Role of Preoperative Multidetector Computed Tomography Diagnosis of Solid Pseudopapillary Tumors of the Pancreas with Postoperative Surgical and Histopathological Correlation

Rakhee Kumar Paruchuri, Harvarshdan Ramanjaneylu Kuruba, Deepthi Pathapati, Aruna Prayaga[1]
Departments of Radiology and Imageology and [1]Pathology, Nizam's Institute of Medical Sciences, Hyderabad, Telangana, India

Correspondence: Dr. Rakhee Kumar Paruchuri, C559, 1st Floor, New Friends Colony, New Delhi - 110 025, India.
E-mail: rakheekumar@gmail.com

ABSTRACT

Purpose: The purpose of this study was to evaluate the role of preoperative multidetector computed tomography (MDCT) diagnosis of solid pseudopapillary tumors (SPTs) of the pancreas with postoperative surgical and histopathological correlation. **Materials and Methods:** A prospective study was conducted in our institute for MDCT evaluation of patients with ultrasound-proven pancreatic tumors. Preoperative diagnosis of SPT was given in 10 of 36 total patients evaluated. These findings were correlated with surgical and histopathological findings. **Results:** A preoperative MDCT diagnosis of SPT was given in 10 patients on the basis of characteristic CT appearances, of which 9 were confirmed by postoperative histopathology. One was a histopathological examination (HPE) proven to be a neuroendocrine tumor. Two MDCT-negative but HPE-positive cases gave a total of 11 of 36 patients. 10 patients were females with a mean age of 27 (range 16–38 years). 6 lesions were identified in the head, with the average size of the lesions being 6.5 cm. No SPTs with malignant features were diagnosed on MDCT or HPE in our study. The sensitivity of MDCT to identify SPT in this series is 81.81%, specificity 96%, positive predictive value of 90%, negative predictive value of 92.31%. **Conclusion:** MDCT has a high specificity and positive predictive value with higher negative predictive values for diagnosing SPTs. However, atypical lesions pose a diagnostic challenge. A diagnosis with a greater degree of confidence can be made using knowledge of characteristic appearance on MDCT along with clinical correlation. The majority are benign, but follow-up is suggested if signs of aggressiveness are identified radiologically or by HPE.

Key words: Multidetector computed tomography, pancreas, solid pseudopapillary tumors

Introduction

The pancreas is a unique organ with different cells performing different functions and ultimately giving rise to different pathologies. Radiological investigations are now routine for evaluating pancreatic masses with a high diagnostic accuracy. Compared to most pancreatic tumors that have a poor prognosis, solid pseudopapillary tumors (SPTs) are predominantly benign lesions with surgical resection being essentially curative.

Although transabdominal ultrasound is routinely performed as the initial investigation, endoscopic ultrasound and computed tomography (CT) are more sensitive and specific

Access this article online	
Quick Response Code:	Website: www.wajradiology.org
	DOI: 10.4103/1115-3474.198105

How to cite this article: Paruchuri RK, Kuruba HR, Pathapati D, Prayaga A. Role of preoperative multidetector computed tomography diagnosis of solid pseudopapillary tumors of the pancreas with postoperative surgical and histopathological correlation. West Afr J Radiol 2017;24:45-51.

and have shown to be more accurate in diagnosing SPTs.[1,2] These lesions show a characteristic pattern on nonenhanced and enhanced CT studies with a reported diagnostic accuracy of 60% on CT scan evaluation.[3] Increasingly, magnetic resonance imaging (MRI) is now being performed to evaluate these lesions. MRI is a helpful tool, especially to evaluate indeterminate lesions, such as those that are small in size, simulate solid neoplasms or endocrine tumors. However, the study duration, patient cooperation, cost, and availability of MRI are important factors that still impede it from becoming the investigation of choice. The higher temporal resolution of CT is also better at detecting local invasion and nodal metastasis. Review of literature revealed that most studies so far have been retrospective, correlating the several features on various imaging modalities. This prospective study was thus conducted to study the role of multidetector computed tomography (MDCT) in preoperative diagnoses of SPT and to prove that knowledge of these characteristic MDCT features increases the degree of confidence in identifying SPTs.

Histopathological features are characteristic and mandatory to reach the diagnosis.

