Original Article

Analysis of clinical characteristics and treatment of pancreatic cystic tumors

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Background: To summarize experience in the diagnosis and treatment of pancreatic cystic neoplasms.

Methods: This is a retrospective study of 207 patients who were diagnosed with pancreatic cystic tumors at Peking Union Medical College Hospital between Jan 2009 and Mar 2014. Clinical data, such as clinical manifestations, radiological and pathological images and surgical recordings, were collected.

Results: Of the 207 included patients, females accounted for 76.81%, and the mean patient age was 52.04 years. Malignancy was more common in older patients who presented with marasmus and jaundice. Other risk factors included solid components in the tumor, a large tumor size, and elevated levels of tumor markers. Surgical treatment was required when a malignant tumor was suspected. The operation approach was selected based on the location, size and characteristics of the tumor. The position of the tumor relative to the pancreatic duct also played a significant role.

Conclusions: No specific symptoms were observed for the patients with pancreatic cystic tumors. Imaging played an important role in making a differential diagnosis. Furthermore, surgical treatment should be proposed for patients with significant symptoms and potentially malignant tumors. The tumor resection rate is high, suggestive of good prognosis.

Keywords: Cystic tumor; diagnosis; pancreatic cyst; treatment

Submitted Sep 11, 2015. Accepted for publication Jan 16, 2016.
doi: 10.21037/cjcr.2016.03.02
View this article at: http://dx.doi.org/10.21037/cjcr.2016.03.02

Introduction

Pancreatic cystic tumors account for 10–15% of pancreatic lesions and 1–2% of pancreatic tumors. Due to advances in imaging techniques and the increasing health consciousness of people, the detection rate of pancreatic cystic tumors has increased annually. Patients have long been receiving inappropriate treatment because of lack specific knowledge of the biological features of these tumors and the disease course. A significant number of patients are over-treated when the diagnosis is uncertain or indications for surgery are broad. By contrast, other patients are treated conservatively and do not undergo surgical treatment in time, resulting in partial rather than complete resection of the tumor. To promote the clinical diagnosis and treatment of pancreatic cystic tumors, we conducted a retrospective study of 207 patients who were diagnosed with pancreatic cystic tumors at Peking Union Medical College Hospital between Jan 2009 and Mar 2014. Clinical characteristics, such as clinical manifestations, radiology and pathology images, and surgical recordings, were collected.

Methods

We conducted a retrospective study of 236 patients who were diagnosed with pancreatic cystic tumors at Peking Union Medical College between Jan 2009 and Mar 2014. The exclusion criteria included a lack of surgical treatment and unclear pathology results obtained after surgery. Ultimately, 207 pancreatic cystic neoplasms patients received surgery and were analyzed retrospectively. Demographic data (age and gender), clinical manifestations (abdominal pain, nausea, marasmus, jaundice, and new onset of diabetes mellitus), imaging patterns of the tumor (location, size, and solid or papillary tubercles), the preoperative CA19-9 and CEA levels, the operation type and pathological diagnostic data were collected. The cohort was divided into two groups according to tumor pathology. One group consisted of patients diagnosed with a benign tumor (SCN, benign MCN, or benign IPMN). The other group comprised patients diagnosed with a borderline or malignant tumor (including borderline or malignant MCN or borderline or malignant IPMN). We compared the abovementioned clinical data, including the demographic data, clinical symptoms, imaging results, pathology findings, etc., in both groups. All statistical analyses were performed using SPSS 16.0. Univariate analysis was performed based on the χ^2 test and Wilcoxon rank-sum test. Multivariate analysis was conducted via logistic regression. A P value of <0.05 was considered significant. This study was approved by the Institutional Review Board of Peking Union Medical College Hospital. Written informed consent was obtained from all of the patients.

Results

Gender, age and clinical symptoms

About 76.81% of the patients diagnosed with pancreatic cystic tumors were females. No gender difference was observed between the benign and malignant groups. The mean age at diagnosis was 52.04 years. Moreover, the patients in the malignant group were much older than those in the benign group (P=0.025). Half of the patients were asymptomatic. A total of 83 (40.10%) presented with non-specific abdominal pain, 28 (13.53%) reported nausea and vomiting, 42 (20.29%) had marasmus, 12(5.80%) had obstructive jaundice, and 7(3.38%) had new-onset diabetes mellitus. Significant differences between the two groups were observed for the presence of clinical symptoms (P=0.01), marasmus (P=0.01) and jaundice (P=0.01).

