The British Journal of Radiology, 85 (2012), 571–576

MRI features of serous oligocystic adenoma of the pancreas: differentiation from mucinous cystic neoplasm of the pancreas

[1,2]J H LEE, MD, [1]J K KIM, MD, [1]T H KIM, MD, [3]M-S PARK, MD, [3]J-S YU, MD, [3]J-Y CHOI, MD, [4]J H KIM, MD, [4]Y B KIM, MD and [3]K W KIM, MD

[1]*Department of Diagnostic Radiology, Ajou University School of Medicine, Gyeonggi-Do, Republic of Korea,* [2]*Department of Medicine, The Graduate School of Yonsei University, Gyeonggi-Do, Republic of Korea,* [3]*Department of Diagnostic Radiology, Yonsei University College of Medicine, Gyeonggi-Do, Republic of Korea, and* [4]*Department of Pathology, Ajou University School of Medicine, Gyeonggi-Do, Republic of Korea*

Objectives: The purpose of this study was to describe the MRI features of the benign pancreatic neoplasm serous oligocystic adenoma (SOA) that differ from those of mucinous cystic neoplasm (MCN), a neoplasm with the potential for malignant degeneration.
Methods: Seven patients with SOA (seven women; mean age 36.6 years) and eight patients with MCN (eight women: mean age 39.9 years) were included. Several imaging features were reviewed: mass size, location, shape, wall thickness, cyst configuration (Type I, unilocular; Type II, multiple clustered cyst; Type III, cyst with internal septation) and signal intensity of the lesion with heterogeneity.
Results: SOA lesions were smaller (3.4 cm) than those of MCN (9.3 cm) ($p=0.023$). The commonest lesion shape was lobulated (85.7%) for SOA, but oval (50.0%) or lobulated (37.5%) for MCN ($p=0.015$). The most common cyst configuration was Type II (85.7%) for SOA and Type III (75.0%) for MCN ($p=0.008$). Heterogeneity of each locule in T_1 weighted images was visible in all cases of MCN, but in no case for SOA ($p=0.004$).
Conclusion: SOA could be differentiated from MCN by identifying the imaging features of lobulated contour with multiple clustered cyst configurations and homogeneity of each locule in T_1 weighted MR images.

Received 13 May 2010
Revised 4 August 2010
Accepted 16 August 2010

DOI: 10.1259/bjr/42007785

Serous oligocystic adenoma (SOA) is a recently described rare, benign pancreatic neoplasm and a morphological variant of serous microcystic adenoma, because it contains six or fewer cysts and the cysts are large (>2 cm) [1, 2]. Pathologically, SOA is a benign pancreatic neoplasm composed of a few relatively large cysts uniformly lined with glycogen-rich cuboidal epithelial cells [3]. According to the World Health Organization classification, SOA is a subgroup of pancreatic serous cystic tumours and the term SOA is a synonym for macrocystic serous cystadenoma [3, 4].

The CT and MRI features of SOA of the pancreas are documented [2]. On CT and MRI, SOA typically appears as a small unilocular or bilocular cyst (<5 cm) with a thin wall (<2 mm) that lacks mural nodules or calcifications [2]. Because the cystic spaces are >2 cm, SOA images can be mistaken for mucinous cystic neoplasm (MCN), pseudocyst or intraductal papillary mucinous tumour [2, 5–7]. It is very difficult to differentiate SOA from MCN by clinical and radiological features [2, 6, 8, 9]. SOA does not require resection unless it causes symptoms, but MCN should be resected because of a potential for malignant degeneration [5, 7, 8]. Endoscopic ultrasound and cyst fluid aspiration have a role in distinguishing mucinous and serous lesions, but it is an invasive procedure with a risk of complications such as pancreatitis [10]. Therefore, it is clinically valuable to determine characteristic imaging findings that can distinguish SOA from MCN.

