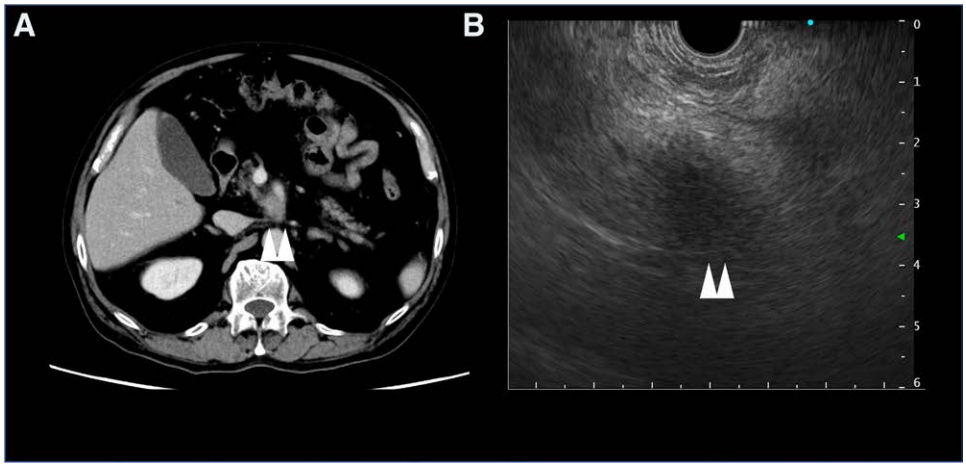



**Figure 2.** A case in which any finding associated with pancreatic cancer (PC) was detected. (A) A mass around the superior mesenteric artery (SMA) was seen. (B) Endoscopic ultrasonography showed a hypoechoic mass with irregular margins around SMA. ▲▲ indicate PC.

### *3.6. How cases initially not diagnosed as PC in the CT reports lead to the PC diagnosis*

Ten cases (5.2%) were completely overlooked in the CT reports. Among those 10 cases with neither direct nor indirect findings, the specialists pointed out direct findings and suspected PC in 9. In the remaining case, the specialist could not diagnose with PC, even from when examined retrospectively. In this case, magnetic resonance cholangiopancreatography, which was performed simultaneously to follow intraductal papillary mucinous neoplasms, detected pancreatic duct stenosis, which led to the diagnosis of PC. In 2 of these 10 cases, the physicians requested the reading without mentioning that a pancreatic lesion might be present. However, in the remaining 8 cases, they suggested the possibility of a pancreatic lesion when requesting the report.

### *3.7. Summary*

To summarize, the specialists initially diagnosed PC in 15 out of the 18 cases. The 3 cases where PC was not reported were diagnosed as pancreatitis, accessary spleen, and intraductal papillary mucinous neoplasms, respectively. In cases not diagnosed by CT reports, the final diagnostic modality of PC was EUS-FNA in 17 cases and through upper gastrointestinal endoscopy in 1 case. In the case in which gastrointestinal endoscopy was performed, PC had invaded the stomach, and a biopsy was performed on the stomach. Twelve out of these 18 cases, which were diagnosed using EUS-FNA, underwent surgery. In all cases, the pathological diagnosis was pancreatic ductal carcinoma. The median time from CT reports to diagnosis was 10 days (range 2–73 days).

## 4. Discussion

PC is a disease with a poor prognosis. Although the prognosis has improved in recent years owing to an increase in the number of cases diagnosed at an early stage and advances in chemotherapy, it still has a higher mortality rate than other cancers.[1,2] In previous reports, the sensitivity, specificity, and diagnostic rate of CT in the diagnosis of PC were 94.1% to 97%, 80% to 83%, and 90.4% to 96% respectively,[3–9] the sensitivity of the detection of small pancreatic masses was 77%, and the specificity was 100%.[2] However, in a previous report, the diagnostic rate of PC and other pancreatic diseases varied by approximately 20%, depending on radiologists.[6] In this study, there were 18 cases (9.4%) in which the diagnosis of PC was not stated and 10 of these 18 cases (5.2%) in which no findings associated with PC were noted in the initial CT report. Therefore, it is crucial to remember that PC could be overlooked in CT reports. In addition, it is important to note that overlooking PC can occur at any location in the pancreas and in cases of large size or advanced stage.

The specialists were able to diagnose PC even in cases that were either overlooked or not diagnosed directly in the CT report. This may be because specialists routinely assess images to diagnose PC. Another major factor may be that specialists diagnose PC with reference to symptoms, clinical course, blood tests, medical history, and family history.