Imaging features

A total of 152 patients (73.43%) had a tumor located at the pancreatic tail rather than at the pancreatic head. However, the positions of the tumors showed no obvious differences between the benign and malignant groups. The overall mean tumor diameter was 45.22 mm. The tumor diameter in the malignant group was much larger than that in the benign group (P=0.025). Twelve patients had specific imaging findings, such as a papillary process and solid components in the tumor, and more specific findings were observed in the malignant group than in the benign group (P=0.01).

Tumor markers

We routinely measured the serum CA19-9 and CEA levels before surgery and found that the average levels were 17.32 (95% CI, 12.67–21.97) U/mL and 2.01 (95% CI, 1.53–2.50) U/mL, respectively. The levels of both of these tumor markers significantly differed between the two groups (P=0.01 and P=0.01, respectively) (*Tables 1* and *2*).

Multivariate analysis for diagnosis of pancreatic cystic tumors

We substituted the above single factors with a P<0.2 into a multivariate analysis model, including advanced age, the presence of symptoms, marasmus, jaundice, and tubercles or solid components in the cyst, tumor size, and the CA19-9 and CEA levels. Advanced age (P=0.027) and a high serum CA19-9 level (P=0.035) were found to be independent risk factors for pancreatic cystic tumors (*Table 3*).

Surgical approach

All patients underwent surgical treatment, including spleen-preserving pancreatic resection (n=127; 61.35%), distal pancreatectomy with splenectomy (n=19; 9.18%), duodenum-preserving pancreatic head resection (n=4; 1.93%), pylorus-preserving pancreaticoduodenectomy (n=12; 5.79%), pancreaticoduodenectomy (n=13; 6.28%), pancreatic lesion myomectomy (n=21; 10.14%), pancreatic segmental resection (n=10; 4.83%), total pancreatectomy (n=1; 0.48%) and laparotomy biopsy (n=6; 2.9%).

Perioperative complications and postoperative follow-up

There were no perioperative deaths. However, 4 patients

Table 1 Clinical pathology data

Basic characteristics	Data
Overall case number	132
Sex [n, (%)]	
Male	106 (80.3)
Female	26 (19.7)
Average age (years)	51.74
Symptoms [n, (%)]	
Asymptomatic	72 (54.5)
Abdominal pain	55 (41.7)
Nausea and vomiting	12 (9.1)
Weight loss	29 (22.0)
Jaundice	9 (6.8)
Newly onset diabetes	4 (3.0)
Tumor location (%)	
Head/neck	37 (28.0)
Body/tail	95 (72.0)
Size of tumor (mm)	46.71
Nodules and solid components in the cyst (%)	12 (9.1)
Preoperative serum CA19-9 (U/mL)	28.82
Postoperative serum CEA (U/mL)	1.96
Operation type [n, (%)]	
Spleen-preserving distal pancreatectomy	79 (59.8)
Distal pancreatectomy and splenectomy	10 (7.6)
Duodenum-preserving pancreatic head resection	3 (2.3)
Pylorus-preserving pancreaticoduodenectomy	7 (5.3)
Whipple	8 (6.1)
Lesion foci resection	12 (9.1)
Segmental resection of the pancreas	7 (5.3)
Total pancreatectomy	1 (0.8)
Laparotomy	5 (3.8)
Postoperative pathology [n, (%)]	
Benign	110 (83.3)
Borderline and malignant	22 (16.7)

Table 2 Univariate analysis for qualitative diagnosis of tumor

Factors	χ^2 test and Wilcoson rank-sum test	P value
Sex	0.036	0.849
Age	4.864	0.029
Symptoms	5.126	0.024
Abdominal pain	0.121	0.728
Nausea and vomiting	0.66	0.417
Weight loss	5.524	0.019
Jaundice	5.366	0.021
Newly onset diabetes	0.199	0.656
Tumor location	0.008	0.931
Size of tumor	4.183	0.043
Nodules and solid components in the cyst	5.94	0.015
Preoperative serum CA19-9 (U/mL)	7.94	0.006
Preoperative serum CEA (U/mL)	7.12	0.009

*, P value of <0.05 was considered significant.

