VERSITA

Cent. Eur. J. Med. • 9(1) • 2014 • 92-107
DOI: 10.2478/s11536-013-0244-8

Central European Journal of **Medicine**

Pancreatic cysts: etiology, diagnosis and management

Review Article

Beata Jabłońska*

Department of Digestive Tract Surgery, Medical University of Silesia, Medyków 14 St., 40-752 Katowice, Poland

Received 23 May 2013; Accepted 13 August 2013

Abstract: Pancreatic cysts involve a wide spectrum of pathologies from post-inflammatory cysts to malignant neoplasms. Pancreatic pseudocysts, serous cystadenomas, mucinous cystadenomas, intraductal papillary mucinous neoplasms (IPMNs) and solid pseudopapillary tumors occur most frequently. Differential diagnosis involves the following imaging investigations: transabdominal ultrasonography (TUS), contrast enhanced ultrasonography (CEUS) and endoscopic ultrasonography (EUS), computed tomography (CT), magnetic resonance (MR) and magnetic resonance cholangiopancretography (MRCP), endoscopic retrograde cholangiopancretography (ERCP). The cyst fluid cytology is performed in difficult differential diagnosis between pseudocysts and benign and potentially malignant or malignant tumors. Most frequently, viscosity, amylase, CEA and CA 19-9 levels are determined. Imaging findings should be correlated with cytology. The management depends on the cyst type and size. Small asymptomatic pseudocysts, serous cystadenomas and branch-duct IPMNs should be carefully observed, whereas symptomatic large or uncertain serous cystadenomas and cystadenocarcinomas, mucinous cystadenomas and cystadenocarcinomas, main-duct IPMNs and large branch-duct IPMNs with malignant features, serous and mucinous cystadenocarcinomas, and solid pseudopapillary tumors require surgery. Pseudocysts are usually drained. Percutaneous / EUS-guided or surgical cyst drainage can be performed. Complicated and uncertain pseudocysts and cystic tumors need surgical resection. The type of surgery depends on cyst location and size and includes proximal, central, distal, total pancreatectomies and enucleation.

Keywords: *Hyoid bone • Pancreas • Cyst • Pseudocyst • Neoplasm • Cystadenoma • Drainage • Resection*

Abbreviations

ANC	acute necrotic collection
APFC	acute peripancreatic fluid collection
AREG	amphiregulin
CEUS	contrast enhanced ultrasonography
CT	computer tomography
ERCP	endoscopic retrograde cholangiopancretography
ESGE	European Society of Gastrointestinal Endoscopy
EUS	endoscopic ultrasonography
EUS BR	endoscopic ultrasonography guided cytology brushing
FNA	ine needle aspiration
IPMN	intraductal papillary mucinous neoplasm
MCA	mucinous cystadenoma
MRCP	magnetic resonance cholangiopancretography
MRI	magnetic resonance imaging
NOTES	Natural Orifice Translumenal Endoscopic Surgery
SCA	serous cystadenoma
SPN	solid pseudopapillary neoplasm
SPT	solid pseudopapillary tumor
TUS	transabdominal ultrasonography
WON	walled-off necrosis

1. Introduction

Pancreatic cysts involve a wide and heterogeneous spectrum of pathologies including non-neoplastic post-inflammatory cysts as well as benign and malignant neoplastic cystic tumors. Therefore, descriptive “pancreatic cystic lesions” is used to define all pancreatic cysts [1,2]. There are different classifications of pancreatic cystic lesions in the literature. According to epithelial lining of the pancreatic cysts, they are divided into

* *E-mail: bjablonska@poczta.onet.pl*

true cysts (lined with the epithelium) and pseudocysts (without the epithelium) [1]. According to development type and etiology, they are divided into primary and secondary cysts [2,3]. Primary lesions include the following pathologies: pseudocysts, serous cystic neoplasms (cystadenoma and cystadenocarcinoma), mucinous non-neoplastic cysts, mucinous cystic neoplasms (cystadenoma and cystadenocarcinoma), intraductal papillary mucinous neoplasms (IPMNs), solid pseudopapillary tumors and lymphoepithelial cysts. Secondary lesions are a result of the transformation of solid pancreatic tumors (adenocarcinomas and neuroendocrine tumors) in the cystic forms [2,3]. Pseudocysts due to acute and chronic pancreatitis are most common pancreatic cysts (70%) [1-6]. Pancreatic cystic neoplasms constitute less than 1% of all pancreatic tumors [1]. Proper differential diagnosis of the pancreatic cysts is very important for decision regarding management. It is very important to differentiate pseudocysts from neoplastic cysts because management is different. Pseudocysts and incidental benign cystic neoplasms can be observed or drained and other pancreatic cysts should be removed surgically. Therefore, it is an essential problem for gastroenterologists, radiologists and surgeons. The aim of this paper is to present classifications, diagnostics and management in different pancreatic cystic lesions. The most common pseudocysts and cystic pancreatic tumors and the importance of proper differential diagnosis in both pathology groups were discussed.

