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CASE REPORT

Mucinous cystic neoplasm of the pancreas assessed with a real-time three-dimensional imaging using a transesophageal echocardiography probe

Takuya Ishikawa[1] · Yoshiki Hirooka[2] · Hiroki Kawashima[1] · Eizaburo Ohno[1] · Mitsuhiro Fujishiro[1]

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Abstract
Ultrasonographic imaging techniques have been rapidly developing. The new transesophageal echocardiography (TEE) system made it possible to obtain the real-time three-dimensional (3D) image of the cardiac system through the esophagus, that can be applied to the field of gastroenterology. We herein present a case of 72-year-old woman who was referred for evaluation of an incidentally found cystic lesion in the tail of the pancreas. The real-time 3D imaging with TEE probe clearly demonstrated the internal features of the cyst consistent with MCN, which helped narrow down the differential diagnosis. The patient was proceeded with distal pancreatectomy and a definite diagnosis of MCN was confirmed with the histopathological findings of the resected specimen associated with ovarian-type stroma. This is the first report which showed the real-time 3D image of MCN in the pancreas obtained with TEE. Further investigation is warranted to determine the clinical relevance of 3D ultrasonographic techniques used to evaluate the pancreatic cystic lesions.

Keywords Mucinous cystic neoplasm · Pancreas · Transesophageal echocardiography

Introduction

The differential diagnoses for pancreatic cystic lesions include a variety of tumors such as intraductal papillary mucinous neoplasms, serous neoplasms, mucinous cystic neoplasms and degenerative changes of solid tumors and inflammatory changes such as pseudocysts. Endoscopic ultrasound (EUS) helps narrow the diagnosis, but the preoperative diagnosis is still difficult. Transesophageal echocardiography (TEE), with the aid of real-time three-dimensional (3D) imaging, can provide additional information. We present a case of which we could obtain the 3D TEE image for the assessment of a mucinous cystic neoplasm (MCN) of the pancreas.

✉ Yoshiki Hirooka
hirooka@med.nagoya-u.ac.jp

[1] Department of Gastroenterology and Hepatology, Nagoya University Graduate School of Medicine, Nagoya, Aichi, Japan

[2] Department of Endoscopy, Nagoya University Hospital, Nagoya, Aichi, Japan

Case report

A 72-year-old woman was referred for evaluation of an incidentally found cystic lesion in the tail of the pancreas. Her past medical history included cardiac sarcoidosis with a pacemaker placement but no history of acute pancreatitis, and the cystic lesion was detected on the positron emission tomography (PET) using 18F-fluorodeoxyglucose (FDG) performed for the evaluation of sarcoidosis. She was not a smoker or alcohol drinker. A general examination was normal with no palpable masses in the abdomen. The laboratory data showed no abnormality including tumor markers of carcinoembryonic antigen (CEA) and carbohydrate antigen (CA) 19-9. Transabdominal ultrasound showed a round-shaped 43 × 38 mm cystic lesion in the tail of the pancreas (Fig. 1a). Computed tomography (CT) of the abdomen revealed a cystic lesion with a calcified septum. Pancreatic parenchyma was unremarkable and the main pancreatic duct was not dilated (Fig. 1c, d). Endoscopic ultrasonography showed a round cystic lesion with lateral shadowing, rather thick wall and calcified septum (Fig. 1b). Following the observation with EUS, TEE probe (PEI-512VX, Canon Medical Systems, Tokyo, Japan) was inserted into the stomach for further evaluation. Detailed features of the TEE