Table 3 Multivariate analysis for qualitative diagnosis of tumor

Factors	P value
Advanced age	0.043
Symptomatic	0.575
Weight loss	0.099
Jaundice	0.718
Size of tumor	0.081
Nodules and solid components in the cyst	0.097
Elevated serum CA19-9	0.048
Elevated serum CEA	0.799

*, P value of <0.05 was considered significant.

had a grade II pancreatic fistula. Among them, one had a 4-cm SCN at the pancreatic neck and underwent segmental pancreatic resection. Another patient with a 2.5-cm SCN also underwent segmental pancreatic resection. The third patient underwent spleen-preserving pancreatic resection to treat a 4.5-cm mucinous cystadenoma with a focal junction. Moreover, a patient with a 5-cm SCN at the pancreatic head after pancreaticoduodenectomy had a grade III pancreatic fistula. This patient also suffered from grade III bleeding and intraperitoneal infection. Grade II bleeding was observed in 3 patients. One patient with an 8-cm serous cystadenoma at the pancreatic head underwent pancreaticoduodenectomy. Another patient with a 4-cm serous cystadenoma at the pancreatic head underwent the same operation. The 4 patient had a 7-cm borderline mucinous cystadenoma at the pancreatic body and tail and underwent spleen-preserving pancreaticoduodenectomy. In addition, 3 patients suffered from grade III postoperative

bleeding. One patient with a 5-cm mucinous cystadenoma at the pancreatic body underwent spleen-preserving pancreaticoduodenectomy, and one patient with 4-cm serous cystadenomas at the pancreatic head and tail underwent segmental pancreatic resection. We followed up with 20 patients and did not follow up with 9 patients in the malignant group. We did not follow up with any of the patients in the benign group. Three of these patients died, while others experienced metastasis. Among them, one patient was diagnosed with a tumor at the pancreatic head and peripheral lymphadenopathy by transesophageal echocardiography.