Recently, Kim et al [6] and Cohen-Scali et al [5] described characteristic CT findings that can be used to differentiate SOA from MCN. MRI can demonstrate septa within a lesion with greater sensitivity than CT; therefore, MRI provides a better evaluation of tissue characteristics than CT [1, 11]. However, few studies have described the MRI features of SOA [1, 2]. The purpose of this study was to describe the differences in the MRI features of SOA and MCN in the pancreas.

Methods and materials

Patient selection

The Institutional Review Board approved this study and waived the need to obtain informed consent. By performing a computerised search of medical records, we identified 15 patients with a diagnosis of SOA and 27 patients with a diagnosis of MCN of the pancreas who

Address correspondence to: Jei Hee Lee, Department of Diagnostic Radiology, Ajou University School of Medicine, San 5, Wonchun-Dong Yeongtong-Gu, Suwon, Gyeonggi-Do 443-721, Republic of Korea. E-mail: radljh@ajou.ac.kr
This study was supported by a 2008 grant from Ajou University School of Medicine.

underwent surgery between January 1999 and December 2008 at two institutions. Pre-operative MR images had been obtained in seven patients (male:female=0:7; mean age 36.6 years; age range 19–54 years) with SOA and eight patients (male:female=0:8; mean age 39.9 years; age range 24–60 years) with MCN of the pancreas.

All patients with SOA underwent complete pancreatic tumour resection by either distal pancreatectomy (n=4), pancreaticoduodenectomy (*i.e.* the Whipple procedure) (n=2) or excision (n=1). All patients with MCN underwent complete pancreatic tumour resection by either distal pancreatectomy (n=6), pancreaticoduodenectomy (Whipple procedure) (n=1) or excision (n=1).

Image acquisition

Seven patients with SOA underwent MRI examination, four with intravenous (iv) gadolinium contrast enhancement and three without. Eight patients with MCN of the pancreas underwent MRI, six with iv gadolinium contrast and two without. None of the 15 patients underwent cystic lesion aspiration prior to MRI. All MR examinations were performed with the following 1.5 T or 3 T MRI systems: Signa MR (GE Healthcare, Waukesha, WI), Magnetom Vision (Siemens, Erlangen, Germany), Gyroscan Interna or Gyroscan Achieva (Philips Medical Systems, Best, Netherlands). MRI included axial fat-suppressed T_1 weighted spin-echo imaging or T_1 weighted spoiled gradient-echo images, with or without fat suppression, and axial or coronal T_2 weighted fat-suppressed fast spin-echo or spin-echo images. Dynamic MRI was also performed for 10 patients using a fat-suppressed breathhold spoiled gradient-echo sequence before and after iv bolus injection of 0.1 mmol kg^{-1} of gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany).

Imaging analysis

Two board-certified abdominal radiologists, each with at least 6 years of clinical experience, collectively and retrospectively reviewed the MR images by consensus on a picture archiving and communication system workstation. Both observers were blinded to the specific diagnosis and clinical information, but knew that the patients were diagnosed as SOA or MCN.

Several morphological features of the pancreas were evaluated: maximal transverse diameter of the tumour, location of the tumour in the pancreas (head, neck, body or tail), shape (round, oval or lobulated), margin of a cyst wall (well defined or ill defined), thickness of a cyst wall [thin (<2 mm) or thick (>2 mm)], presence or absence of septa, morphology of cyst configuration (Type I, unilocular; Type II, multicystic or multiple clustered cyst; Type III, cyst with internal septation), number of locules in the cystic mass, presence of mural nodules and degree of septal enhancement. Lobulation was defined as the shape of a simple closed curve with multiple, smooth external undulations. A ''Type II cystic lesion'' was defined as a conglomeration of two or more round cysts. A ''Type III cystic lesion'' was defined as a simple closed curve with the borders of the same circle with internal septation. Enhancement of the wall or septa was described as no, mild or strong enhancement on images obtained before and after contrast enhancement. Images were also evaluated for pancreatic duct dilatation (main pancreatic duct >3 mm).

