Solid-Pseudopapillary Tumor of the Pancreas

Kristin M. Coleman, MD • Michael C. Doherty, MD • Steven A. Bigler, MD

History
A 28-year-old black woman with no significant medical or surgical history presented to the emergency department with a chief complaint of left flank pain of several months duration. She also had a history of early satiety and postprandial epigastric pain that radiated to the back. The abdominal pain lasted for approximately 3 hours after eating, and there were no relieving factors. The patient had normal vital signs and was afebrile. Physical examination revealed tenderness at palpation over the epigastric region but was otherwise unremarkable. Her serum amylase level was normal.

Imaging Findings
Abdominopelvic computed tomography (CT) with both orally and intravenously administered contrast material showed an enlarged pancreatic head (4.5 × 3.0 cm) containing a subtle, rounded low-attenuation area about 1.5 cm in diameter (Fig 1). An underlying neoplasm was suspected. Bilateral ovarian masses containing soft tissue, fat, and calcium were incidentally noted, a finding that was consistent with bilateral ovarian teratomas.

Breath-hold abdominopelvic magnetic resonance (MR) imaging included axial fast spoiled gradient-echo (PSPGR) fat-saturated T1-weighted images and axial and coronal single-shot fast spin-echo T2-weighted images. Unenhanced and contrast-enhanced arterial and portal venous phase images were obtained. Unenhanced T1-weighted imaging demonstrated a round, well-circumscribed, hypointense 1.5-cm mass in the enlarged pancreatic head just anterior to the common bile duct (Fig 2). The mass was slightly hyperintense at T2-weighted imaging (Fig 3). On the initial arterial phase contrast-enhanced images, the mass was hypointense (Fig 4a), but on the portal phase images, it showed progressive filling and became almost imperceptible (Fig 4b). These findings suggested a solid pancreatic head neoplasm.

Pathologic Evaluation
The patient underwent elective resection of the bilateral ovarian teratomas. A few months later, the patient underwent elective resection of the mass in the pancreatic head and pancreateicodudenectomy (Whipple procedure) with jejunostomy tube placement. The distal stomach, pancreas, distal common bile duct, and gallbladder...
were resected and sent to the pathology department.

At gross examination, a soft, round, well-circumscribed 1.9-cm mass was identified in the pancreatic head (Fig 5). At histologic analysis, the tumor was composed of uniform polygonal cells with moderate to abundant amphophilic cytoplasm and arranged in solid nests with areas of degeneration characterized by separation of the

**Figures 2–4.** (2) Fast spoiled gradient-echo fat-saturated T1-weighted MR image reveals a round, well-circumscribed, low-signal-intensity 1.5-cm mass in the enlarged pancreatic head just anterior to the common bile duct (arrow). (3) On a single-shot fast spin-echo T2-weighted MR image, the mass is slightly hyperintense (arrow). (4a) Initial contrast-enhanced arterial phase fast spoiled gradient-echo fat-saturated T1-weighted MR image demonstrates the lesion as slightly hypointense (arrow). (4b) On a contrast-enhanced portal phase fast spoiled gradient-echo fatsaturated T1-weighted MR image, the lesion (arrow) is almost imperceptible.
cells into pseudopapillary aggregates with intervening accumulation of mucopolysaccharide rich ground substance (Fig 6a). No vascular space or perineural invasion was identified. The tumor was not encapsulated, and although the tumor-pancreatic parenchyma interface was irregular at histologic analysis, the tumor did not deeply invade the pancreas. The tumor cell nuclei were oval or coffee bean shaped (Fig 6b). No mitotic figures were identified. One peripancreatic lymph node was negative for metastasis. At immunohistochemical analysis, the tumor cells were positive for broad-spectrum cytokeratin in a patchy distribution, diffusely positive for α-1-antitrypsin, positive for progesterone receptor, and positive for synaptophysin in approximately 50% of the cells. The cells were negative for chromogranin A, glucagon, insulin, gastrin, pancreatic polypeptide, somatostatin, lysozyme, estrogen receptor, and Ki-67 antigen (a proliferation marker). These findings helped establish a diagnosis of solid-pseudopapillary tumor (SPT) of the pancreas, although the finding of synaptophysin positivity is somewhat unusual for this tumor.

**Discussion**

SPTs of the pancreas are rare (1%–2% of exocrine pancreatic tumors at most institutions). Franz (1) first described this tumor in 1959 as a “papillary tumor of the pancreas, benign or malignant.” Since the report of five cases by Kloppel et al (2) in 1981, the number of reported cases has increased. According to Lam et al (3), a total of 452 cases have been reported in the English literature. Synonyms include solid and cystic tumor, solid and papillary epithelial neoplasm, papillary-cystic neoplasm, papillary cystic epithelial neoplasm, papillary-cystic tumor, and Franz tumor. In 1996, the World Health Organization (WHO) renamed this tumor as SPT for the international histologic classification of tumor of the exocrine pancreas (4).

This uncommon, typically benign tumor is found mainly in young non-Caucasian women between the 2nd and 3rd decades of life. It seems to have a predilection for Asian and African-American women, although rare cases have been reported in children and men (3,5). Although most SPTs exhibit benign behavior, malignant degeneration does occur. Lam et al (3) found that 66 of the 452 reported tumors (15%) were malignant, evidencing metastases or invasion of adjacent structures. The malignant pancreatic tumors were often older at presentation and had a male predilection (3). According to the WHO classification scheme, SPTs with clear criteria of malignancy (vascular and nerve sheath invasion or lymph node and liver metastases) are designated as solid-pseudopapillary carcinomas (4).