Materials and Methods

A prospective study was conducted in our institute in the department of radiology and imageology for patients referred from the departments of surgical and medical gastroenterology and surgical oncology with a clinical suspicion and ultrasound diagnosis of pancreatic mass for MDCT evaluation of the same. A total of 36 cases, irrespective of age and sex, were studied during this period. Informed and written consent of all the subjects was taken along with approval from the Ethics Committee. The preoperative CT diagnosis was then later correlated with operative and histopathological examination (HPE) findings. USG findings were not considered in this study.

The study was conducted on 16 slice MDCT (PhilipsBrilliance 16, Philips, Philips Healthcare, The Netherlands). Plain 5 mm sections were performed after oral administration of 20 mL of nonionic contrast media Iohexol 300 mg/ml (Omnipaque, GE Healthcare, Shanghai, China) mixed in 1000 mL of water (2% solution) 45 min before the study. Intravenous administration of 1.25–1.5 ml/kg of nonionic contrast Iohexol (300 mg/ml), (Omnipaque, GE healthcare, Shanghai, China) was given through pressure injector at the rate of 4 ml/s and data acquisition was done in precontrast, arterial and venous phases. 1–2 mm thin sections were taken in the arterial phase for the pancreas. For the venous phase, 5 mm sections with 2 mm recons were obtained for the entire abdomen [Table 1]. Sagittal and coronal reconstruction images using volume rendering, MIP, and curved planar reformations were obtained wherever applicable.

CT findings of different pancreatic masses were analyzed and criteria taken into consideration were: (1) age and sex of patient, (2) presence of a capsule, (3) solid and cystic consistency, (4) hyperdense/hemorrhagic components, (5) heterogeneous enhancement. The size was not taken into consideration as the range is very wide. If other criteria were met, then age and sex of the patient were overlooked. The presence of hyperdense/hemorrhagic components was considered as pathognomonic. On contrast sections, enhancement pattern of the lesion, adjacent organ/vascular/nodal involvement were looked for.

Table 1: Computed tomography scan protocol

Parameters	16 slice CT
Collimation	16 mm × 1.5 mm
Slice thickness	5 mm
Pitch	0.938
Rotation time	0.75 s
Tube voltage/current	120 Kvp/250 mAs
Contrast	Contrast - 80 ml Flow rate - 4 ml/s Arterial phase: Scan delay - 25 s Venous phase: Scan delay - 55 s

CT – Computed tomography

Cytological/pathological findings were noted for correlation. For pancreatic tumors, standard hematoxylin and eosin, Papanicolaou stain, and May-Grunwald-Giemsa-stains were used with specialized stains, wherever applicable. Immunohistochemistry (IHC) with Vimentin, pancytokeratin (CK), and chromogranin was performed for all lesions.

Results

A final histopathological diagnosis of SPTs was obtained in 11 patients out of 36 patients. The most common (n = 10 [90%]) presenting complaint was vague abdominal pain and lump with a duration ranging from 20 days to 2 years. Only one patients' lesion was detected incidentally when being investigated for right hydronephrosis. No patient gave a history of jaundice or pancreatitis. Standard liver function tests were normal in all patients. Ca 19.9 was performed in only two patients and was normal.

A male to female ratio of 1:10 and mean age of 27 years (range 16–38) were observed.

The MDCT studies were read by two senior radiologists in consensus. Using the criteria mentioned in methodology, 10 patients were given a diagnosis of SPT on MDCT, of which 9 were confirmed by histopathology. The 10th patient was histopathologically proven to be a neuroendocrine tumor. Two CT-negative patients (given the initial MDCT diagnosis of solid pancreatic neoplasm and indeterminate cystic lesion) were also histopathologically proven to the SPTs, giving a final total of 11 SPTs.

The head and tail were the most common sites (44.4% each), followed by the body (22.2%) and uncinate process (11.1%). All lesions were reported accurately on MDCT, except the lesion in the uncinated process which was identified in the head region on surgery, making the head the most common site in this series (n = 5). The average size of the lesion was 6.5 cm with a range of 3–10 cm.

On MDCT [Table 2 for imaging features on CT], the lesions were encapsulated, round to oval in shape with some showing lobulated outlines, most showing heterogeneous attenuation with peripheral iso- to hyperdense areas with CT attenuation values of 30–40 HU suggestive of hemorrhage and central hypodensities on precontrast evaluation. Postcontrast scans showed peripheral heterogeneous enhancement with central hypodensities, suggestive of necrosis [Figures 1 and 2]. Although the smallest lesion in our series measured 3 cm, it met the imaging criteria as well [Figure 3]. Patient 4 presented with a lesion measuring 4 cm that was isodense on unenhanced scans showing predominantly solid enhancing component and minimal central necrosis postcontrast was given the diagnosis of solid pancreatic neoplasm. It was HPE proven as an SPT [Figure 4].