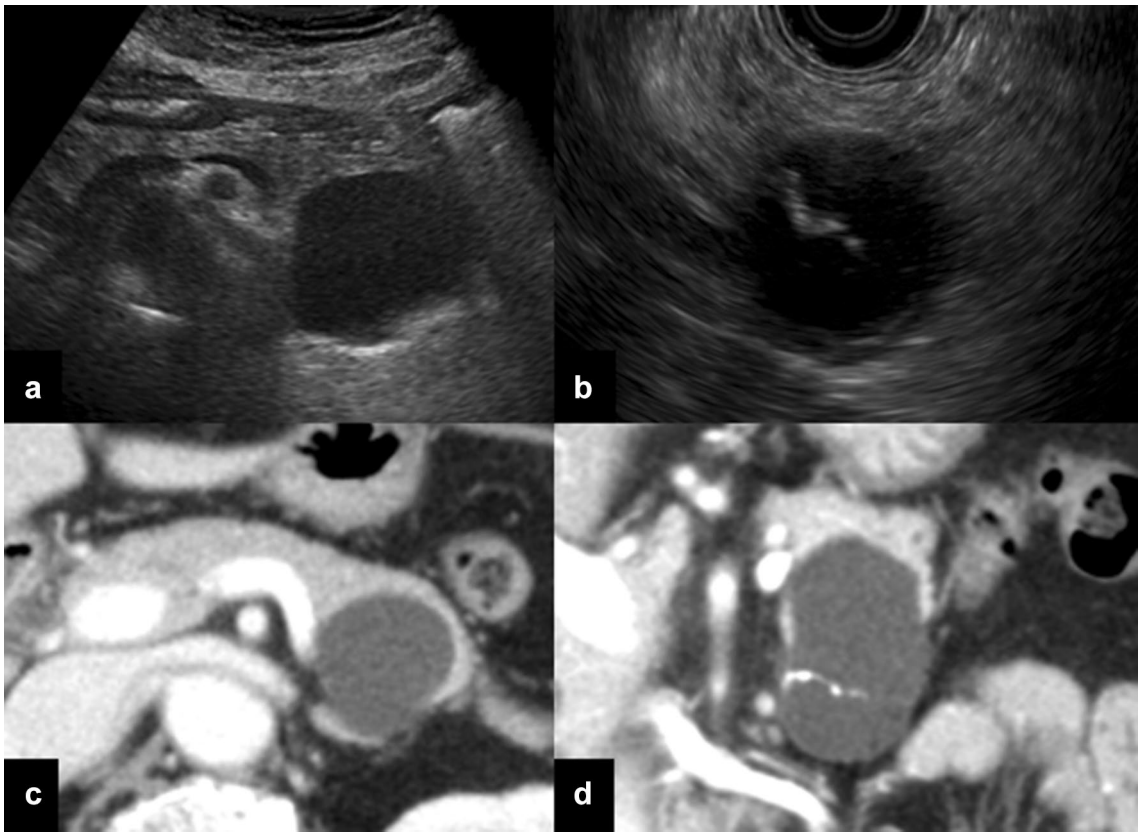

Fig. 1 The cystic lesion in the pancreas with multiple modalities. **a** Transabdominal ultrasound showing a round-shaped 43×38 mm cystic lesion in the tail of the pancreas. **b** Endoscopic ultrasonography using a forward-viewing radial echoendoscope (EG-580UR, Fujifilm medical, Tokyo, Japan) showing a round cystic lesion with lateral shadowing, rather thick wall and calcified septum. **c** and **d** Contrast-enhanced computed tomography of the abdomen demonstrating a cystic lesion with a calcified septum. Pancreatic parenchyma was unremarkable and the main pancreatic duct was not dilated

probe are as follows; working length: 1100 smm, tip diameter: 15.5 mm, outer diameter: 10.5 mm, field of view: 90°, detection mode: real-time 3D mode, transmitting frequency: 5 MHz (range 2.2–8 MHz). The application of TEE for pancreas is off-label use and the procedure was performed under approval by the Institutional Review Board of Nagoya University Hospital. A written consent form was obtained from the patient before the procedure after thorough explanation including the risk and benefit. This new TEE probe in combination with volume matrix function loaded in the ultrasound apparatus of Aplio i900 (Canon Medical Systems, Tokyo, Japan) made it possible to observe the lesion from multi-plane simultaneously, which helped understand the 3D structure of the lesion (Fig. 2). The real-time 3D imaging revealed internal features of the cystic lesion expressing uneven wall and the thickened septum (Fig. 3). Given the gender, location and gross appearance of the lesion, MCN was carried out as our primary differential diagnosis. A surgical resection by distal pancreatectomy was performed without prior cytological diagnosis. The histopathological findings of the cystic lesion revealed coverage of the wall with simple cuboidal epithelium without atypia. Ovarian-type stroma composed of spindle-shaped cells was identified in the cystic wall. These findings supported the final diagnosis of MCN of the pancreas (Fig. 4).

