Vascular Anomaly Associated with Ectopic Pancreas in the Pylorus

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Abstract
The ectopic pancreas is a relatively rare congenital condition, defined as pancreatic tissue lacking anatomical or vascular continuity with the normal pancreatic body. The ectopic pancreas is most frequently found in the stomach, usually asymptomatic and discovered incidentally. We report the case of a 72-year-old man who was diagnosed with cancer in the gastric vestibule. Distal gastrectomy was performed, and 3 cm of the ectopic pancreas was found on the anterior surface of the pylorus intraoperatively. The gastroduodenal artery was not found by approaching the inferior border of the pancreas but by following the branches from the common hepatic artery. Posterior view CT confirmed that the GDA terminated in the ectopic pancreas. An ectopic pancreas may be associated with vascular anomalies. Clinicians must consider the possibility of vascular anomalies when operating on patients with an ectopic pancreas. If the gastroduodenal artery cannot be found intraoperatively, identification should be attempted by following the common hepatic artery.

Introduction
Ectopic pancreas (EP) is a relatively rare congenital condition, defined as pancreatic tissue lacking anatomical or vascular continuity with the normal pancreatic body [1]. EP most often occurs in the upper gastrointestinal tract, and 70–90% of these lesions occur in the stomach, duodenum, or jejunum [2]. Although there are many case reports of the EP, reports
of anatomical abnormalities or surgical pitfalls are sporadic. In this report, we describe the anatomical features associated with an EP discovered intraoperatively.

**Case Report/Case Presentation**

A 72-year-old man visited our hospital with a loss of appetite and heartburn. Gastroscopy found a grade three tumor in the gastric antrum with a diameter greater than 5 cm. Endoscopically, there were no findings suggestive of the EP. Mucosal biopsy was performed, and the tumor was diagnosed as a poorly differentiated adenocarcinoma. Abdominal computed tomography (CT) showed that the wall of the gastric antrum and posterior wall of the stomach were thickened with enlarged lymph nodes. However, no metastases were visualized. The EP could be identified on a retrospective view of the abdominal CT; however, it was not noted before surgery. The abdominal CT scan is shown in Figure 1. A mass with the same density as the pancreatic tissue can be identified in the anterior wall of the pylorus. 3D vascular construction showed that the gastroduodenal artery (GDA) was terminated in the EP and did not form an arcade on the entire pancreas (Shown in Fig. 2). The abdominal CT scan also showed an artery branching from the SMA on the dorsal pancreatic head and running caudally, which was thought to be the inferior pancreaticoduodenal artery.

Standard distal gastrectomy and D2 lymph node dissection were performed. An upper midline incision was made, and dissection was initiated from the separation of the greater omentum along the border of the transverse colon from the right-hand side to the region of the 4sa lymph node. The fusion fascia between the greater omentum and the peritoneum

![Fig. 1. Axial CT image showing ectopic pancreatic tissue (white arrow) located in front of the pylorus.](image1)

![Fig. 2. 3D vascular construction showing the GDA terminating in the EP and the location of the EP (indicated by white triangles). GDA, gastroduodenal artery.](image2)
of the anterior surface of the pancreas was dissected, and the anterior membrane of the pancreatic head was exposed. A 3-cm mass of pancreatic tissue was found on the anterior surface of the pylorus, which was determined to be the EP. The anterior surface of the pancreas was dissected. However, the GDA was not visible after exposing the upper pancreatic margin. The common hepatic artery (CHA) was identified. A blood vessel was found branching off from the right-hand side of the CHA, which flowed into the EP (Shown in Fig. 3). No other GDA-like vessels were branching from the CHA; therefore, we concluded that this was the GDA, and the vessel was subsequently ligated. The right gastroepiploic artery (RGEA) branched off the GDA near the EP and ran toward the right side of the greater omentum, and the RGEA was ligated. The inferior pyloric artery branched near the root of RGEA. Since the EP was tightly adhering to the duodenum, the duodenum was dissected on the peripheral side of the EP after ligating the inferior pyloric artery, and the entire EP was removed. After completing lymph node dissection, Roux-en-Y reconstruction was performed. A drain tube was placed at the anastomosis.

Pathological examination of the tumor revealed a poorly differentiated adenocarcinoma: the tumor was T1b, with submucosal invasion, no lymph node involvement, and no metastases. The duodenal specimen showed EP tissues that contained exocrine components and ducts with minor endocrine elements. The EP invaginated into the muscular layer of the duodenum. The specimen also showed the EP opening into the minor duodenal papilla, indicating that it was a functional pancreas (Shown in Fig. 4).