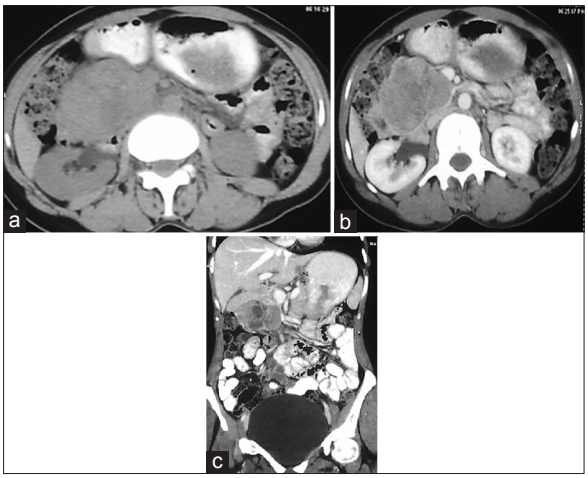

Figure 1: (a) Axial nonenhanced. (b and c) Axial and coronal postcontrast scans showing an isodense uncinate process and head mass with few hyperdense foci showing heterogeneous enhancement and nonenhancing areas in a 28-year-old female

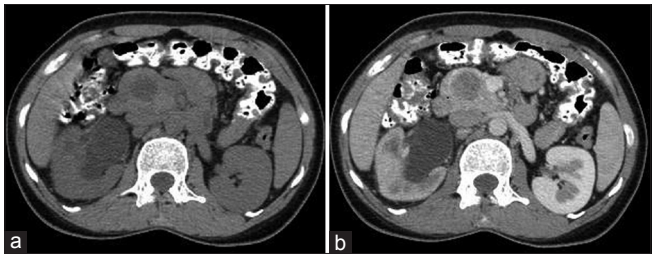

Figure 3: Axial (a) nonenhanced and (b) postcontrast sections through the abdomen in 34-year-old female incidentally detected to have a pancreatic lesion while being investigated for right hydronephrosis. A well-defined, 3 cm sized hypodense lesion showing heterogeneous enhancement postcontrast, was identified in the pancreatic head

Peripheral and punctuate calcifications were seen only in two cases. Main pancreatic duct dilatation was seen in patient 9, where the lesion was situated in the head. No evidence of any associated biliary ductal dilatation was seen. Peripancreatic fat planes were maintained in all cases. Displacement of adjacent structures with maintained fat planes was noted in the larger lesions. Patient 2 developed splenomegaly with portal hypertension due to compression on the portal and splenic veins by the mass [Figure 5] while patient 4 showed loss of fat planes with the 3rd part of the duodenum and splenic vein.

Small, perilesional nodes were seen in one case which were histopathologically proven to be reactive.

Patient 6 showed a thick-walled completely cystic lesion with no solid components, was thought to be a cystic lesion of indeterminate etiology on CT. On HPE, it was diagnosed as SPT with cystic degeneration [Figure 6].

Patient 1, a 38-year-old male presented with a well-defined, lobulated lesion showing enhancing solid and nonenhancing

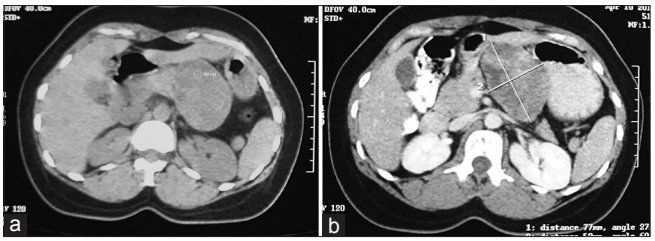

Figure 2: Axial (a) nonenhanced and (b) postcontrast scans reveal an iso- to hyperdense pancreatic body mass showing heterogenous enhancement postcontrast