2. Etiology and classifications of pancreatic cysts

2.1 Pancreatic pseudocysts

2.1.1. Pancreatic post-inflammatory pseudocysts

Pancreatic pseudocysts are localized collections of pancreatic secretions enclosed in a wall of fibrous or granulation tissue lacking an epithelial lining. They occur due to inflammation and ductal disruption usually as a complication of acute and chronic pancreatitis or less frequently as a result of pancreatic trauma [4]. The Atlanta classification distinguished acute and chronic pseudocysts. According to this classification, an acute pseudocyst is a collection of pancreatic juice enclosed by a wall of fibrous or granulation tissue, which arises as a result of acute pancreatitis or pancreatic trauma, whereas a chronic pseudocyst is a collection of pancreatic juice enclosed by a wall of fibrous or granulation tissue, which arises as a results of chronic pancreatitis and lack an antecedent episode of acute pancreatitis [7]. Definition of the pancreatic pseudocyst, as local complication of acute pancreatitis, was revised in 2012 and published in 2013 by Banks et al. [8]. The authors defined the pancreatic pseudocyst as an encapsulated collection of fluid with a well defined inflammatory wall usually outside the pancreas with minimal or no necrosis that usually occurs more than 4 weeks after onset of interstitial oedematous pancreatitis maturation. The authors pointed the following criteria for the pancreatic pseudocysts: well circumscribed, usually round or oval; homogeneous fluid density; no non-liquid component, well defined and completely encapsulated wall; maturation usually requiring >4 weeks after onset of acute pancreatitis; and occurrence after interstitial oedematous pancreatitis. In this classification, an important distinction was made between collections composed of fluid alone versus those arisen from necrosis and containing a solid component which might also contain different amounts of fluid. Therefore, a pancreatic pseudocyst should be distinguished from other morphological features of acute pancreatitis such as interstitial oedematous pancreatitis (acute inflammation of the pancreatic parenchyma and peripancreatic tissues, but without recognizable tissue necrosis), necrotizing pancreatitis (inflammation associated with pancreatic parenchymal necrosis and/or peripancreatic necrosis), acute peripancreatic fluid collection (APFC) (areas of peripancreatic fluid seen within the first 4 weeks after onset of interstitial oedematous pancreatitis and without the features of a pseudocyst), acute necrotic collection (ANC) (a collection containing variable amounts of both fluid and necrosis associated with necrotizing pancreatitis), and walled-off necrosis (WON) (heterogeneous with liquid and non-liquid density with different degrees of loculations).

Acute pseudocysts are usually a result of acute pancreatitis but they also can develop due to exacerbation of chronic pancreatitis. On the other hand, chronic pseudocysts may also develop following an episode of acute pancreatitis. So, the Atlanta definitions are sometimes confusing. In order to clear it, some other pseudocysts classifications have been described in the literature [8]. Sarles et al. [10] (1961) proposed a classification of pancreatic pseudocysts depending on whether they were associated with acute or chronic pancreatitis. Pseudocysts associated with acute pancreatitis were called necrotic pseudocysts because they developed from pancreatic necrosis and extravasations of pancreatic juice. Pseudocysts originating from chronic pancreatitis were called retention pseudocysts based on histopathological findings. This classification made a clear differentiation between acute and chronic pseudocysts based on pathological investigations but has not taken into consideration pseudocysts developing due to acute-on-chronic pancreatitis [9-12]. The D'Egidio and Schein's classification (1991) took into consideration

both aspects mentioned above [13]. Based on clinical and radiographic analysis of pancreatic pseudocysts in 83 patients, D'Egidio and Schein divided pancreatic pseudocysts into three types presented in Table 1.

Table 1. Types of pancreatic pseudocysts according to D'Egidio and Schein's classification.