Internal signal intensity (SI) characteristics of the tumour in MR images were compared with the surrounding pancreas and were described as hypo-, iso- or hypersignal intense. Areas of SI within the tumour on T_1 and T_2 weighted images, approximating the SI of cerebrospinal fluid, were classified as cystic. Heterogeneity of the SI in each locule of the lesion in T_1 or T_2 weighted images was described as homogeneous or heterogeneous.

Statistical analysis

Statistical differences in MRI features of SOA and MCN were analysed with the Student's t-test or Fisher's exact test. The age, size and total number of locules in tumours of the two groups were compared using the Student's t-test. The sex of the patient and the tumour location, shape, margin, wall thickness, presence of septa, cyst configuration and presence of mural nodules on images using MRI were compared using the Fisher's exact test. The presence of pancreatic duct dilatation and the degree of septal enhancement were also compared using the Fisher's exact test. The SI of the cyst in T_1 and T_2 images and the heterogeneity of each locule at MR were compared using the Fisher's exact test. Significant differences were defined as those with $p<0.05$. All statistical analyses were performed using commercially available software packages (MedCalc version 8.2.1.0; MedCalc Software, Mariakerke, Belgium).

Results

Table 1 summarises the different MRI features observed in patients with MCN and SOA. No significant differences were found between MCN and SOA with respect to sex or age of the patient or with respect to tumour location, margin, wall thickness, presence of septa, the number of locules or presence of the mural nodule. Three lesions of MCN were pathologically diagnosed as malignant (two carcinomas and one borderline) and five lesions of MCN were diagnosed as benign.

The size of the tumour was on average larger in MCN (mean size 9.3 cm; size range 2.7–20.1 cm) than in SOA (mean size 3.4 cm; size range 1.7–4.8 cm) (p=0.023). MCN images appeared oval in four cases, lobulated in one and round in three, whereas SOA appeared lobulated in six cases and oval in one (p=0.015). Cyst configuration (p=0.008) was also different. MCN tended to have a Type III (cyst with internal septation) configuration (Figure 1), but SOA tended to have a Type II (multicystic or multiple clustered cyst) configuration (Figure 2).

Pancreatic duct dilatation distal to the mass lesion was present in one of seven patients with SOA (Figure 2) and in two of eight patients with MCN (p=0.897). The lesions appeared as either mild or without remarkable contrast enhancement (four of seven patients with SOA and six of eight patients with MCN) or strongly enhanced [three of seven patients with SOA (Figure 3) and two of eight patients with MCN] (p=0.855).

Table 1. MRI features of mucinous cystic neoplasm and serous oligocystic adenoma of the pancreas

Findings	MCN (n=8)	SOA (n=7)	p-value
Male:female ratio	0:8	0:7	1.00
Age (mean)	39.9	36.6	0.639
Size (cm)	9.3	3.4	0.023
Location (n)			
Head	1	2	
Neck	0	0	
Body	3	2	
Tail	4	3	0.736
Shape (n)			
Round	3	0	
Oval	4	1	
Lobulated	1	6	0.015
Margin (n)			
Well defined	8	7	
Ill defined	0	0	1.00
Wall thickness (n)			
Thin (<2 mm)	6	7	
Thick (≥2 mm)	2	0	0.509
Septa (n)			
Absent	1	1	
Present	7	6	0.509
Cyst configuration (n)			
Type I	1	1	
Type II	1	6	
Type III	6	0	0.008
Number of locules	14.5	4.6	0.094
Mural nodule (n)			
Absent	6	7	
Present	2	0	0.509
Calcification (n)			
Absent	5	7	
Present	3	0	0.244
Degree of septal enhancement (n)			
No enhancement	0	0	
Mild enhancement	6	4	
Strong enhancement	2	3	0.855
Presence of pancreatic duct dilatation (n)	2	1	0.897
Signal intensity on T_1 images (n)			
Low	8	7	
High	0	0	1.000
Signal intensity on T_2 images (n)			
Low	0	0	
High	8	7	1.000
Heterogeneity of the signal intensity of each locule (n)			
T_1 images	7	0	0.004
T_2 images	3	0	0.244

MCN, mucinous cystic neoplasm; SOA, serous oligocystic adenoma.