Discussion

Diagnosis of pancreatic cystic tumors

The diagnosis and evaluation of risk factors determines the treatment approach and prognosis of pancreatic cystic tumors. Although most pancreatic cystic tumors are asymptomatic, the patients in our study presented with non-specific digestive system problems, such as abdominal pain (40.1%) and nausea and vomiting (13.53%). A total of 5.80% developed jaundice due to mechanical suppression of the bile duct by the tumor. In addition, 3.38% experienced new-onset diabetes mellitus due to pancreatic endocrine dysfunction. Forty-two percent developed marasmus. Up to 47.34% of the patients presented with no clinical manifestations, and their pancreatic cystic tumors were only discovered when they underwent routine physical examination or abdominal radiological examination. In our study, 76.81% of the patients diagnosed with pancreatic cystic tumors were females. Morris-Stiff *et al*. (1) reports a total of 338 asymptomatic patients, including 228 women and 110 men. Bose *et al*. (2) report a total of 350 asymptomatic patients, including 197 women and 153 men. Our date was based on the surgical databases. All patients received operation. While in the Western literature, their dates were based on the pathology databases or EUS database. So the selection bias can explain this different. Sometimes female are more anxious than male. They may prefer operation rather than observation. Pancreatic cystic masses can be detected using abdominal BUS and pancreatic CT, which can facilitate the differential diagnosis between malignant and benign disease. Therefore, BUS and CT are important imaging methods for diagnosing pancreatic cystic tumors (3). In our study, all tumors can be located by CT and/or BUS, the average size of the tumor is 45.22 mm, 55 (26.57%) are located at head/neck of pancreas and 152 (73.43%) are located at body/tail of pancreas. A total of 21 (10.14%) patients can be detected nodules and solid components in the cyst. Obviously, it our results, more tumors are located at body/tail of pancreas. It is duo to the operational indication of tumor located at head/neck of pancreas is stricter than that of located at body/tail in our center. Because, the operative complication of the former one is higher than the latter one. In our univariate analysis both the tumor size and nodules or solid components in the cyst is are related to the malignant pancreatic cystic tumor. However, in the further multivariate analysis only the size of tumor (P=0.05) is the independent risk factors for malignant pancreatic cystic tumor. MRI achieves a higher contrast level for examining tumor structural components, such as the cavity, interior partition and surrounding pancreatic parenchyma. Furthermore, it is advantageous for detecting microcapsule structures. When water imaging and non-invasive technology are applied in magnetic resonance cholangiopancreatography (MRCP), the diagnosis of IPMN is greatly facilitated (4). ERCP can be used to directly observe the duodenal papilla, and it also allows for collection of pancreatic fluid for cytological analysis through cholangiopancreatography. Further, it has shown greater advantages in IPMN diagnosis. However, because ERCP is an invasive approach, it may increase the incidence of complications, such as pancreatitis, which somewhat limits its application (5). Endoscopic ultrasound (EUS) can reduce the impact of hollow organs on ultrasonic waves, and it is a more sensitive and accurate approach for examining pancreatic tissue. In addition, we obtained cyst fluid through EUS-guided fine-needle aspiration (FNA) to measure biochemical indicators, such as the CEA and CA19-9 levels, and to perform cytological analyses. All of these tests and parameters contribute to the differential diagnosis of pancreatic cystic lesions (6,7). The majority of the patients in our study underwent direct surgery once their images indicated a diagnosis of pancreatic cystic tumor, in contrast with treatment protocols abroad. Because few patients underwent EUS-FNA, we could not measure the levels of tumor markers in the cyst fluid. Instead, the serum CA19-9 and CEA levels were detected. Both of these levels were higher in the malignant group compared with the benign group. A subsequent multivariate analysis suggested that increasing CA19-9 (P=0.035) levels were independent risk factors for malignant pancreatic cystic tumor. Due to the excellent specificity of FNA, tumors can be diagnosed as malignant as long as malignant cells

are discovered. Generally, more qualified specimens are required to make a cytological/pathological diagnosis, but it is difficult to obtain sufficient cells with atypia by FNA. Moreover, a definite diagnosis by FNA always requires the assistance of an experienced pathologist. Its sensitivity is not satisfactory because the resulting pathological diagnosis is greatly subjective (8,9). Intraoperative frozen pathological diagnosis is reliable for diagnosing pancreatic cystic tumors. However, a definitive pathological diagnosis cannot always be determined because some tissues are difficult to obtain and some obtained tissues are not typical. In our study, we made 22 intraoperative frozen pathological diagnoses, which were 100% concordant with the paraffin pathological diagnoses. In addition, 5.26% of the patients could not be definitively diagnosed. For example, the intraoperative pathological diagnosis of one patient with MCN indicated the possibility of borderline changes, while postoperative pathological diagnosis confirmed that the patient had partial borderline MCN. It is apparent that frozen pathological diagnosis can enhance diagnostic accuracy, which can help surgeons determine the optimal surgery to perform and the excision range.