I	Acute post-necrotic pseudocysts occuring following an episode of acute pancreatitis and associated with normal duct anatomy, and rarely communicating with the main pancreatic duct.
II	Post-necrotic pseudocysts that occuring following an episode of acute-on-chronic pancreatitis (the pancreatic duct is diseased but not strictured), and frequently with communication between the pseudocyst and main pancreatic duct.
III	Retention pseudocysts occuring due to chronic pancreatitis and associating with duct stricture and pseudocyst-duct communication.

This classification has got important practical management implications. Percutaneous pseudocyst drainage may be successfully performed in type I and II, but in patients with type II it should be prolonged and often followed by surgical internal drainage. In type III, percutaneous drainage is contraindicated and surgical internal drainage considering ductal pathology should be performed [13,14]. Anatomy of the main pancreatic duct was considered in Nealon's classification (2002). Nealon and Walser hypothesized that pancreatic ductal anatomy could predict the likely success of percutaneous drainage of the pancreatic pseudocysts. Authors defined seven categories of ductal abnormalities seen in 253 patients with pseudocysts and related their own experiences with different types of treatment. The types of the pancreatic duct anatomy are presented in Table 2.

Table 2. Pancreatic duct anatomy according to Nealon's classification.

I	Normal duct/no communication with cyst.
II	Normal duct with duct-cyst communication.
III	Otherwise normal duct with stricture and no duct-cyst communication.
IV	Otherwise normal duct with stricture and duct-cyst communication.
V	Otherwise normal duct with complete cut-off.
VI	Chronic pancreatitis, no duct-cyst communication.
VII	Chronic pancreatitis with duct-cyst communication.

Authors concluded that pancreatic duct anatomy provided a clear correlation with the failure and successes of pseudocysts managed by percutaneous drainage as well as predicting the total length of drainage. Percutaneous drainage is best applied to patients with normal ducts and is acceptably applied to patients with stricture but no cyst-duct communication [15].

Acute pseudocysts develop as a result of the maturation of an acute inflammatory process, with collection of pancreatic secretions and products of inflammatory response with or without rupture of the pancreatic duct. In acute pancreatitis, duct disruption can occur as a consequence of pancreatic necrosis. In some cases, leakage of the pancreatic juice from an inflamed pancreatic surface can be observed. Although the pancreas has not got a firm capsule, collections of pancreatic juice may remain as focal masses in the region of the duct disruption. If secretion breeches the thin layer of surrounding connective tissue, the anterior pararenal space and lesser sac are involved. The acute pancreatic pseudocyst can be recognized if it is enclosed by a wall of fibrous or granulation tissue 4-6 weeks after an episode of acute pancreatitis. The presence of a wall differentiates the pseudocyst from acute fluid collection. There are two main mechanisms in pathogenesis of chronic pseudocysts. They can be a result of acute exacerbation of chronic pancreatitis (acute-on-chronic pancreatitis) or as a result of blockade of the major branch of the main pancreatic duct by a protein plug, calculus or localized fibrosis. Initially, cysts are intrapancreatic fluid collections but they can reach the pancreatic capsule as they grow. If the capsule ruptures, a pancreatic fistula develops [12].

2.1.2. Other types of pancreatic pseudocysts

Post-inflammatory pancreatitis-related pseudocysts are most common but some other infrequent pancreatic pseudocysts have been described in the literature: paraduodenal wall cysts (cystic dystrophy) and infection-related pseudocysts (parasitic and tuberculous cysts) [1].

2.1.2.1. Paraduodenal wall cysts (cystic dystrophy)

Paraduodenal wall cysts are an unusual complication of chronic pancreatitis. These cysts occur as a consequence of chronic fibrosing inflammation in the periampullary region in which one or more of the accessory ducts form a cyst on a duodenal wall and mimic duodenal duplication. The cysts may be partly lined by ductal epithelium and partly by inflammation as well as granulation tissue. Most frequently, they are localized within the descending part of the duodenum around the accessory ampulla. They occur predominantly in males, at age 40–50 years, often with a history of alcohol abuse, and complaints on severe abdominal symptoms [1].

2.1.2.2. Infection-related Pseudocysts

Infection-related pseudocysts include parasitic and tuberculosis pseudocysts. They are reported sporadically. Hydatid cyst (caused by the larval stage of Echinococcus granulosus) should be considered in differential diagnosis of all pancreatic cysts, especially in the geographical regions where the disease is endemic (Middle East and other parts of world including India, New Zealand, Australia, Turkey and South Europe). Pancreatic location of hydatid disease is extremely rare with an incidence of less than 1% of all locations. Clinical presentation is different and depends on the size and anatomic location

of the cyst within the pancreas and the degree of biliopancreatic involvement. Abdominal pain, discomfort and vomiting are the main clinical symptoms. The others are: obstructive jaundice, weight loss, epigastric mass, and/or recurrent acute pancreatitis [1,16,17].