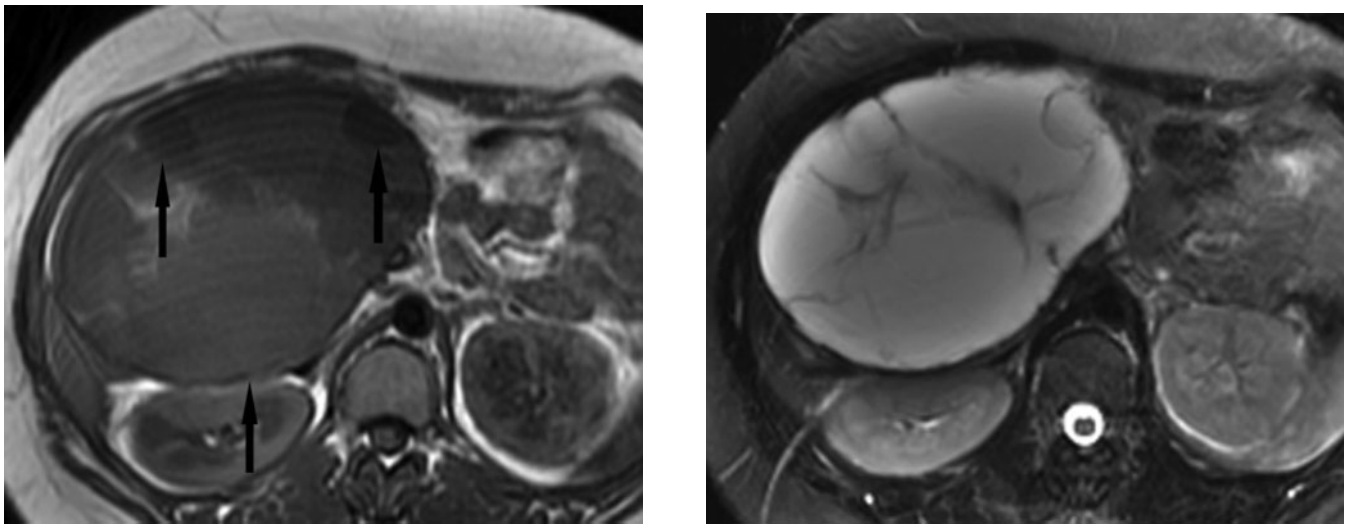
All 15 lesions were hypo-intense in T_1 weighted images and hyperintense in T_2 weighted images. In T_1 weighted images, seven of eight MCN patients showed heterogeneous SI in the cystic mass lesion, but no SOA patients showed heterogeneous SI (p=0.004). In T_2 weighted images, three of eight MCN patients showed heterogeneous SI in the cystic mass lesion, but no SOA patients showed heterogeneous SI (p=0.244).

Discussion

SOA is a rare benign pancreatic neoplasm that radiologically mimics MCN [2, 3]. The purpose of this study was to describe the features of SOA that differed from MCN of the pancreas using MRI, because few studies have described the MRI features of SOA of the pancreas [1, 2].

Macroscopically, SOA typically appears as a cystic mass with a few (and occasionally only one) macroscopically visible, irregularly arranged cysts filled with watery, clear or brown fluid [3]. The cysts usually range between 1 and 2 cm in diameter. Microscopically, SOA generally has the same histological features as serous microscopic adenoma; however, the cyst walls are lined by a single layer of cuboidal or flattened epithelial cells with abundant intracytoplasmic glycogen [3].