Discussion

This is the first report which showed the real-time 3D image of MCN in the pancreas obtained with TEE. Transesophageal echocardiography was first reported by Frazin et al. [1] in 1976 to observe the cardiac system from the esophagus using ultrasound. It is useful for the cases which were difficult to obtain sufficient image with a transthoracic echocardiography due to the ribs, lung or fat, because you can get closer to the target. Endoscopic ultrasound is a modality which is widely accepted in the field of gastroenterology with similar concept to TEE. Given the high spatial and chronal resolution, EUS plays an important role in the diagnosis of pancreatic lesions. However, some of the functions in EUS are limited compared to TEE

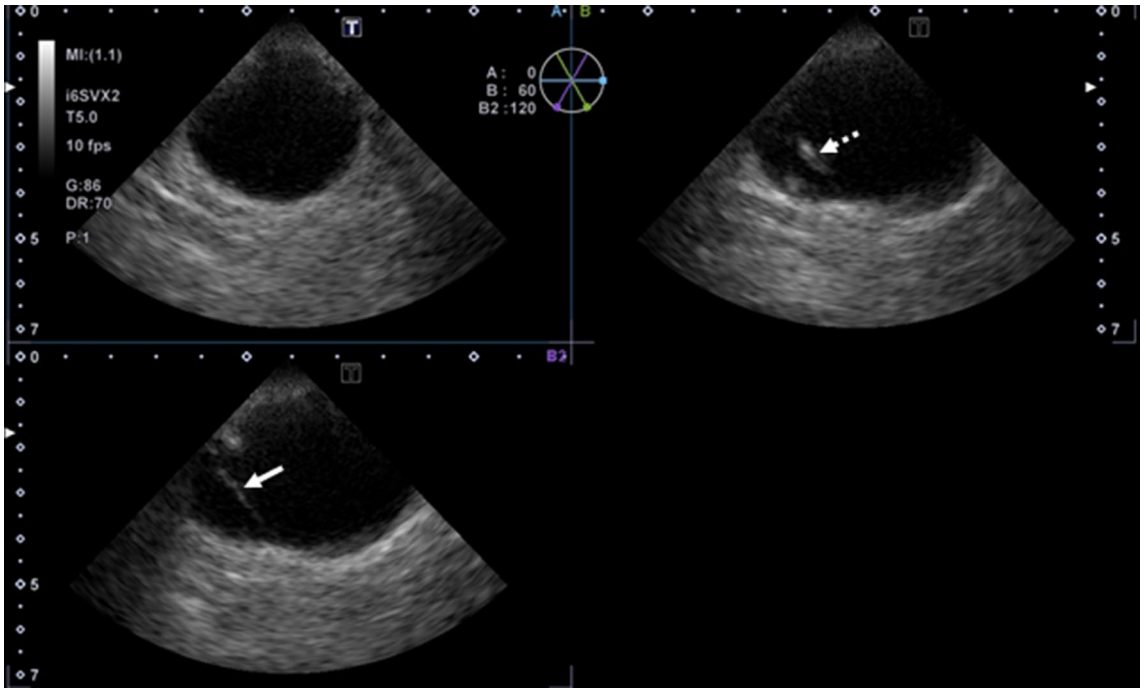

Fig. 2 The multi-plane view of the cystic lesion in the pancreas using the transesophageal echocardiography probe. Images from three different directions are shown simultaneously in one screen, demonstrating the septum (arrow) and thickened calcification (broken arrow)