2.2. Pancreatic cystic neoplasms

Pancreatic cystic neoplasms account for 10–15% of pancreatic cysts and 1% of all pancreatic tumors. The WHO classification (2010) distinguished four main groups of pancreatic cystic neoplasms: serous cystic neoplasm, mucinous cystic neoplasm, intraductal papillary mucinous neoplasm, and solid pseudopapillary neoplasm [18,19]. Classification of four common pancreatic cystic neoplasms is presented in Table 3.

Table 3. Classification of pancreatic cystic neoplasms.

Serous cystic neoplasm
Serous cystadenoma
Serous cystadenocarcinoma
Mucinous cystic neoplasm
Mucinous cystadenoma
Mucinous cystadenocarcinoma
Intraductal papillary mucinous neoplasm
Main-duct type intraductal papillary mucinous neoplasm
Branch-duct type intraductal papillary mucinous neoplasm
Combined-duct type intraductal papillary mucinous neoplasm
Solid pseudopapillary neoplasm

2.2.1. Pancreatic serous cystic neoplasms

2.2.1.1. Serous cystadenoma and cystadenocarcinoma

Serous cystadenomas (SCAs) are rare pancreatic tumors composed of cuboidal epithelium producing serous fluid. They account 1–2% of all exocrine pancreatic tumors and about 30% of pancreatic cystic neoplasms. These tumors occur more frequently in females (female:male ratio 1.5–4.5:1) who are older than 60 years (mean age 70 years old). Therefore, the term "grandmother" lesion has been coined to describe these tumors. Serous cystadenomas are benign, asymptomatic and are usually found incidentally [20,21]. They do not require surgery and can be observed because they are benign and most frequently asymptomatic (30%). Large tumors can cause epigastric pain, weight loss, nausea, and vomiting. They are usually single. hHowever, multifocal lesions may be associated with Von Hippel-Lindau disease. According to the appearance, they are divided into two groups: microcystic (multilocular) and oligocystic (unilocular) lesions. SCAs are usually <5 cm in diameter, with a median size of 25-30 mm. Typically, SCAs have a microcystic appearance, with numerous small (2 cm), well-defined cystic loculations, central calcifications, enhancement around microcysts after injection, and larger cysts on the periphery of the mass in computed tomography. A central stellate scar caused by calcification of the central fibrous stroma creates the pathognomonic "starburst" radiological appearance. Malignant serous cystadenocarcinomas account for only 1–3% of serous tumors of the pancreas [3,18,21].

2.2.1.2. Pancreatic mucinous cystic neoplasms

2.2.1.2.1. Mucinous cystadenoma and cystadenocarcinoma

Mucinous tumors represent approximately 2% of all pancreatic neoplasms and one third of cystic neoplasms. They are typically large multilocular cysts composed of mucin-producing columnar epithelium, resting on a fibrous ovarian-type stroma. According to their malignant behavior, they are divided into benign mucinous cystadenomas, borderline with malignant potential, or malignant (carcinoma in situ or invasive carcinoma). Most frequently, mucinous neoplasms are reported in females (female:male = 9: 1) at the middle age (mean age at diagnosis: 48 years). The common clinical symptoms are epigastric pain, palpable mass, nausea, vomiting, diarrhea, anorexia and weight loss. Most frequently (70–90%), mucinous cystic neoplasms are located in the pancreatic body or tail, and only 10–30% is located in the pancreatic head. Mucinous cystic neoplasms are usually large with a mean diameter from 7 to 10 cm. These cysts usually have got a thick wall with calcifications (30%). The irregular wall and solid components suggest an aggressive behavior. These tumors usually do not communicate with the main pancreatic duct but they can cause pancreatic duct obstruction [18,22,23].