In this study, 8 cases (4.2%) were not diagnosed with PC directly, but other pancreatic lesions were detected, and indirect findings, such as stenosis or dilation of bile ducts and pancreatic ducts were noted, even if not diagnosed with PC. An indirect finding of PC is a narrowing of the main pancreatic duct with dilation of the caudal pancreatic duct, seen in many cases of PC. Dilation of the pancreatic duct or stricture of the bile duct is not a characteristic finding of PC as it is also seen in benign pancreatic diseases including chronic pancreatitis and autoimmune pancreatitis. However, indirect findings such as are useful in triggering the diagnosis in cases where the tumor cannot be directly noted.[5–11] Recently, atrophy of the entire caudal parenchyma has been reported as a characteristic indirect finding in diagnosing microscopic PC.[12] Therefore, it was considered desirable to have a specialist review CT report if such a description of indirect findings is found in CT reports. In cases where such indirect findings are shown, it may be less problematic because it is not a complete oversight, but it is still desirable for the non-specialists to clearly write even the suspicion of PC when writing the indirect findings, because without the word PC, non-specialists may not perform advanced examinations. In addition, non-specialists should be educated to better understand that indirect findings of PC can lead to the diagnosis of PC. In addition, 10 cases (5.2%) with no findings related to PC were recorded in CT reports. In such cases, if the physician reviewing the report is a non-specialist, it would be challenging to diagnose PC; however, if clinical information or other information leads one to suspect pancreatic disease, it would be better to keep in mind the possibility of overlooking something and consider examination with another modality or consultation with a specialist. It is advisable to consider examination or consultation with a specialist.

EUS is useful in diagnosing PC, with a 96.9% to 100% presence rate and an 82.6% to 96% qualitative rate, which is higher than that of CT.[2,12–18] In a previous study of PC with a tumor of 20 mm or less, including intraepithelial carcinoma, the direct detection rate of lesions by each imaging test was 51.5% for CT, whereas a detection rate of 76.3% was reported