due to the limited volume in the tip of the device as EUS needs to carry both ultrasound and endoscopy device. The novel TEE probe, PEI-512VX in combination with Aplio i-series has shown significant evolution including the real-time 3D imaging. Recently, the reports showing the usefulness of real-time 3D imaging with TEE in cardiology have been increasing [2–4]. Suresh et al. [2] have reported a case of cardiac tumor (papillary fibroelastoma) which underwent 3D TEE defining the exact attachment point of the tumor in the mitral valve. Elkaryoni et al. [4] have compared 3D TEE to multi-detector CT (MDCT) for aortic annular sizing and reported that the 3D TEE demonstrated high level of correlation with those evaluated by MDCT. They emphasize the advantage of 3D TEE compared to MDCT in real-time assessment, lack of contrast, and no radiation exposure. There has been no report using TEE in gastrointestinal (GI) field. We have performed transabdominal 3D ultrasound before EUS/TEE for this patient using a sector probe (i6SVX2, Canon Medical Systems, Tokyo, Japan). However, likely due to the distance from the abdominal wall to the lesion, we could not obtain a clear view. Therefore, to perform 3D TEE from the stomach is important to reduce the distance between the probe and the target and obtain the high-quality image for pancreatic lesions. One of the advantages of using TEE is that we can obtain 3D images from multiple directions and angles in real-time, which enables us to easily understand the structure of the lesion. Typical MCN cases show characteristic radiological findings, such as a multilocular cyst with a cyst-in-cyst appearance with wall thickening, but it is not always easy to detect these findings even with multiple modalities. The 3D image in our case helped understand the characteristics of the lesion and led us to the preoperative diagnosis of MCN.

The most challenging part in using TEE for GI lesions is the manipulation of the probe in the esophagus or stomach without an endoscopy-guidance. In the present case, we performed a regular EUS prior to TEE to confirm the position where the target can be observed and make sure that there is no anatomical abnormality such as esophageal diverticulum or large hiatal hernia so that the endosonographer could safely insert the TEE into the stomach. To obtain the image of pancreas with TEE, we did not accumulate water in the stomach. Instead of that, we attempted to push the probe against the gastric wall to eliminate the space between the probe and the stomach. This maneuver was almost the same with that of a regular EUS and although there is no suction function in TEE, a small amount of air did not affect the image by pushing the scope to the gastric wall. The gastric peristalsis may affect the 3D image finding, but in most cases the body to tail of the pancreas can be observed from the body of the stomach, where the peristalsis is weaker compared to the antrum. Therefore, we assume the effect of peristalsis is not a big problem as long as we handle the probe in the proximal side of the stomach and push against the gastric wall.