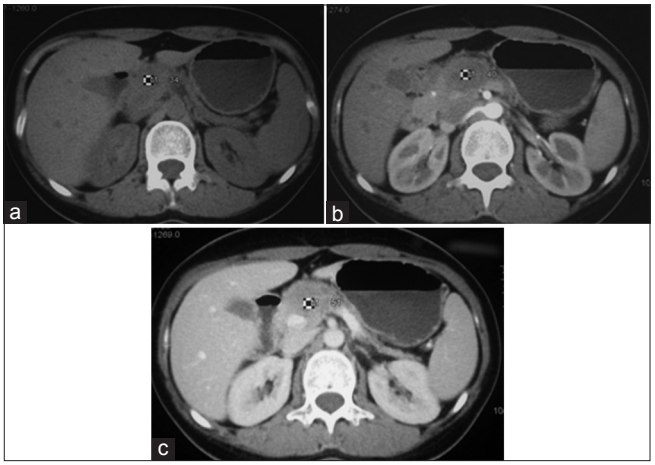

Figure 4: Axial images through abdomen in a 28-year-old female reveal a 4 cm sized pancreatic head mass that is isodense on noncontrast computed tomography (a), hypodense in the arterial phase (b) and nearly isodense on the portovenous phase (c), emphasizing the importance of triple phase scans in smaller lesions. Multidetector computed tomography diagnosis of solid pancreatic lesion was given in this case, but was histopathologically proven to be a solid pseudopapillary tumor

Table 2: Findings on computed tomography

Serial number	Age	Sex	CT findings							Radiological diagnosis	HPE
			Site	Noncontrast			Enhancement pattern				
				Heterogeneous (hypo/iso- and/or hyperdense components)	Completely cystic	Calcifications	Heterogeneous	Intense	Peripheral	Adjacent organ/vascular involvement	
1	38	Male	Head	+ (peripheral cystic component)	-	+	+	-	-	-	SPT	Neuroendocrine tumor
2	28	Female	Body	+	-	-	+	-	-	Splenomegaly, compression of SV, PV, and collaterals	SPT	SPT
3	18	Female	Tail	+	-	-	+	-	-	-	SPT	SPT
4	32	Female	Uncinate process	+	-	-	+	-	-	Abutting liver, SMA, SMV, IVC	SPT	SPT
5	36	Male	Body	+	-	-	+	-	-	-	SPT	SPT
6	16	Female	Tail	-	+	-		-	+	-	Cystic lesion	SPT
7	28	Female	Head	+	-	-	+	-	-	-	Solid pancreatic tumor	SPT
8	18	Female	Head	+	-	-	+	-	-	-	SPT	SPT
9	30	Female	Head	+	-	+	+	-	-	Dilated MPD	SPT	SPT
10	34	Female	Head	+			+	-	-	-	SPT	SPT
11	30	Female	Body	+	+	+ (septae and wall)	+	-	-	Abutting DJ flexure	SPT	SPT

CT – Computed tomography; SV – Splenic vein; PV – Portal vein; DJ – Duodenojejunal; MPD – Main pancreatic duct; SMV – Superior mesenteric vein; IVC – Inferior vena cava; SMA – Superior mesenteric artery; HPE – Histopathological examination; SPT – Solid pseudopapillary tumors; + – Present/positive; - – Absence/negative

cystic components, was identified in the pancreatic head as an SPT's. This was, however, histopathologically proven to be a nonfunctioning neuroendocrine tumor [Figure 7].

Thus, out of a total of 36 patients, 11 were histopathologically proven to be SPT's, with an incidence of 30% in our study. Of these, 9 were MDCT- and HPE-positive, while two MDCT-negative cases were confirmed on HPE, giving MDCT diagnosis of SPT a sensitivity rate of 81.81%, specificity of 96%, positive predictive valve of 90%, negative predictive valve of 92.31%.

Complete surgical excision was possible in all cases, with Whipple's procedure performed for lesions in the head and distal pancreatectomy with splenectomy performed for lesions in the body and tail. No significant vascular or adjacent organ infiltration was found other than one case which showed duodenojejunal flexure and mesenteric adhesions.

Gross examination revealed globular solid, well-encapsulated lesions with cut section revealing solid and cystic components showing necrotic and hemorrhaging areas with some lesions showing friability. No obvious capsular breach was identified in any of the lesions examined. HPE revealed cells arranged in pseudo papillae which were showing ovoid and folded nuclei with indistinct nucleoli. IHC was performed in all lesions showing vimentin positivity and chromogranin negativity. Pan CK was positive in few cases, showing patchy focal positivity [Figures 8 and 9].