Pancreatic cystic tumor indications for surgery

Unlike pancreatic cancer, most pancreatic cystic tumors are benign or low-grade malignant tumors. It is of great clinical significance to consider surgical indications in these patients to prevent their over-treatment or delayed treatment, which may result in missing of the optimal therapy time. Donahue *et al.* have summarized 114 cases of pancreatic cystic tumors and have found that advanced age (P=0.03), weight loss (P=0.01), jaundice (P=0.02), and pancreatic duct dilation (P=0.01) are related to malignancy; thus, timely surgical treatment is necessary (10). Dai *et al.*'s study has also reported a similar conclusion after reviewing 126 patients with pancreatic cystic tumors. They have found that patient gender (P<0.01), clinical symptoms, such as jaundice or weight loss (P<0.001), imaging features, such as papillary lesions in the tumor and solid components (P<0.001), a septum (P=0.01) and an elevated serum CA19-9 level (P=0.007) are important indicators for diagnosing malignant pancreatic cystic tumors (11). As in the relevant literature, our study revealed that the diagnosis is more likely to be malignant in patients with the following characteristics: advanced age, the presence of clinical symptoms, marasmus and jaundice, a lack of tubercles or solid components in the cyst, a larger tumor size and elevated serum tumor markers. Multivariate analysis revealed that both advanced age and an elevated serum CA19-9 level are independent risk factors for malignant pancreatic cystic tumors. There is a basic consensus that surgical treatment should be proposed for patients with symptomatic pancreatic cystic tumors and potentially malignant tumors. However, with rapid advances in imaging techniques and the increasing health consciousness of people, the incidence of asymptomatic pancreatic cystic tumors has gradually increased. There remains controversy about the surgical indications in this group of patients (12). Morris followed up on 338 patients with asymptomatic pancreatic cystic tumors. Under the guidance of EUS, biochemical indicators in the cyst fluid were detected by FNA. Combining biochemical indicators with imaging features, the natural courses of the tumors were evaluated. He found that cystic tumors with a diameter of less than 1.5 cm rarely transformed, indicating that it was safer for this group to be followed up compared with those with tumors of larger than 1.5 cm in diameter (11). Bose *et al.* reviewed 350 patients with asymptomatic pancreatic cystic tumors, finding that only 41 underwent surgical intervention and that 92.7% (38/41) of them had premalignant and malignant pathological diagnoses. This group suggested that most cases of asymptomatic cysts in which a clear diagnosis is made based on a detailed review of preoperative CT imaging and EUS findings can be managed without surgery. Thus, there is no doubt that an accurate preoperative diagnosis is the basis for evaluating surgical indications (12). However, we cannot neglect the fact that most asymptomatic tumors are at an early stage and that no specific biological features are present in some cases. This type of tumor cannot be definitely preoperative diagnosed. Correa *et al.* retrospectively reviewed 330 patients with incidentally discovered pancreatic cystic tumors, 136 of whom underwent surgery and received a final histological diagnosis. Most of the lesions presumed to be main-duct IPMN, combined IPMN or serous cystadenoma were confirmed as such after resection. The consistency rate between preoperative and postoperative diagnoses of MCN was only 60%, while that of branch-duct (BD) IPMN was 64%. In addition, 20% of the patients who were preoperatively diagnosed with BD IPMN were confirmed to have main duct involvement. Nearly one-third of patients with asymptomatic pancreatic cystic tumors cannot be accurately preoperatively diagnosed (13). In our study, almost half of the patients were asymptomatic. Because the surgical indications were more stringent when the preoperative diagnosis was considered to be SCN,

surgery was usually only performed when the tumor was rather large or the patient expressed a strong desire to undergo surgery. Conversely, surgical treatment should be actively considered in patients with MCN and IPMN. In addition, inconsistencies between pre- and postoperative diagnoses were observed in our study, consistent with previous reports. Therefore, further investigation is needed to improve the diagnostic methods and to formulate appropriate treatment strategies.

Types of pancreatic cystic tumors

The WHO modified the classification of pancreatic cystic tumors in 2000, excluding solid pseudopapillary neoplasm of the pancreas (solid-cystic pseudopapillary neoplasm of the pancreas has cystic solid pseudopapillary structures. Prognosis of tumor is better than other pancreatic cystic tumor. In case of large slow growing pancreatic tumor with splenic metastasis, solid-cystic pseudopapillary tumor of the pancreas should be considered in the diagnosis) and classifying pancreatic cystic tumors as SCN, MCN and IPMN. The biological features of certain tumor types vary, and the treatments and prognoses are also distinct. We will discuss the various tumor types as follows.

