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Differentiation between benign and malignant solid pseudopapillary tumor of the pancreas by MDCT☆

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ABSTRACT

Purpose: The purpose of this study was to determine if characteristic features on computed tomographic and (or) magnetic resonance imaging can differentiate benign and malignant solid pseudopapillary neoplasms (SPN).
Materials and methods: A total of 82 pathologically diagnosed SPN patients were included. CT and MRI were reviewed by 3 radiologists. Each tumor was analyzed through the clinical and imaging features.
Results: The highest occurrence of malignant SPN was observed in the group of patients (11–19 years old) followed by the group of patients (50–65 years old). When the tumor was located in the tail and the size was equal or larger than 6.0 cm, the positive and predictive value, the predictive value, sensitivity and specificity for a malignant SPN were 61.5%, 100%, 100% and 78.6%, respectively. Presence of complete encapsulation was more frequent in benign SPNs, but focal discontinuity in the malignant SPNs. Amorphous or scattered calcifications, all near-solid tumors and presence of upstream pancreatic ductal was found in the benign SPNs.
Conclusion: A focal discontinuity of the capsule, large tumor size (>6.0 cm) and a pancreatic tail location may suggest malignancy of SPN. In contrast, tumors with amorphous or scattered calcifications, and all near-solid tumors may be indicative of benignancy. Age (less than 20 or more than 50 years old) is a possible risk factor of SPN. In comparison to other pancreatic neoplasms, such as ductal adenocarcinoma, a complete/incomplete pseudo-capsule, without upstream pancreatic duct dilatation and lymph nodes metastasis, and the presence of internal calcification and hemorrhage are more likely SPN.
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1. Introduction

SPN is a rare disease with predominant occurrence in women, especially in young women. SPN accounts for approximately 1–2% of all exocrine pancreatic tumors [1]. Studies have shown that SPN occurred more frequently in eastern countries, but the incidence in different geographic areas has not been reported [2,3]. SPN has an excellent prognosis and a high 5-year survival rate (up to 95–100%) [4,5]. Almost all SPN is developed from the pancreas, and approximately 15–20% of the cases may result in invasions of adjacent organs or distant metastasis. Liver is the most common site of metastasis, while metastasis of lymph node is rare [1,5].

En bloc resection has been regarded as the only curative treatment of SPNs. When metastasis is present, concomitant metastasectomy is recommended [6,7]. Failure of complete tumor excision can increase the risk of recurrence (approximately 6.6%) [8]. With the development of medical technology, conservative resection, e.g., central pancreatectomy or enucleation, and laparoscopic surgery, has been used to preserve the normal pancreas and reduce the morbidity, which is especially important for young female patients [9,10]. Thus, it is important to predict the malignant potential of a tumor before surgery. Less extensive surgery should be considered for a benign looking SPN, whereas en bloc resection with sufficient safety margins must be performed for a malignant SPN [11]. The differential imaging features between benign and malignant SPNs are not well understood. The purpose of this study was to investigate if there are characteristic CT features that can be used to differentiate the benign and malignant SPNs.

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Table 1
Patient clinical characteristics and preoperative diagnosis accuracy rate.

	Benign ($N = 68$)	Malignant ($N = 14$)
Sex		
Male	15	2
Female	53	12
Age, median (range)	33.5 ± 9.8 (14–58)	33.6 ± 14.2 (11–65)
Clinical manifestation		
Abdominal pain	25 (36.8%)	8 (57.1%)
Palpable abdominal mass	10 (14.7%)	3 (21.4%)
Back pain	11 (16.2%)	5 (35.7%)
Incidental finding	38 (55.9%)	4 (28.6%)
Indigestion	10 (14.7%)	5 (35.7%)
Weight loss	5 (7.4%)	6 (42.9%)
Preoperative diagnosis accuracy rate	60.2% (41/68)	28.6% (4/14)

2. Materials and methods

2.1. Subjects

The institutional review board of our institution approved this retrospective study and waived the requirement for informed consent. Between January 2001 and April 2011, all patients (17 males and 65 females; range 11–65 years, mean age 33.1 years, male 35.9 years and female 32.3 years) had confirmed SPNs of the pancreas by surgery and pathologic diagnosis (Table 1 and Fig. 1a). These patients had preoperative imaging examinations, including CT in 73 patients, and both CT and MR in 9 patients. The tumor was diagnosed as malignant SPN based on the pathologic characteristics, e.g., perineural invasion, angioinvasion, deep invasion into the surrounding tissue on microscopy, or distant metastasis. A total of 68 patients (15 males and 53 females, mean age 32.5 ± 9.8 years, range 14–58 years) were regarded as benign SPN, while 14 patients (2 males and 12 females, 1:6; mean age 33.6 ± 14.2 years, range 11–65 years) were confirmed to be malignant SPN (Fig. 1b and c).