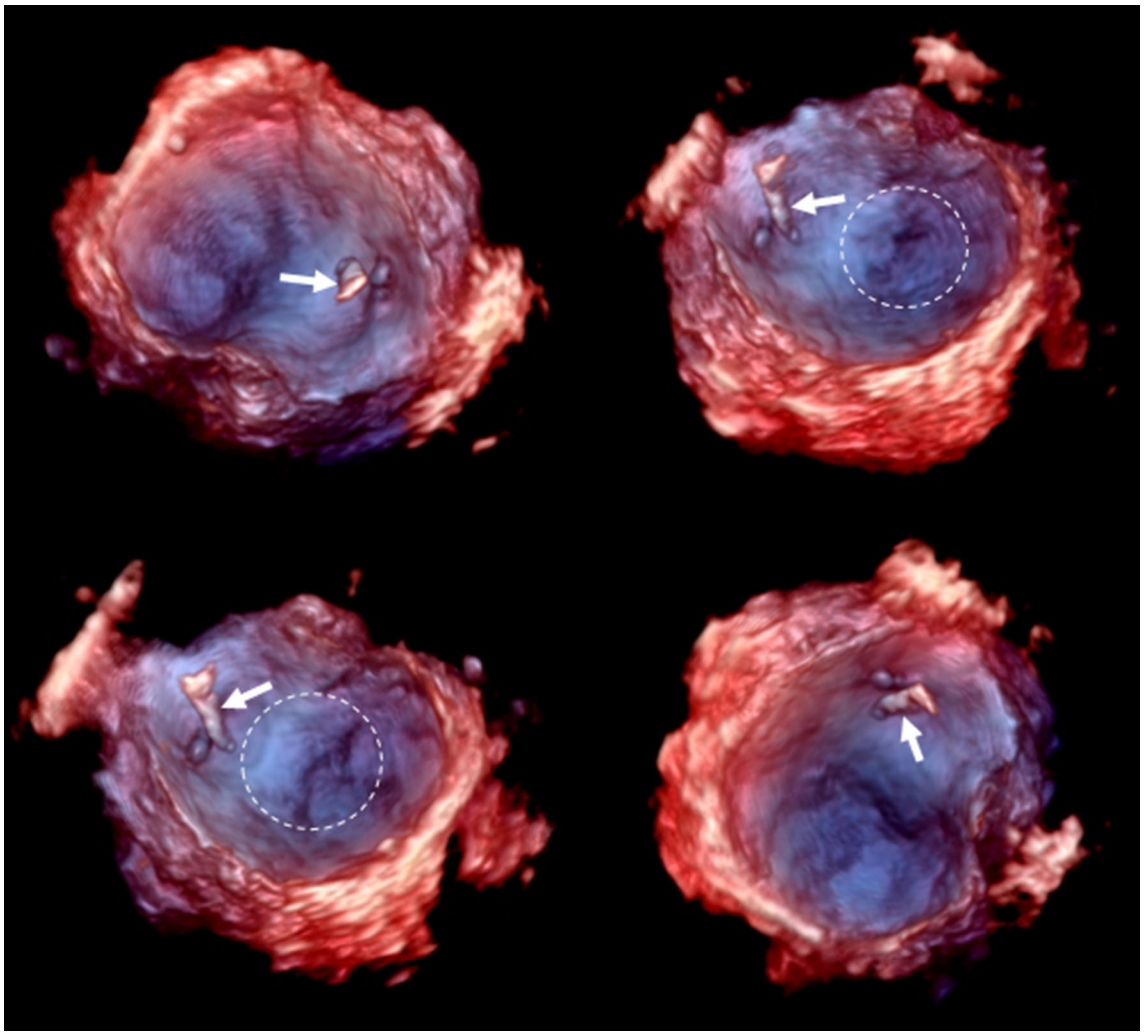

Fig. 3 The real-time three-dimensional images from multiple angles of the cystic lesion in the pancreas obtained with the transesophageal echocardiography probe. Internal features of the cystic lesion are clearly demonstrated with uneven wall (circle) and the thickened septum (arrow)

The limitation of using TEE for pancreatic lesion is because the length of the probe is only 1100 mm, it may be too short to evaluate the whole pancreas. In addition, it is difficult to advance the probe into the antrum or duodenum without endoscopy-guidance. Thus, the evaluation of pancreas with TEE is limited to the area where you can achieve images from the proximal side of the stomach, mainly body to tail of the pancreas at present.

We hope an EUS probe equipped with a matrix transducer such as TEE will be developed in the near future. 3D EUS would be beneficial for real-time evaluation of treated area by EUS-guided tumor treatment. Moreover, by combining color Doppler mode and 3D mode, it is easy to understand the relationship between the lesion and the surrounding vessels, which may help decide the surgical indication or understand the anatomy prior to surgery in GI field.

In conclusion, we presented the first case report that demonstrated the usefulness of 3D TEE in characterizing MCN of the pancreas. Our experience has indicated the possibility to apply real-time 3D ultrasonography for the assessment of pancreatic lesions. Further investigation is warranted to determine the clinical relevance.