Patients with SPT of the pancreas are often clinically asymptomatic. They may present with a gradually enlarging abdominal mass or complain of vague abdominal pain or discomfort. The abdomen is usually nontender on palpation, but obstructive symptoms may occur if the tumor grows large enough to compress adjacent viscera. There are usually no abnormalities in clinical laboratory tests (eg, serum amylase levels) or in pancreatic cancer markers (eg, CA19–9, carcinoembryonic antigen, α-fetoprotein). The diagnosis is not uncommonly made incidentally at abdominal examination, ultrasonography (US), or CT performed for other reasons.

SPT of the pancreas has distinctive pathologic features. The mass may occur anywhere in the pancreas but is most frequently found in the head or tail. At gross examination, the mass is usually large (mean maximum dimension, 9.3 cm) and well encapsulated and contains varying amounts of necrosis, hemorrhage, and cystic change. At microscopic analysis, there are two distinct types of cellular arrangements: solid and papillary. The hallmark histologic pattern occurs when the tumor cells form papillary configurations composed of a fibrovascular stalk surrounded by several layers of epithelial cells. Solid areas containing ne-
crosis, foamy macrophages, cholesterol granulomas, and calcifications may also be seen (3).

Theories of histogenesis are controversial but have generally been divided into three main groups: pancreatic duct cell origin, acinar cell origin, or primitive cell origin. SPTs are typically positive for vimentin, neuron-specific enolase (NSE), α-1-antitrypsin, and α-1-antichymotrypsin and negative for chromogranin, epithelial membrane antigen, and cytokeratin. Differentiation along endocrine cell lines has been postulated for this tumor on the basis of NSE positivity, but the expression of vimentin and α-1-antitrypsin does not support this interpretation. A study by Kosmahl et al (6) demonstrated that SPTs have a complex immunoprofile that is inconsistent with that of any of the pancreatic cell types and that a pancreatic origin was unlikely. The authors speculated that on the basis of some similarities between SPT and ovarian surface cells and the proximity between genital ridges and the pancreas anlage during early embryogenesis, SPTs might originate from the genital ridge–related cells that were incorporated into the pancreas during organogenesis (6). Furthermore, sex hormones may play a role in the pathogenesis or growth of SPTs: Nearly all studies demonstrate no evidence of estrogen receptors; however, progesterone receptors are present in many cases (3). Morales et al (7) described the temporal relationship between a fast-growing SPT and pregnancy in a young woman and also demonstrated the presence of a progesterone receptor in the tumor tissue. The growth rate of the SPT of the pancreas seemed to be enhanced by the concurrence of pregnancy. Although these hypotheses of origin are intriguing, they are yet unproved, and further research is necessary.

The variety of imaging techniques available may help differentiate SPT from other cystic neoplasms (eg, serous cystadenomas, mucin-producing tumors, islet cell tumors). In children with no specific symptoms, the differential diagnosis must include a nonfunctioning islet cell tumor or pancreatoblastoma. CT usually demonstrates a well-encapsulated lesion with varying solid and cystic components owing to hemorrhagic degeneration (8). Following contrast material administration, enhancing solid areas are typically noted peripherally, whereas cystic spaces are usually more centrally located (9). MR imaging typically demonstrates a well-encapsulated lesion with heterogeneous signal intensity on T1- and T2-weighted images, which reflects the complex nature of the mass. Areas of high signal intensity on T1-weighted images and low or inhomogeneous signal intensity on T2-weighted images can help identify blood products (10) and may also help differentiate SPTs from islet cell tumors, whose cystic components have moderately increased signal intensity.
on T1-weighted images and increased signal intensity on T2-weighted images. Moreover, the peripheral portions of SPTs do not demonstrate the hypervascularity typically seen in islet cell tumors (9). Our case is somewhat atypical due to the small size of the tumor, which may the lack of significant cystic change or hemorrhage at MR imaging. Also, the importance of arterial phase images must be emphasized in our case because the lesion was much better seen on arterial rather than portal venous phase images. US findings have also been described in the literature. Lee et al (11) retrospectively evaluated US findings in 11 cases of pathologically proved solid and papillary epithelial neoplasms of the pancreas. Well-encapsulated cystic and solid masses were typically seen, but sometimes a mass was pure and solid-looking or had internal septa or calcifications. Fine-needle aspiration may play an important role in preoperative planning by helping distinguish SPTs from other pancreatic lesions with a significantly different prognosis and treatment (12). Accurate diagnosis of the special type of pancreatic tumor is obviously important. SPTs generally carry a much better prognosis than does the typical adenocarcinoma of the pancreas. Although the radiologic features are often informative, significant overlap does exist. Fine-needle aspiration biopsy and cytologic analysis or excisional biopsy and histologic analysis are needed for definitive diagnosis.

SPT of the pancreas is treated with surgery, and complete resection is usually curative. Nishihara et al (13) indicated that venous invasion, high nuclear grade, and prominent “necrobiotic nests” help detect the malignant potential of papillary cystic tumors. Shimizu (14) suggested that capsular invasion may also be an important pathologic indicator of malignant potential in SPTs. Their patient had liver metastases only 17 months after surgery. Close inspection of the surgical specimen revealed capsular invasion without signs of vascular or nerve sheath invasion. In most patients, however, prognosis is excellent; individuals have been reported to be disease free 21 years after surgery (3).

References