2.2.1.2.2. Pancreatic Intraductal Papillary Mucinous Neoplasms (IPMNs)

IPMNs represent approximately 1% of all pancreatic neoplasms and 25% of cystic neoplasms. The WHO defined IPMNs as intraductal mucin-producing neoplasms with tall, columnar, mucin-containing epithelium with or without papillary projections [24]. Absence of ovarian-type stroma differentiates these tumors from mucinous cystic neoplasms. IPMNs are divided into three types: main-duct, branch-duct and combined types. The main-duct type is characterized by involvement of the main pancreatic duct with, or without, associated involvement of the branch ducts (combined IPMNs). Branch-duct type involves the side branches of the pancreatic duct and appears as cystic lesions communicating with a non-dilated main pancreatic duct. Papillary proliferation leads to obstructive dilation of the main or side branch pancreatic ducts. According to the epithelial dysplasia and malignancy potential, IPMNs are classified as adenoma, borderline, carcinoma in situ, and invasive carcinoma. Most frequently, these tumors occur in men older than 60 years [18,20]. According to most authors,

branch-type IPMNs are more frequently non-invasive compared with main-duct IPMNs. Bernard et al. [24], based on the analysis of 53 patients with IPMNs, did not reported carcinoma in the branch-type IPMNs smaller that 30 mm and without mural nodule. Hwang et al. [25] analyzed factors determining malignancy in the branch-type IPMNs. The tumor size and mural nodule were factors determining malignancy in a multivariate analysis, and elevated CEA, tumor size and mural nodule were factors determining malignancy in an univariate analysis. Based on their analysis, authors constructed a malignancy-predicting scoring formula: 22.4 (mural nodule (0 or 1)) + 0.5 (cyst size (mm)). The tumor staging influences on the patients prognosis. Turrini et al. [26], based on an analysis of 412 patients with IPMNs, reported that the tumor size large than 2 cm and lymph node involvement were associated with a poorer prognosis. In IPMNs, adenoma-carcinoma sequence is postulated. IPMNs seem to follow progressing from IPMN adenoma, to borderline IPMN with dysplasia, to IPMN with carcinoma in situ (CIS), and to invasive carcinoma. Patients with invasive IPMNs are older than patients with non-invasive tumors. The increase of tumor dysplasia degree associated with the older patients age has been reported in the literature [23,25,26].

2.2.1.3. Pancreatic Solid Pseudopapillary Neoplasms (Tumors) (SPNs, SPTs)

SPNs constitute 0.1%–5.0% of all pancreatic tumors. They are called Frantz's tumors because were first reported by Frantz in 1959. They have a low malignant potential and occur most commonly in young women in second and third life decade as a palpable mass. SPNs can arise from ductal, acinar, endocrine or multipotential stem cells. These tumors are often located within the pancreatic head and tail. Guo et al. [27] suggested the following features indicating malignant potential: histological findings of high nuclear grade, cellular pleomorphism, venous invasion and necrobiotics; and immunohistochemistry findings of expression of Ki-67.

2.3. Rare pancreatic cystic lesions

The other pancreatic cystic tumors occur very rarely and involve: acinar cell cystadenocarcinoma, lymphangioma, hemangioma, paraganglioma, adenocarcinoma (due to cystic degeneration within solid tumors), neuroendocrine tumors, metastasis, cystic teratoma, sarcoma. The rare non-neoplastic pancreatic cystic lesions include true pancreatic cysts such as lymphoepithelial cysts and cysts associated with von Hippel–Lindau disease, autosomal-dominant polycystic kidney disease, and cystic fibrosis [18,28-31].

3. Diagnosis of pancreatic cysts

Diagnosis includes medical review, physical examination, and accessory investigations. In patients with post-inflammatory pseudocysts, an acute pancreatitis episode or chronic pancreatitis is usually reported. But it should be emphasized that pancreatic tumors, commonly intraductal papillary mucinous neoplasms, can present as recurrent pancreatitis due to the pancreatic duct obstruction and mimicking pancreatic pseudocysts. Mucinous adenomas mimicking an acute pancreatitis have been also reported in the literature. Serous cystadenomas seldom cause acute pancreatitis that is related to obstruction or communication with the pancreatic duct. It has been reported that both benign and malignant IPMNs can lead to recurrent pancreatitis due to pancreatic duct obstruction. According to the literature, the rate of acute pancreatitis in patients with IPMNs has varied from 12% to 67%. Both the main duct-IPMN and side branch-IPMN may be the cause of acute pancreatitis with a similar risk [32-34]. A number of pancreatic cysts are asymptomatic. Patients with pancreatic cysts usually complain of a palpable mass, epigastric pain, nausea, vomiting and weight loss. Accessory laboratory and imaging investigations can be useful in differential diagnosis. It has been reported that elevated enzyme levels are noted in approximately 75% of patients with pancreatic pseudocyst, whereas enzymes fall within normal limits in the majority of pancreatic neoplasms. However, in case of an acute pancreatitis due to the cystic tumor enzymes (amylase and lipase) levels are also elevated. In IPMNs, increased enzymes levels reflect communication of the cystic tumor with the main pancreatic duct or its branch [35]. Differential diagnosis of all pancreatic cysts is presented in Table 4.