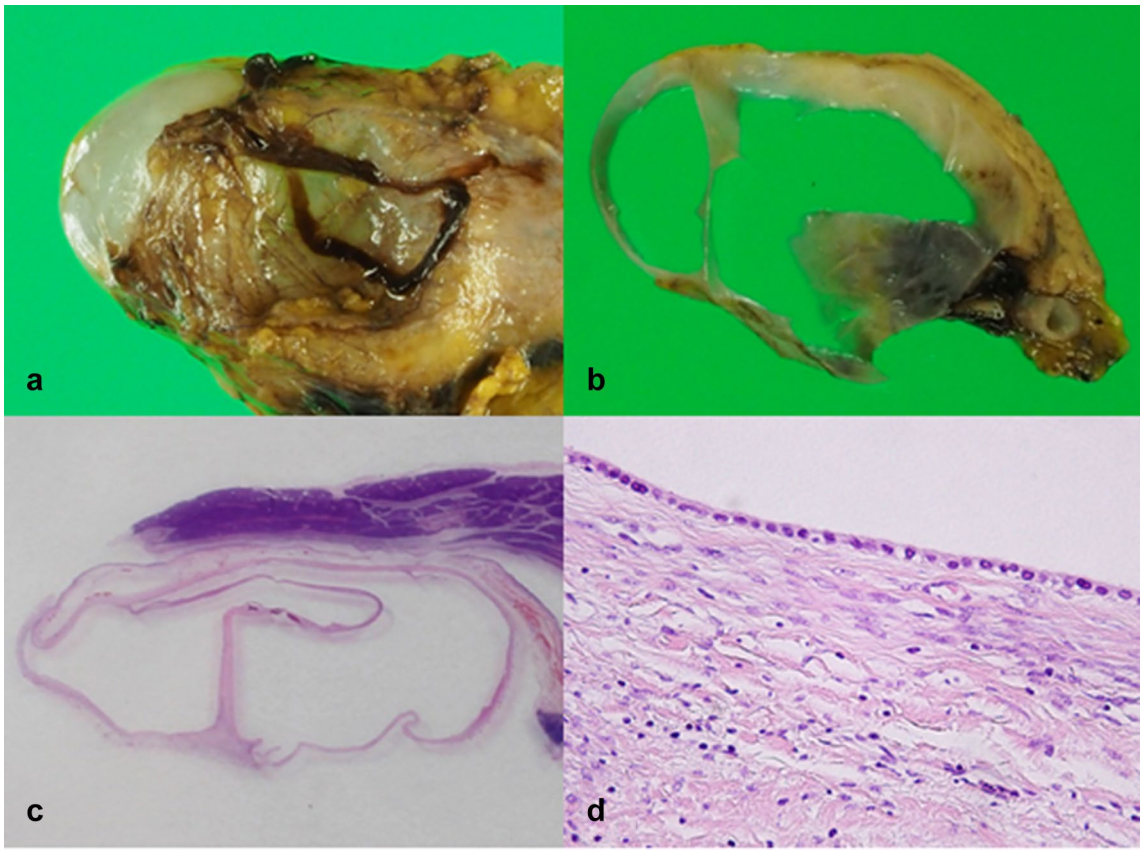

Fig. 4 Gross and microscopic findings of the resected specimen. **a** The surface of the cyst was smooth and was covered with a thin capsule. **b** and **c** The cut section of the resected specimen showed a 4 cm multilocular cyst without intracystic nodular lesions. **d** Microscopy confirmed the cyst to be lined by a single-layered, mucin producing epithelial cells associated with ovarian-type stroma (**d**)

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Compliance with ethical standards

Conflict of interest Takuya Ishikawa, Yoshiki Hirooka, Hiroki Kawashima, Eizaburo Ohno and Mitsuhiro Fujishiro declare that they have no conflict of interest.

Human rights All procedures followed have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed consent Informed consent was obtained from all patients for being included in the study.

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