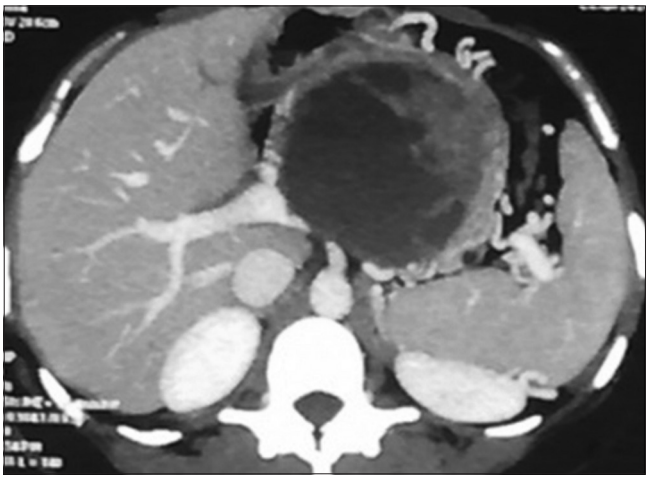

Figure 5: 28-year-old female with a mass in the abdomen. Axial contrast-enhanced computed tomography shows large, well-encapsulated mass in the body of pancreas showing solid enhancing and cystic nonenhancing components. The mass is causing mass effect on the portal vein with multiple, resultant perigastric, splenic hilar, and lienorenal collaterals

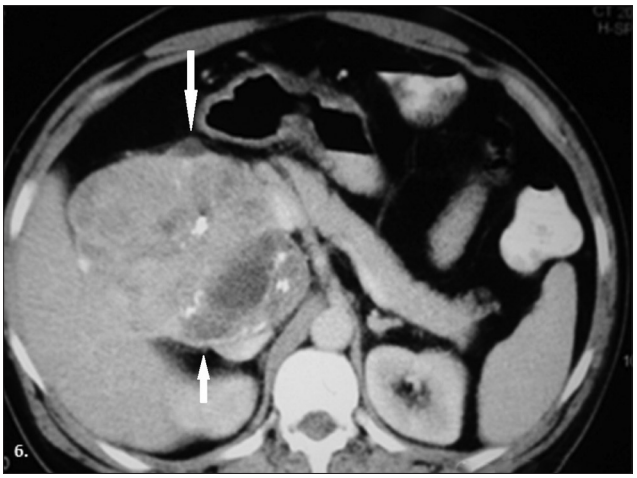

Figure 7: Contrast-enhanced computed tomography in 38-year-old male with complaints of pain abdomen revealed a heterogeneously enhancing head mass with punctate calcifications and peripheral cystic areas (see arrows). Histopathological examination revealed nonfunctioning neuroendocrine tumor

Discussion

SPT's are described under "epithelial tumors" of uncertain malignant potential according to the World Health Organization classification of exocrine pancreatic tumors.[4] They are also included in the cystic tumors of the pancreas, the groups being serous cystic, mucinous cystic, and intraductal papillary mucinous tumors.[5] These are rare tumors with an incidence of 0.13%–2.7% of all pancreatic tumors.[6]

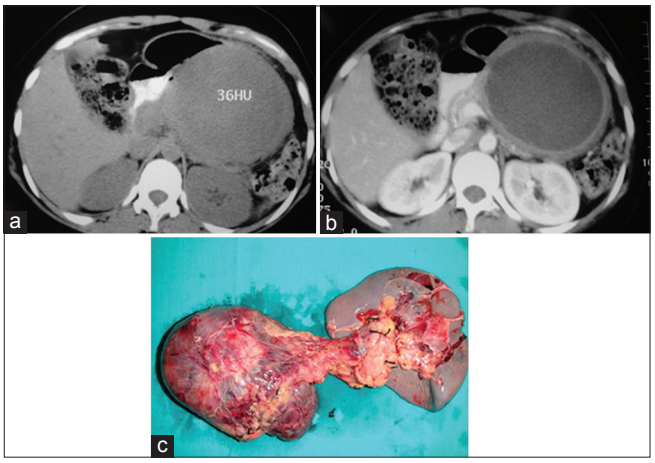

Figure 6: Noncontrast computed tomography (a) and contrast-enhanced computed tomography (b) in a 16-year-old female reveals a mass with average attenuation values of 36 HU showing peripheral enhancement postcontrast. No solid components were identified and multidetector computed tomography diagnosis of a cystic lesion was given. Histopathological examination revealed cystic solid-pseudopapillary tumors. (c) Gross postsurgical specimen