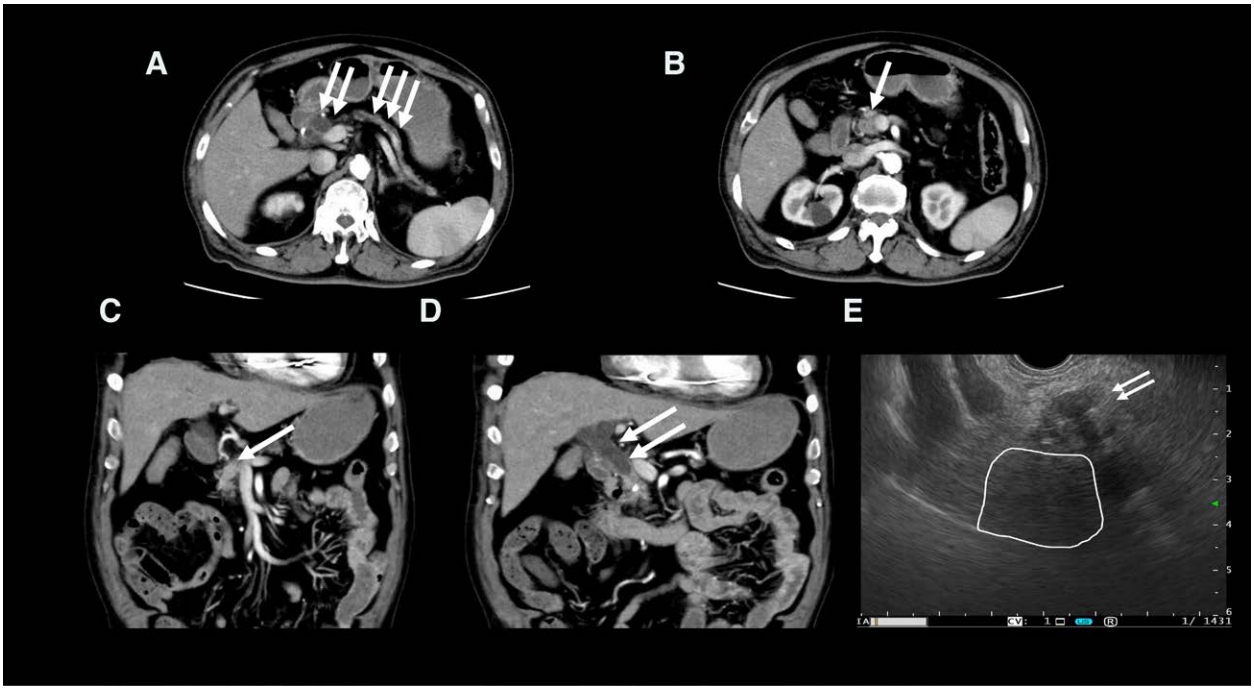



**Figure 3.** A case in which dilation of the common bile duct and pancreatic duct were noted but not directly diagnosed with pancreatic cancer (PC) in a CT report. (A) CT showed dilation of the common bile and pancreatic ducts. (B) The pancreas is atrophic, and a tumor was seen in the pancreatic head, which was detected by the specialist. (C) The common bile duct was dilated. (D) Pancreatic mass was seen in the pancreatic head. (E) Endoscopic ultrasonography showed a hypoechoic mass with irregular margins. ↑ PC. ↑↑ Dilation of the common bile duct. ↑↑↑ Dilation of the pancreatic duct. The enclosure showed PC. CT = computed tomography.

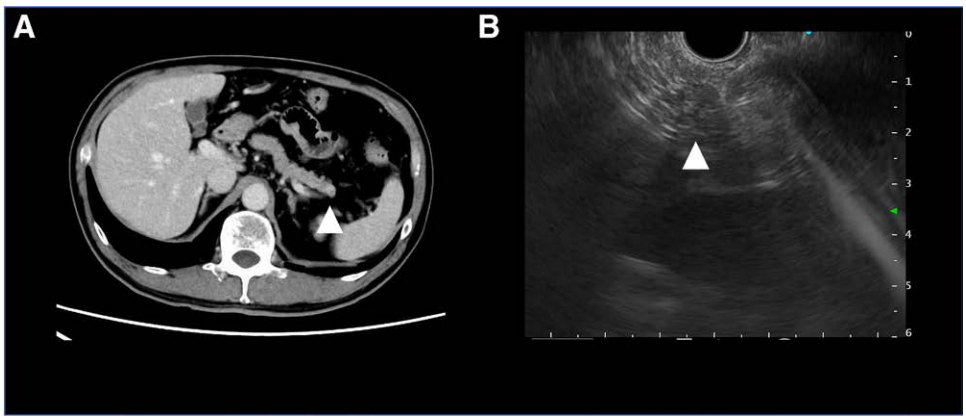



**Figure 4.** A case in which a pancreatic mass was noted but could not be diagnosed as pancreatic cancer (PC) on a CT report. (A) A tumor was found in the pancreatic tail and was diagnosed as an intrapancreatic accessory spleen in a CT report. (B) Endoscopic ultrasonography showed a hypoechoic mass suspected to be PC, which was found at the tail of the pancreas. ▲ Indicate PC. CT = computed tomography.

for EUS.[2] EUS-FNA has been developed recently and has a high positive diagnosis rate; even small tumors can be diagnosed.[2,19] In our study, EUS was capable of reporting tumors, and EUS-FNA confirmed PC histologically, even in cases where the specialists were unable to directly identify them on CT. Thus, if PC is even marginally suspected based on CT findings or clinical information, EUS should be considered. However, not all patients with PC can be assessed by the specialists at the outset, but only by physicians of other specialties. It is important to suspect pancreatic disease and lead to EUS rather than performing these tests from the beginning. In this study, we found that some CT reports did not mention the possibility of PC, despite pointing out direct or indirect findings. Therefore, it is important to ask radiologists to add a comment to at least rule out PC when such findings are noted, or to educate non-specialists like general physicians that these are findings that may indicate PC.

## 5. Limitations

This study had some limitations. First, this was a single-centered retrospective study and participants were small in number; thus, some uncontrolled confounding factors that affected the results possibly exist. Several of the cases that were not diagnosed as PC did not mention pancreatic disease in the comments of the reading request. Second, some of the contrast-enhanced CTs were dynamic studies, while others were not. Third, in some cases, the radiologists were not necessarily experts in abdominal imaging. Therefore, it is expected that the development of imaging equipment and artificial intelligence will improve the

accuracy of diagnosis of PC and improve prognosis with early diagnosis in the future.

## 6. Conclusion

Although several PC cases were not diagnosed based on the CT reports in this study, most of the cases were diagnosed by specialists for pancreatic diseases. To improve accuracy of the diagnosis of the PC, it is important that specialists provide feedback to diagnostic radiologists regarding the findings they did not report. It is also crucial to inform non-specialists to seek the advice of specialists when such indirect findings or any kind of pancreatic mass are present. Even if there are no findings related to PC in CT reports, EUS-FNA should be performed by specialists when there is clinical information which indicates pancreatic disease of any kind.

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**Writing – original draft:** Kento Shionoya.
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