The patient resumed eating on the 8th day after surgery. There was no elevation of amylase, but the patient presented with mild postoperative lymphatic leakage, which delayed drain removal. The drain was removed on the 10th postoperative day. On the 13th postoperative day, he developed a fever of 38.0°C and showed an elevated inflammatory response.
After reinserting the drain tube, grayish-white effluent emerged, leading to the diagnosis of postoperative pancreatic fistula. Drainage angiography was performed, but the intestinal lining did not appear contrasted. Subsequently, the intra-abdominal cavity was washed through the drain tube, and antibiotics were administered. No reoperation was performed. On the 36th postoperative day, the drain effluent turned serous, and the patient resumed eating. The patient was discharged home on the 42nd postoperative day, and there were no adverse findings such as abdominal symptoms or fever at the 4-month follow-up.

**Discussion/Conclusion**

Ectopic or heterotopic pancreas is a relatively rare congenital condition in which a portion of the pancreas lacks anatomical or vascular continuity with the normal pancreatic body [1]. Most cases of EP are identified incidentally during surgery or upon autopsy. Autopsy reports indicate that the prevalence of EP ranges from 0.6% to 13.7% [3]. Most cases of EP are found in the stomach (25–38%), followed by the duodenum (17–36%) or jejunum (15–22%) [4]. EP associated with the stomach is most commonly found in the pylorus [5]. Other reported sites include the biliary tract, liver, esophagus, spleen, ileum, Meckel’s diverticulum, greater omentum, mesentery, and colon [6].

Four classifications of EP have been proposed [7]:

- **Type I**: consists of typical pancreatic tissue with acini, ducts, and Langerhans cells.
- **Type II**: (canalicular variety) consists of only pancreatic ducts.
- **Type III**: (exocrine pancreas) consists of only acinar tissue.
- **Type IV**: (endocrine pancreas) consists of only Langerhans cells.

Based on this classification scale and the pathology findings, our patient had type I EP. Tanaka et al. [8] recommend resection for histological diagnosis when EP is incidentally found during surgery. In this case, EP was suspected upon observing pancreatic tissue in the antrum of the pylorus and was dissected with the duodenum. Postoperative pathological findings showed that the pancreatic tissue had invaginated into the duodenum. Therefore, detachment of the EP would have been impossible, and the decision to remove the EP was appropriate.

Preoperative diagnosis of asymptomatic EP is often difficult [9]. Preoperative diagnosis using CT is not very promising; however, magnetic resonance imaging may be helpful [10].

An association between gastrectomy and pancreatic fistula has been shown previously, with an incidence of 0–26% [11]. The EP of the pylorus is anatomically close to the pancreas, and both are susceptible to damage from dissection. Although the relationship between EP and pancreatic leakage has not yet been investigated, it could potentially be a risk factor for pancreatic fistula due to intraoperative manipulation or pancreatic injury. Fibrin glue and PGA sheets reportedly help prevent postgastrectomy pancreatic fistula [12]. In our patient, the use of fibrin glue and PGA sheets could have helped prevent pancreatic fistula.

It should be noted that the GDA flowed into the EP, and there was no pancreatic duodenal arcade on the anterior surface of the pancreas. To the best of our knowledge, malformation of GDA flowing only into the EP has not yet been reported. Embryologically, it is likely that the ventral pancreas failed to rotate around the duodenum, leaving pancreatic tissue and vessels behind. Our findings suggest that EP may be associated with anomalies of the GDA and surrounding vessels. Gastrectomy with EP may be complicated by vascular mutations, such as in the present case, and this should be considered during surgery. When performing surgery in such cases, it is necessary to rapidly change the surgical field to identify GDA with the help of CHA.
This case suggests that EP may be associated with vascular anomalies. Clinicians must consider the possibility of vascular anomalies when operating on patients with an EP. If the GDA cannot be found intraoperatively, identification should be attempted by following the CHA.

**Statement of Ethics**

Written informed consent was obtained from the patient for publication and any accompanying images. Ethical approval is not required for this study in accordance with local or national guidelines.

**Conflict of Interest Statement**

The authors declare that they have no competing interests.

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**Author Contributions**

Shota Sato performed the surgery and wrote the manuscript. Tuyoshi Shoji and Hiroshi Sato performed the surgery, reviewed the manuscript, and provided feedback. Hirotoshi Maruo reviewed the manuscript and provided feedback.

**Data Availability Statement**

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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