3.1. Radiological investigations

Radiological investigations are most useful in diagnostics of pancreatic cysts. They allow differentiation of pseudocysts from cystic tumors as well as serous from mucinous neoplasms. The following imaging investigations are used in diagnosis of pancreatic cysts: transabdominal ultrasonography (TUS), contrast enhanced transabdominal ultrasonography (CEUS), computed tomography (CT), magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), EUS (endoscopic ultrasonography) [3,5,17,18,19,28,36-44].

3.1.1. Transabdominal ultrasonography (tus)

TUS is simple and non-invasive. Therefore, a transabdominal conventional B-mode US is the investigation of

Table 4. Differential diagnosis of pancreatic cysts.

Cyst type	PC	SCA	MCA	IPMN	SPT
Mean age	Any	70	48	>60	31
Main gender	Male	Female	Female	Male	Female
Main location	Any	Any	Body/Tail	Head	Any
Typical image	Unilocular Uniform	Central scar Honeycomb Microcystic	Unilocular/ Multilocular Macrocystic	Macrocystic Ductal Involvement	Solid Component
Viscosity	Low	Low	High	High	Low
Amylase	High	Low	Low	High	Low
CEA	Low	Low	High	High	Low
CA 19-9	Low	Low	High	Any	Low

PC Pseudocyst; SCA Serous cystadenoma; MCA Mucinous cystadenoma; IPMN Intraductal papillary mucinous neoplasm; SPN Solid pseudopapillary neoplasm.

first choice in patients with pancreatic cysts. On TUS, pancreatic pseudocysts are hypoechogenic and homogeneous lesions with a thin wall. Pancreatic cystic tumors are usually not homogeneous with a thick wall. The presence of identifiable mass lesions within a cyst or a cystic lesion with (peripherally) located solid nodules (with or without septae) are considered indicators for neoplasia. TUS is an initial screening investigation and it usually requires further imaging investigations [45].

3.1.2. Contrast Enhanced Ultrasonography (CEUS)

CEUS improves differentiation between pseudocysts and pancreatic cystic neoplasms, in comparison to the conventional US, by analysis of the perfusion within the mass lesions, nodules and septae within the pancreatic cysts. It has been reported that CEUS is helpful in differential diagnosis of cystic-solid pancreatic lesions (pancreatic cysts with solid components). In CEUS, patients are investigated before and after intravenous contrast administration. It allows the assessment of the pancreatic lesion during different phases of contrast distribution. Based on these findings, vascularization type of the pancreatic cyst can be described. Macrovascularity visualized as the cyst transversing arterial macrovessels is typical for pseudocysts and pancreatic necrosis whereas microvascularity is typical for pancreatic neoplasms. In cystic neoplasia, iso- or hyper-vascularisation within solid parts, compared to the surrounding pancreatic parenchyma (independently of being benign or malignant), is visualized. It has been reported that most cystic neoplasms are hypervascular and hyperenhancing in comparison to the surrounding pancreatic parenchyma, but the difference between benign and malignant neoplasia is not detectable [45]. Beyer et al. [45] compared the conventional US with CEUS in differentiation of pseudocysts versus neoplasia and concluded that conventional US had a sensitivity of 94% and a low specificity of 44% whereas CEUS had a higher specificity of 77% with the same sensitivity of conventional USG. Xu et al. [46] compared the accuracy of the conventional US with CEUS in diagnostics of 54 solid-cystic pancreatic lesions and concluded that CEUS characterized a significant higher diagnostic accuracy compared to conventional US.

3.1.3. Endoscopic Ultrasnonography (EUS)

EUS provides better delineation of pancreatic cysts compared to TUS. It allows delineation of lesion characteristics, pancreatic ductal anatomy, pancreatic parenchyma, peripancreatic tumor invasion and lymph node involvement. Similarly to TUS, the presence of solid components within the cystic lesion, thick wall, multiple septae, invasion outside the pancreas, pancreatic ductal obstruction and lymphadenopathy are typical for pancreatic malignancy. EUS alone cannot reliably differentiate between benign and malignant pancreatic cystic lesions, but EUS offers guidance for fine needle aspiration (FNA) of cystic lesions which has been demonstrated to be as accurate as CT-guided FNA. Volmar et al. [46] reported that for lesions <3 cm, the EUS-guided FNA had higher accuracy than US or CT. With CT or EUS guidance, samples of the cystic fluid and cyst walls can be taken by fine needle aspiration and brushing for cytology and measurement of tumour markers, viscosity, and amylase (that will be described in the further part of this paper) [17,28,47-52]. Similar to transabdominal US, EUS also allows a therapeutic approach such as EUS-guided pancreatic pseudocyst drainage (that will be discussed in a chapter regarding management) [53-61].