2.2. Image acquisition

All abdominal multidetector-row CTs (MDCTs) were performed on a 4-slice, 16-slice or 64-slice multi-detector row CT scanner (LightSpeed QX/I or Lightspeed 16 or lightspeed 64; GE Medical Systems, Milwaukee, WI, USA). All axial CT images were obtained during breath holding before (non-enhanced, 30–35s arterial phase, 60–65s portal phase) after the initial administration of contrast materials. Contrast enhanced MDCT was performed after the intravenous injection of iohexol (Omnipaque 370; Amersham,Shanghai, China) at a dose of 2.0 ml/kg body weight through an antecubital vein using a power injector (LFCT 9000; Liebel-Flarsheim, Cincinnati, OH) at a flow rate of 2.5–3.0 ml/s. The CT angiography (CTA) and reformed images were obtained using maximum intensity projection (MIP) or multiplanar volume reformation (MPVR) technique on the workstation (ADW4.2 and ADW4.4). Besides MDCT, MRI was performed for 9 cases. Magnetic resonance imaging was performed with 1.5T or 3.0T MR imaging units (MagnetomAvanto; Siemens AG, Erlangen, Germany, and Signa 1.5 or 3.0T Signa HD, GE Medical Systems). All images were obtained using an 8-elementphased-array surface coil. The imaging protocols of precontrast and postcontrast scanning were as follows: T2-and T1-weighted images were acquired with a respiration or avigator-triggered and T2-weighted turbo spin echo (fast spin echo) pulse sequence with fat suppression and a breath-hold-dimensional (2D) T1-weighted fast multiplanar spoiled gradient-recalled echo pulse sequence with and without fat suppression, respectively. The slice thickness was 5 mm for both T1- and T2-weighted images, with 2 mm of slice gap; dynamic gadolinium-enhanced pulse sequences included a breath-hold T1-weighted 2D fast multiplanar spoiled gradient-recalled echo with fat suppression, T1-weighted volume interpolated three dimensional gradient echo pulse sequences and a breathhold 3D parallel spoiled gradient echo sequence with arterial, pancreatic, and portal phase. Five patients received intravenous administration of contrast material (gadopentetate-dimeglumine, Magnevist; Bayer Healthcare, Berlin, Germany) at 2.0 ml/s, followed by 20 ml of normal saline.

2.3. Image analysis

All images from 82 patients on a picture archiving and communication system (GE Medical System) without any relative patient information were reviewed in consensus by 2 abdominal radiologists. Disputes in readings were resolved through consultation with the third experienced abdominal radiologist. Each tumor was analyzed according to the following categories: age and sex, tumor location (head, head and neck, neck, neck and body, body,body and tail, tail,and lesions too large to be located), tumor size, tumor shape (oval or round, smoothly scallop-shaped contour, focal or eccentric lobulated), proportion of solid component (near-complete cystic, 0 < 50%, 50–50%, <100%, and near-complete solid), capsule (completely encapsulated, focal discontinuity of capsule, and no visible capsule), growth pattern (mainly replacing and mainly exophytic), bleeding (with visible patchy bleeding or without), morphology of calcification (complete rim, incomplete rim, focal nodular, amorphous or scattered, and none), and presence of upstream pancreatic ductal dilatation.

An oval or round form, including ill-defined margin, was defined as oval or round shape without any lobulation. A smoothly scallop-shaped contour was defined when one diameter of the tumor was not too much longer than other two others', and the outline of the tumor also remained round or oval. A focal or eccentric lobulation had one much longer diameter than two others', and the tumor outline does not keep its round or oval shape, in stead, it shows smoothly scallop-shaped contour (Fig. 2).

Morphology of capsule and calcification was evaluated by CT. Morphology of calcification was evaluated by CT ($n = 82$). When the maximum diameter of upstream pancreatic duct was more than 3 mm, according to CT, presence of pancreatic ductal dilatation was confirmed.

2.4. Pathological studies

The diagnosis of SPNs was based on the histopathological examination as well as immunohistochemical staining, including staining with antibodies against beta-catenin. Each specimen was reviewed a second time by a different pathologist. Each SPN was classified according to the WHO criteria as either a benign SPN with an uncertain potential for malignancy or as a malignant SPN [12]. Criteria that could distinguish potentially malignant tumors, classified as malignant SPN, included the following: perineural invasion, angioinvasion, deep invasion into the surrounding tissue, and distant metastasis.

2.5. Statistical analysis

Statistical analysis was performed with the Statistical Package for the Social Sciences, version 13.0 for Windows (SPSS 13.0, Chicago, III). $P < 0.05$ was considered to be significant different.

The characteristics of the benign and malignant SPNs were compared using an independent sample t test. Pearson χ^2 or Fisher exact test and multivariate logistic regression were used to determine if there were differences in tumor characterization between benign

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