A pre-operative distinction between SOA and MCN is of the utmost importance because MCN is considered to be potentially malignant and should be surgically resected [8]. Because SOA cystic spaces are larger than those of



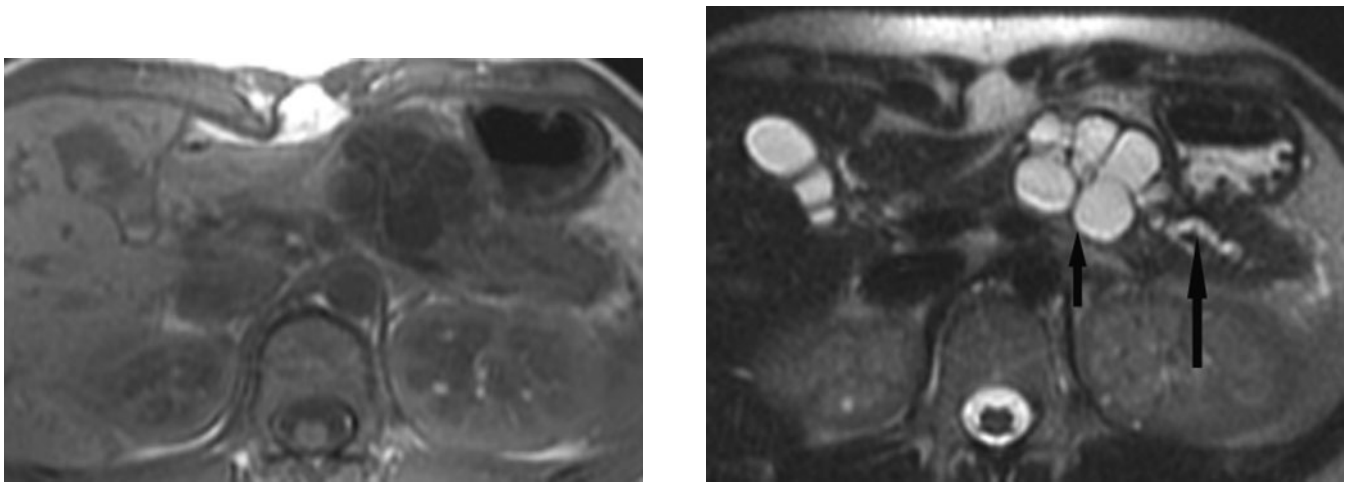
(a) (b)

Figure 1. Mucinous cystic neoplasm of the pancreas in a 24-year-old woman. (a) Axial T_1 weighted MR image (550/9.0) shows a cystic mass in the head of the pancreas with internal septations. Heterogeneous signal intensity of each locule (arrows) is also visible. (b) Axial T_2 weighted MR image (10 000/101.02) shows a cystic mass with internal septations and homogeneous signal intensity of each locule.

serous microcystic adenoma, they can be mistaken for MCN on imaging. Cohen-Scali et al [5] reported that CT was helpful for differentiating SOA and MCN and described specific CT imaging features indicative of SOA, namely location in the pancreatic head, a lobulated contour and the absence of wall enhancement. Goh et al [8] reported that SOA differs from MCN in its relatively higher male:female ratio, higher frequency of tumours occurring in the head of the pancreas and smaller cyst size. Kim et al [6] reported that lesion shape was the most useful feature for the differential diagnosis of SOA and MCN: multicystic and lobulated shapes were prevalent in SOA, whereas smooth shapes were prevalent in MCN.