SCN

Most SCN patients in our study were asymptomatic and were accidentally diagnosed when imaging was performed as part of routine physical examination or for another reason. The tumors were predominantly located at the pancreatic body and tail and consisted of numerous small cysts. Their cross sections had a honeycomb appearance with a clear border. The cysts were always filled with serum, and there was typically no connection with the pancreatic duct. Based on their phenotype, SCNs is classified as serous microcystic adenoma (SMA) or serous oligocystic adenoma (SOIA). SMA is more frequent, accounting for 20% of all pancreatic cystic tumors. It is characterized by small cysts with diameters of less than 2 cm. A honeycomb-like structure can be seen on EUS. CT reveals specific characteristics of the tumors, such as the presence of multiple small cysts and a lobulated external contour. Calcification occurs in 20% of the cases, and it is typically found along with formation of a cluster around a central scar from which fibrotic bands radiate. Because most of the cysts are small, they are often not detected on CT, while MRI enables better resolution of cyst structures, septum, and peripheral pancreatic structures, especially micro-cyst structures. High signals in cysts are always detected by T2-weighted MRI (14). The oligocystic variant SOIA is characterized by just a few large cysts or no cysts, and they are primarily located at the pancreatic head. The tumor is lobulated and has a thin wall. The majority of SCNs are benign, with few exceptions diagnosed as histologically malignant. Twenty cases of malignant SCN have been reported (15). Most patients with malignancy are diagnosed with SOIA, characterized by a large tumor size (length of more than 10 cm). If patients are asymptomatic and definitively diagnosed, then no extra management is needed, except for regular follow-up. If patients have specific clinical manifestations or their tumor is sufficiently large and difficult to differentiate from other potentially malignant tumors, such as MCN and IPMN, surgical intervention should be proposed. The optimal surgery to perform is mainly selected according to the location and size of the tumor, and possible surgeries include local resection, segmental pancreatic resection, pancreatectomy and the Whipple procedure.

MCN

Ninety-five percent of MCNs occur in women. Abdominal pain is much more common in MCN than in SCN. Patients can present with similar symptoms as those of acute pancreatitis, although its incidence rate is lower than that of IPMN. Malignancy should be suspected when patients present with obvious weight loss and occlusive jaundice. It is seldom observed at any location except for the pancreatic tail. The gross shape of the tumor is usually spherical or oval. Several septa and eccentric nodules are present inside of the macrocysts, which are defined as nodules with a diameter of >2 cm, thin walls and mucinous cystic fluid. There is no connection between lesions and pancreatic ducts (16). Malignant MCN is usually indicated when pancreatic CT reveals a large tumor (diameter of >2 cm), numerous eccentric nodules, a thick wall, irregular septa, an egg-shaped calcification on the cyst wall and other peripheral infiltration signs (14,17). The biological behavior of MCN is difficult to predict according to the cell phenotype because many benign tumors tend to infiltrate and metastasize. As a consequence, benign mucinous cystadenoma is also currently regarded as a potentially malignant tumor. Once a patient is diagnosed with MCN, surgical resection is suggested (18). In our study, simple excision was performed for small tumors that were located far from the pancreatic duct; segmental pancreatic resection was performed for pancreatic neck tumors located adjacent to the pancreatic duct, with the intention to preserve the endocrine/exocrine

function of the pancreas. For large tumors located at the pancreatic body/tail, spleen-preserving pancreatic resection was preferred when the biological behavior was benign, with inflammation (not infiltration) adherent to the peripheral tissues and encapsulation. Duodenum-preserving pancreatic head resection is a better choice for larger tumors located at the pancreatic head. All tumors should be resected without reservation. The cutting edge should no less than 5 mm. The management of malignant MCN is similar to that of pancreatic cancer. The selection of the type of radical surgery to perform is mainly based on the tumor's location. Metastatic foci should be excised as soon as metastasis is observed (19). The 5-year survival rates of MCN patients after complete resection are 100% in benign, borderline and non-infiltrating cystadenocarcinoma patients and 37.5% in invasive carcinoma patients, indicating good prognosis (20).