3.1.4. Computed tomography (CT)

A contrast enhanced CT is very important in diagnosis of pancreatic cysts. It is usually performed as second imaging investigation following ultrasonography because it is more precise than TUS. It allows delineation of the pancreatic cyst size, communication with the pancreatic duct, and staging of pancreatic neoplasms (involvement of the surrounding structures and lymph nodes and pres-

ence of metastases). CT is important for surgeons during surgical procedure planning because it allows them to determine resectability of the pancreatic lesion. According to Le Borgne et al. [20], spiral CT is the investigation of choice for a correct prediction of cystic tumor type.

A typical pancreatic pseudocyst is usually a hypodense unilocular well defined lesion without internal septae, solid components, or central–cyst wall calcification with uniform enhancing walls. It may be associated with inflammation within the peripancreatic fat [28].

SCA is visualized as a hypodense mass with fibrous septa and a small calcification located in 50% of cases within the pancreatic head. In 70% of serosus cystadenomas, CT demonstrate a polycystic or microcystic lesion consisting of a collection of cysts (usually more than six) that range from a few millimeters up to 2 cm in size. A central scar is a pathognomonic feature of SCA and it is seen in 30% of cases. In 20% of cases, these tumors are composed of microcysts in a honeycomb pattern and appear as well delineated "spongy" lesions with soft-tissue or mixed attenuation and a sharp interface with the vascular structures at CT [18,28].

MCA is visualized as a hypodense unilocular or septated multilocular macrocystic lesion without communication with the pancreatic duct (which is different from IPMN) located usually within the pancreatic body or tail. Although communication with the pancreatic duct is not typical for this tumor, obstruction of the pancreatic duct by the cystic mass may be visible in CT [18,28].

IPMN is also a multilocular macrocystic lesion, but with characteristic dilatation and communication with the pancreatic duct in contrast to MCA. On CT without contrast enhancement, a main-duct IPMN is demonstrated as a dilated and tortuous main pancreatic duct. A branch-duct IPMN appears as a lobulated cystic lesion with characteristic grape-like clusters or "tubes and arcs" appearance limited to segmental ducts. A combined type IPMN is demonstrated as cystic lesion located typically in the uncinate process. It has a characteristically lobular appearance with multiple intercommunicating cysts, and a grossly dilated main pancreatic duct. On contrast enhanced CT, a thin irregular, peripheral ring-enhancing multicystic lesion associated with branch-duct lesions is apparent. Cholangiopancreatography (MRCP or more rarely ERCP) is performed in order to demonstrate all morphologic IMPN features [18,28].

SPN is manifested as a clear-bordered heterogeneous cyst with a solid component. The enhancement of the solid part of the tumor and the capsule is showed in CT [18,27,28]. Yin et al. [62] analyzed CT and MRI features that could delineate the malignancy of SPN. Based on analysis of 82 SPNs confirmed histopathologically, authors concluded that a focal discontinuity of the capsule, large tumor size (>6.0 cm) and a pancreatic tail location might suggest malignancy of SPN whereas amorphous or scattered calcifications and all near-solid mass might be indicative of benignancy.

CT aids the differential diagnosis of pancreatic cysts for malignancy assessment. Pongpornsup et al. [63] analyzed accuracy of 64 slice multidetector computed tomography (MDCT) in delineation of malignancy. Authors indicated the type of cyst (unilocular, multilocular microcystic, multilocular macrocystic and solid component) as the only finding that had statistical significance for differentiating between the benign and malignant groups.

3.1.5. Magnetic resonance imaging (MRI) and magnetic resonance imaging with cholangiopancreatography (MRCP)

MRI plays an additional role in differential diagnosis of pancreatic cysts [28]. It is useful in differentiation of benign from malignant pancreatic cystic tumors and assessment of communication of cysts with the pancreatic duct [64]. According to some authors, MRI provides better resolution than CT for evaluating small pancreatic cysts less than 3 cm and delineation of ductal communication and cyst morphology [28]. Currently, MRCP as non-invasive imaging is considered as the investigation of choice for demonstrating the morphologic features of the pancreatic cyst (including septae and mural nodules). It can show the presence of communication between the cystic lesion and the pancreatic duct and can be used to evaluate the extent of pancreatic ductal dilatation in IPMNs [18]. Song et al. [65] compared MDCT and MRI in differentiation of IPMNs from other cystic lesions and concluded that MRI was significantly more accurate than MDCT. Endoscopic retrograde cholangiopancreatography, which is an invasive investigation, is now rarely required for diagnosis of IPMNs.