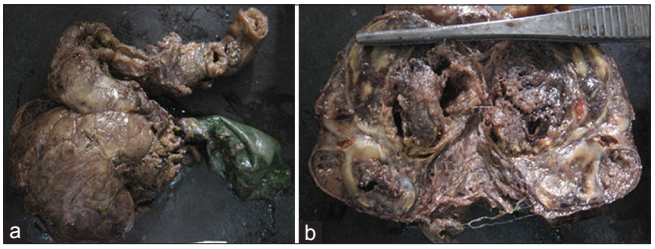

Figure 8: Gross (a and b) cut section of mass post-Whipple's resection (same patient as figure 1) shows large lobulated mass with solid, cystic, and hemorrhagic areas with focal gray and white areas

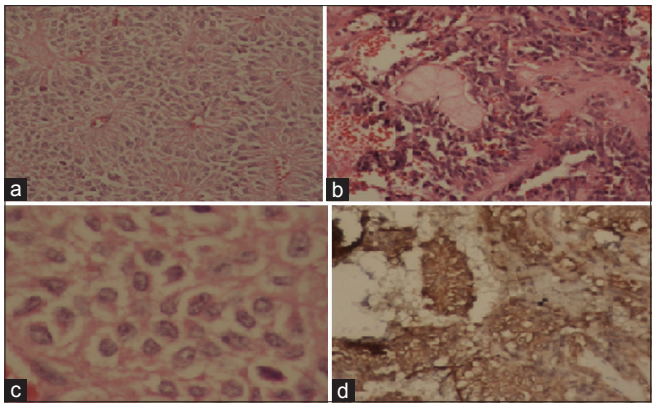

Figure 9: (a) Histopathological examination with H and E stain (b) ×40 and (c) ×100 shows cells arranged in forms of solid nests and sheets separated by hyalinized vascular septae. Pseudopapillary pattern is noted. Cells are uniform, polyhedral, with clear cytoplasm and monomorphic nuclei. (d) Immunohistochemistry shows vimentin positivity

SPTs are often called the "daughter" tumors because of their high incidence in young, non-Caucasian females in the second and third decades of life.[7] However, cases in males and children have also been reported.[8,9] The mean age in our series was 27 years, which correlates with the findings of Choi *et al*., who also had a mean age of 27 years and closely so with Huang *et al*. with a mean age of 31 years.[10,11] This is marginally older than those reported by Patil *et al*. (mean age 20) and Mao *et al*., who showed the incidence in a mean age of 23.9 years in a cumulative review of the literature.[7,12] The male to female ratios, however, concur with both Huang *et al*. and Mao *et al*., no male cases being reported in the Patil *et al*. series.[7,11,12] Furthermore, concurring with Huang *et al*., our oldest patient at 36 years was a male.[11] Podevin *et al*., in a study of 5 patients, reported a male: female ratio of 3:2.[13] The male patient showed features matching our radiological criteria and hence was included in the study. Location wise, SPTs can be found anywhere in the pancreas but are most frequently found in the head or tail.[14] 50% of tumors were reported in the tail by Patil *et al*., while Huang reported 71% in their series.[7,11] On the contrary, 55% (n = 6) of the lesions were found in the head in this study.

The average size of the lesions was 6.5 cm in our series which is less than that reported by Huang *et al*. (10.5 cm), Mao *et al*. (10.3 cm), and Coleman *et al*. (9.3 cm).[11,12,14] This, however, matched more closely the average size of 5.8 cm, reported by Wang *et al*.[15]

Nine patients showed characteristics typical of SPTs, i.e. well-encapsulated lesions with solid, cystic, and hemorrhagic components, located in the head or tail of the pancreas, predominantly in females in the second to fourth decade of life, features which are atypical for other cystic neoplasms. Calcifications were rare in our series.

SPTs with minimal cystic component or no intralesional hemorrhage are difficult to differentiate from nonfunctioning islet cell tumors. In our series, a male patient with a lesion showing more solid than cystic component and coarse punctuate calcifications was given MDCT diagnosis of SPT, was later histopathologically proven to be a nonfunctioning islet cell tumor. On retrospect, the cystic components were more peripheral rather than central, unlike what is seen typically in SPTs. MRI evaluation of nonfunctioning islet cell tumors shows the cystic components as moderately hyperintense on T1-weighted images and hyperintense on T2-weighted images, compared to SPTs that show hyperintense signal on both T1- and T2-weighted images.[16] These are also seen more often in elderly patients with no sex predilection. Thus, MRI could have been performed for further evaluation.