IPMN

IPMN is named for the hyperplasia and papillary arrangement of epithelial cells that produce mucinous fluid in the pancreatic duct. Approximately one-third of patients have clinical symptoms, which manifest as acute or chronic pancreatitis symptoms, including abdominal pain, back pain, steatorrhea, and diabetes (21). IPMN is divided into the following four successive stages according to epithelial atypia: mild dysplasia, moderate dysplasia (borderline IPMN), severe dysplasia (carcinoma *in situ*) and invasive carcinoma. Using pancreatic CT and ultrasound endoscopy, the range of the involved lesion is assessed, and based on these findings; IPMN is further divided into the following three types: BD, main pancreatic duct and mixed (22), ERCP also contributes to the diagnosis of IPMN. More than half of cases have a bulging duodenal papilla, a widely opened papillary orifice, and a large volume of mucus is secreted. To facilitate diagnosis, the mucinous fluid may be collected to analyze tumor cells and measure the CEA and CA19-9 levels (23). It is difficult to predict the biological behaviors of IPMN according to the cellular phenotype, similar to MCN. Benign tumors may transform into malignant tumors. Surgical treatment is proposed for the main duct and mixed types of IPMN (24). Because only 30% of BD-IPMN cases are malignant, it remains controversial whether this tumor type requires resection. In 2012, many physicians specializing in pancreatic surgery, gastroenterology and pathology gathered in Fukuoka, Japan. This working group created new international guidelines for diagnosing and treating MCN and IPMN. These guidelines state that treatment should always be more conservative for asymptomatic BD-IPMN, i.e., a tumor diameter of <3 cm without "high-risk stigmata". Close follow-up of these patients is still needed. However, the above conclusion is based on accurate classification according to imaging findings. Due to the limitations of existing imaging techniques, some patients preoperatively diagnosed with BR-IPMN are found to have mixed or main-duct IPMN after surgery (13). Furthermore, even BR-IPMNs that are <3 cm without malignant signs can ultimately develop into invasive pancreatic cancer. As a result, some groups have recommended that all IPMNs should be resected (25). Because BR-IPMNs are usually benign and involve the pancreatic head, various types of surgery, such as tumor excision and duodenum-preserving pancreatic head tumor resection (Beger surgery), are widely recommended. Tumor-free resection margins are required for all cases of IPMN (26). Moreover, for main-duct and mixed IPMNs, total pancreatectomy was advocated in the past because of the multifocal lesions and limitations of intraoperative frozen pathology. However, some groups have recently found that the degree of malignancy of such tumors is low, and even if patients relapse, a second surgery can be performed. Considering the numerous postoperative complications after pancreatectomy and the poor quality of life of patients, pylorus-preserving pancreaticoduodenectomy, pancreatic segmental resection and spleen-preserving pancreatic resection have been applied. Under these conditions, close follow-up is necessary (24). Most patients in our study chose the above surgeries with only one exception, a patient who underwent total pancreatectomy. Malignant tumors are more likely to invade the peripheral lymph nodes, nerves and vessels; as a result, in addition to tumor resection, regional lymph node dissection is required. IPMN has a good overall prognosis, regardless of whether it is non-invasive or invasive. Although postoperative recurrence and metastasis may occur, re-operation can achieve good results. The 5-year survival rate for benign, borderline and non-invasive IPMN is up to 89%, while that for invasive IPMN is 57.7% (20).

In conclusion, clinical symptoms in elderly patients, such as weight loss, jaundice and other imaging findings, including nodules and solid components in cysts, a large tumor size, and elevated levels of serum tumor markers, are signs of malignancy that require an active surgical strategy. The optimal type of surgery to perform depends on the location, size, position relative to the pancreatic duct and characteristics of the tumor. Currently, surgical indications for asymptomatic pancreatic cystic tumors remain controversial. Their biological features should be

further studied, and clinical research should be conducted using a large sample size to evaluate the potential risk factors for transformation to malignancy. Standardization of the diagnosis and treatment of pancreatic cystic tumors will become another clinical focus of pancreatic surgery. With further research of pancreatic cystic tumors, we have reason to believe that the diagnosis and treatment of this disease will be improved.

Acknowledgements

Funding: This study was supported by grants from the Research Special Fund for the Public Welfare Industry of Health (201202007), the National Science & Technology Pillar Program during the Twelfth Five-year Plan Period (2014BAI09B11), the National Natural Science Foundation of China (81472327), the Fundamental Research Funds for the Central Universities and the PUMC Youth Fund (3332015004).

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: You L, Xiao J, Cao Z, Zhang W, Liao Q, Dai M, Zhang T, Zhao Y. Analysis of clinical characteristics and treatment of pancreatic cystic tumors. Chin J Cancer Res 2016. doi: 10.21037/cjcr.2016.03.02