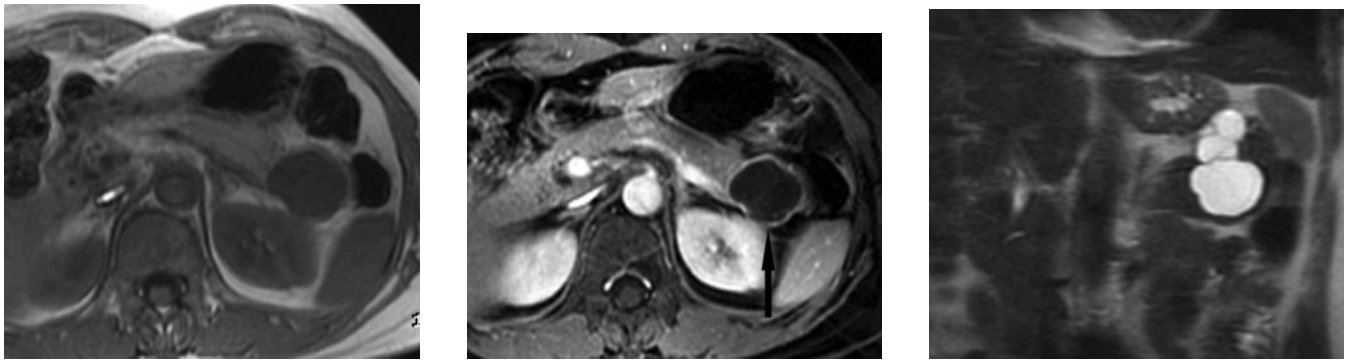
In our study, shape and cyst configuration were also useful imaging features for the differential diagnosis of SOA and MCN. SOA shows a lobulated shape and multicystic or multiple clustered cyst configuration (Type II), whereas MCN shows an oval shape with Type III cyst configuration (cyst with internal septation). Lesion size was also a useful imaging feature in the differential diagnosis of SOA and MCN.

MRI can demonstrate septa within a lesion with greater sensitivity than CT imaging [11]. Thus, MRI should provide a better evaluation of tissue characteristics than CT imaging, including serous and mucinous fluid, solid components and other aspects [1, 11]. Seven of eight MCN patients showed heterogeneous SI of each



(a) (b)

Figure 2. Images obtained in a 19-year-old woman with serous oligocystic adenoma of the pancreas with pancreatic duct dilatation. (a) Axial T_1 weighted MR image (130/4.2) shows a cystic mass lesion in the body of the pancreas with a multiple clustered cyst configuration. (b) Axial single-shot fast spin-echo T_2 weighted MR image (55 376/183) demonstrates a similar finding as the T_1 weighted MR image. The signal intensity of each locule in the mass lesion (short arrow) is homogeneous. Pancreatic duct dilatation (long arrow) distal to the mass lesion is visible.



(a) (b) (c)

Figure 3. Images obtained in a 47-year-old woman with serous oligocystic adenoma of the pancreas with cyst wall enhancement. (a) Axial gradient-echo T_1 weighted images (190/4.2) show a low signal intensity lesion in the pancreas tail. (b) Axial gradient-echo T_1 weighted images (8.1/2.9) after gadopentate dimeglumine injection shows strong enhancement of the cyst wall (arrow). (c) Coronal T_2 weighted images (22 533.81/96.82) show a cystic mass in the tail of the pancreas with lobulated contour and multiple clustered cyst configuration. Homogeneous signal intensity of each locule is also visible.

locule in T_1 weighted images, but all SOA patients showed homogeneous SI of each locule. This could provide another useful imaging feature for the differential diagnosis of SOA and MCN, if CT imaging features are equivocal. The cyst fluid of SOA is typically described as a clear, thin, watery fluid in contrast to that of MCN, which contains thick, viscous fluid [8]. This property might explain the observed MCN variable SI, which could depend on the fluid content of each locule [12]. Fluid-like material has low SI on T_1 weighted images, whereas proteinaceous or haemorrhagic material can demonstrate high SI [12]. Kobayashi et al [1] reported a case of SOA that showed high SI on T_1 weighted images and very high SI on T_2 weighted images; however, in our study, all seven SOA patients who underwent MRI showed low SI on T_1 weighted images and high SI on T_2 weighted images.

Three of eight MCN patients showed heterogeneous SI of each locule in T_2 weighted images, but all SOA patients showed homogeneous SI of each locule. The reason for the difference between T_1 and T_2 weighted images seems to be the influence of proteinaceous or haemorrhagic material on the SI of T_1 and T_2 weighted images.

Although Cohen-Scali et al [5] reported that the absence of wall enhancement was the CT imaging feature necessary to indicate SOA, in our study some SOA patients showed strong contrast enhancement on MRI (Figure 3). In one SOA patient, upstream pancreatic duct dilatation distal to the mass lesion is visible (Figure 2). However, the sample size was relatively small and additional studies with a large number of patients are needed to further evaluate these findings.