Smaller lesions are less common since SPTs have a reported average size of 9.3 cm.[14]

Our smallest lesion showed characteristic MDCT features of SPT and correct preoperative diagnosis could be made. Coleman *et al*. reported arterial phase scanning to be better at more clearly depicting such lesions, compared to the portal venous phase images, smaller lesions becoming isodense on the late phases.[14] One case, although not the smallest in our series, showing a similar enhancement pattern due to lack of cystic component, was given the MDCT diagnosis of a solid pancreatic neoplasm, later was histopathologically proven to be SPT.

We had one male patient in our series, with a lesion showing characteristic MDCT appearance of SPTs. Although SPTs are rare in males, the appearance of the mass was similar to those seen in females of study group, giving us a greater degree of confidence in reaching the diagnosis, thus concurring Choi *et al*. who stated that SPTs should be the differential diagnostic consideration of a pancreatic mass with encapsulation and cystic solid components, even in males.[16]

Peripheral, as well as central punctuate, stippled, and eggshell and rarely peripheral, dense calcifications have also been reported in SPTs.[15,17] Only two cases in our series showed punctuate, but not peripheral calcifications. The pattern of calcification is also helpful in differentiating these tumors from other cystic neoplasms such as serous cystadenomas that have central calcification with a central scar and mucinous cystic neoplasms that may have peripheral calcifications.

Of 11 HPE-proven cases of SPT's, we were able to correctly diagnose 9 cases on CT based on their size, characteristic CT appearances, being well-encapsulated lesions with well-defined margins, showing peripherally solid enhancing components and predominantly central necrosis. Hemorrhage which is highly specific can be seen as high attenuating areas within the cystic component of the lesions. Small lesions, lack of cystic component, and larger lesions with the lack of solid components posed a diagnostic dilemma. This is a marked improvement in contrast to Lam *et al*., who reported a negative preoperative diagnosis for all their 7 cases, proving

that knowledge of characteristic appearances and higher resolution of MDCT increase the accuracy of the diagnosis.[8]

Recent studies show inherent limitations of CT when compared to MRI, especially while evaluating specific tissue characteristics such as hemorrhage, presence of capsule, or cystic degeneration.[18] Its role also has been emphasized in evaluating small lesions where they are often unencapsulated and do not show any hemorrhage.[19] However, in this series, the sensitivity of MDCT to identify the SPT was 81.81%, with a specificity of 96%, positive predictive valve of 90%, negative predictive valve of 92.31%. This is better than Procacci *et al* who reported the CT accuracy in diagnosing cystic pancreatic masses to about 60%,[3] reiterating that CT scan evaluation can still be used as the primary imaging modality for the evaluation of SPTs,[3,20] especially in a scenario where the cost and availability of MRI are still of concern. Patil *et al*. also stated that a preoperative tissue diagnosis was not necessary and surgical resection could be undertaken on the basis of the radiological findings.[4]

Lam *et al*. have reported an incidence of 2.6% in their case series of SPTs while Coleman *et al*. have reported an incidence of 1–2% of exocrine pancreatic tumors at most institutions.[8,14] The incidence of SPTs in this series was 26% which is much higher than the incidence reported. This may have been due to the fact that ours is tertiary referral center with a high volume of patients and cases from surgical oncology, surgical, and medical gastroenterology were considered in this study.

The other limitation was our small sample size. No solid pseudopapillary carcinomas were identified in our study. Follow-up was not considered in this series.

Conclusion

SPT's are tumors of low-grade malignant potential with surgical resection being essentially curative. As more cases are reported in literature, characteristic features as identified on MDCT and accurate application of these, can point to the correct diagnosis with a high degree of confidence, obviating the need for preoperative tissue diagnosis. MDCT also provides an excellent road map to the surgeon. MRI can be used to evaluate lesions that are smaller or have an indeterminate appearance to resolve doubts before surgery.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Trivedi N, Sharma U, Das PM, Mittal MK, Talib VH. FNAC of papillary and solid epithelial neoplasm of pancreas – A case report. Indian J Pathol Microbiol 1999;42:369-72.
2. Stömmer P, Kraus J, Stolte M, Giedl J. Solid and cystic pancreatic tumors. Clinical, histochemical, and electron microscopic features in ten cases. Cancer 1991;67:1635-41.
3. Procacci C, Graziani R, Bicego E, Zicari M, Bergamo Andreis IA, Zamboni G, *et al*. Papillary cystic neoplasm of the pancreas: Radiological findings. Abdom Imaging 1996;21:554-8.
4. Hamilton SR, Altonen LA. World Health Organization Classification of Tumours. Tumours of the Digestive System. Lyon: IARC Press; 2000. p. 246-8. Available from: http://www.w2.iarc.fr/en/publications/pdfs-online/pat-gen/bb2/BB2.pdf.
5. Barreto G, Shukla PJ, Ramadwar M, Arya S, Shrikhande SV. Cystic tumours of the pancreas. HPB (Oxford) 2007;9:259-66.
6. Crawford BE 2nd. Solid and papillary epithelial neoplasm of the pancreas, diagnosis by cytology. South Med J 1998;91:973-7.
7. Patil TB, Shrikhande SV, Kanhere HA, Saoji RR, Ramadwar MR, Shukla PJ. Solid pseudopapillary neoplasm of the pancreas: A single institution experience of 14 cases. HPB (Oxford) 2006;8:148-50.
8. Lam KY, Lo CY, Fan ST. Pancreatic solid-cystic-papillary tumor: Clinicopathologic features in eight patients from Hong Kong and review of the literature. World J Surg 1999;23:1045-50.
9. Jung SE, Kim DY, Park KW, Lee SC, Jang JJ, Kim WK. Solid and papillary epithelial neoplasm of the pancreas in children. World J Surg 1999;23:233-6.
10. Choi BI, Kim KW, Han MC, Kim YI, Kim CW. Solid and papillary epithelial neoplasms of the pancreas: CT findings. Radiology 1988;166:413-6.
11. Huang HL, Shih SC, Chang WH, Wang TE, Chen MJ, Chan YJ. Solid-pseudopapillary tumor of the pancreas: Clinical experience and literature review. World J Gastroenterol 2005;11:1403-9.
12. Mao C, Guvendi M, Domenico DR, Kim K, Thomford NR, Howard JM. Papillary cystic and solid tumors of the pancreas: A pancreatic embryonic tumor? Studies of three cases and cumulative review of the world's literature. Surgery 1995;118:821-8.
13. Podevin J, Triau S, Mirallié E, Le Borgne J. Solid-pseudopapillary tumor of the pancreas: A clinical study of five cases, and review of the literature. Ann Chir 2003;128:543-8.
14. Coleman KM, Doherty MC, Bigler SA. Solid-pseudopapillary tumor of the pancreas. Radiographics 2003;23:1644-8.
15. Wang DB, Wang QB, Chai WM, Chen KM, Deng XX. Imaging features of solid pseudopapillary tumor of the pancreas on multi-detector row computed tomography. World J Gastroenterol 2009;15:829-35.
16. Choi JY, Kim MJ, Kim JH, Kim SH, Lim JS, Oh YT, *et al*. Solid pseudopapillary tumor of the pancreas: Typical and atypical manifestations. AJR Am J Roentgenol 2006;187:W178-86.
17. Buetow PC, Buck JL, Pantongrag-Brown L, Beck KG, Ros PR, Adair CF. Solid and papillary epithelial neoplasm of the pancreas: Imaging-pathologic correlation on 56 cases. Radiology 1996;199:707-11.
18. Cantisani V, Mortele KJ, Levy A, Glickman JN, Ricci P, Passariello R, *et al*. MR imaging features of solid pseudopapillary tumor of the pancreas in adult and pediatric patients. AJR Am J Roentgenol 2003;181:395-401.
19. Yu MH, Lee JY, Kim MA, Kim SH, Lee JM, Han JK, *et al*. MR imaging features of small solid pseudopapillary tumors: Retrospective differentiation from other small solid pancreatic tumors. AJR Am J Roentgenol 2010;195:1324-32.
20. Sunkara S, Williams TR, Myers DT, Kryvenko ON. Solid pseudopapillary tumours of the pancreas: Spectrum of imaging findings with histopathological correlation. Br J Radiol 2012;85:e1140-4.