There are limitations to our study. Firstly, owing to the rare occurrence of SOA, the number of lesions is limited and there might be selection bias. However, despite the small sample size, the imaging features of cyst shape, configuration, size and heterogeneity of each locule on T_1 weighted images were features that could significantly differentiate SOA from MCN. Additional studies with larger numbers of patients would be important. Secondly, because the cases were collected retrospectively, MRI protocols were not standardised across all cases. Despite this, we think that the different imaging protocols did not influence the results of our study.

In conclusion, SOA of the pancreas may be differentiated from MCN by the imaging features of tumour size, cyst shape and configuration; the heterogeneity of each locule on T_1 weighted images could also be used to differentiate SOA from MCN. Using these imaging features to distinguish SOA from MCN might be helpful in determining the proper management of cystic pancreatic tumours.

References

1. Kobayashi T, Kawabe A, Uenoyama S, Kazui T, Takehara Y, Kosugi I. Macrocystic serous cystadenoma of the pancreas: case report. Abdom Imaging 2001;26:69–71.
2. Khurana B, Mortele KJ, Glickman J, Silverman SG, Ros PR. Macrocystic serous adenoma of the pancreas: radiologic-pathologic correlation. AJR Am J Roentgenol 2003;181: 119–23.
3. Capella C, Solcia E, Klöppel G, Hruban RH. Serous cystic neoplasms of the pancreas. In: Hamilton SR, Aaltonen LA, editors. World Health Organization classification of tumours: pathology and genetics of tumours of the digestive system. Lyon: IARC Press; 2000. pp. 231–3.
4. Lewandrowski K, Warshaw A, Compton C. Macrocystic serous cystadenoma of the pancreas: a morphologic variant differing from microcystic adenoma. Hum Pathol 1992;23:871–5.
5. Cohen-Scali F, Vilgrain V, Brancatelli G, Hammel P, Vullierme MP, Sauvanet A, et al. Discrimination of unilocular macrocystic serous cystadenoma from pancreatic pseudocyst and mucinous cystadenoma with CT: initial observations. Radiology 2003;228:727–33.
6. Kim SY, Lee JM, Kim SH, Shin KS, Kim YJ, An SK, et al. Macrocystic neoplasms of the pancreas: CT differentiation of serous oligocystic adenoma from mucinous cystadenoma and intraductal papillary mucinous tumor. AJR Am J Roentgenol 2006;187:1192–8.
7. Santos LD, Chow C, Henderson CJ, Blomberg DN, Merrett ND, Kennerson AR, et al. Serous oligocystic adenoma of the pancreas: a clinicopathological and immunohistochemical study of three cases with ultrastructural findings. Pathology 2002;34:148–56.
8. Goh BK, Tan YM, Yap WM, Cheow PC, Chow PK, Chung YF, et al. Pancreatic serous oligocystic adenomas: clinicopathologic features and a comparison with serous microcystic adenomas and mucinous cystic neoplasms. World J Surg 2006;30:1553–9.

9. Kim YH, Saini S, Sahani D, Hahn PF, Mueller PR, Auh YH. Imaging diagnosis of cystic pancreatic lesions: pseudocyst versus nonpseudocyst. Radiographics 2005;25:671–85.
10. O'Toole D, Palazzo L, Hammel P, Ben Yaghlene L, Couvelard A, Felce-Dachez M, et al. Macrocystic pancreatic cystadenoma: the role of EUS and cyst fluid analysis in distinguishing mucinous and serous lesions. Gastrointest Endosc 2004;59:823–9.
11. Israel GM, Hindman N, Bosniak MA. Evaluation of cystic renal masses: comparison of CT and MR imaging by using the Bosniak classification system. Radiology 2004;231: 365–71.
12. Buetow PC, Rao P, Thompson LD. From the archives of the AFIP. Mucinous cystic neoplasms of the pancreas: radiologic-pathologic correlation. Radiographics 1998;18: 433–49.