3.1.6. Endoscopic Retrograde Cholangiopancreatography (ERCP)

ERCP is an invasive investigation. Therefore, currently its role in pancreatic cysts imaging is limited when it is compared to non-invasive MRCP. The advantage of ERCP (that is superior to MRCP) is the therapeutic possibility, but in pancreatic cysts, surgery is the treatment of choice. It can delineate pancreatic duct system and communication of the pancreatic cyst with the pancreatic duct. It can be useful in diagnosis of IPMNs (demonstrating mucin at the ampulla and diffuse dilatation of the pancreatic ducts) [66]. ERCP can demonstrate so-called triad of Ohashi: bulging ampulla of Vater, mucin secretion and dilated pancreatic duct. This investigation can real-time visualization of increased mucin secretion within the papilla of Vater [28]. ERCP is also performed

in order to describe the pancreatic ductal system in pancreatic pseudocysts, because communication of the cyst with pancreatic ducts is contraindication for percutaneous cyst drainage [13,15].

3.2. Laboratory investigations

3.2.1. Pancreatic cyst fluid analysis

The cyst fluid analysis plays an important role in differential diagnosis of doubtful cases of pancreatic cysts. According to European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline (2011), EUS-FNA with determination of amylase and carcinoembryonic antigen (CEA) levels plus cytopathological examination of fluid aspirate is recommended for lesions >2 cm in diameter (Recommendation grade B). EUS-guided cyst wall brushing may be useful in well-selected cases (Recommendation grade D) [49]. Cyst fluid can be studied after aspiration in order to analyze cytology, viscosity, extracellular mucin, tumor markers (CEA, CA 19-9, CA 15-3, Ca 72-4, etc.), enzymes (amylase, lipase), as well as DNA analysis of DNA quality/content or mutational analysis to study allelic imbalance/LOH (loss of heterozygosity) and K-ras mutations [67]. Cyst fluid analysis is useful in differential diagnosis between mucinous and non-mucinous pancreatic cystic tumors [37]. It has been reported that an amylase concentration <250 U/L excluded the pancreatic pseudocyst and suggested serous cystadenoma, mucinous cystadenoma, or mucinous cystadenocarcinoma (sensitivity 44%, specificity 98%). A carcinoembryonic antigen (CEA) <5 ng/mL suggested a pseudocyst or serous cystadenoma (sensitivity 50%, specificity 95%) whereas CEA >800 ng/mL strongly suggested mucinous tumors (MCA or MCAC) (sensitivity 48%, specificity 98%). A carbohydrate-associated antigen (CA) 19-9 <37 U/mL strongly suggested pseudocyst or serous cystadenoma (sensitivity 19%, specificity 98%) [38]. According to Brugge et al. [42] analysis of CEA concentration in the cystic fluid is the best available test for differential diagnosis of mucinous from non-mucinous tumors and proposed optimal cutoff of 192 ng/mL. In this study, the accuracy of CEA (88 of 111,79%) was significantly greater than the accuracy of EUS morphology (57 of 112, 51%) or cytology (64 of 109, 59%). Sperti et al. [43] analyzed fluid aspiration for enzymes (amylase and lipase), tumor markers (CEA, CA 19-9, CA 125, CA 72-4) and cytology in 52 pancreatic cysts including pseudocysts and neoplasms. Authors reported that an amylase, lipase, CEA, and CA 19-9 concentrations were variable and did not discriminate pancreatic lesions. In this study, CA 125 fluid levels were high in 63% of malignant cysts. CA 72-4 fluid levels were significantly higher in mucinous cystic tumors than in pseudocysts showing 95% specificity in detecting mucinous or malignant cysts. Cytology showed a sensitivity of 61% and a specificity of 100%. A CA 72-4 determination raised the sensitivity of cytology to 92% in detecting mucinous or malignant cysts. Park et al. [52] validated the accuracy of CEA and amylase fluid concentration in differential diagnosis of mucinous from non-mucinous cystic lesions, benign from malignant mucinous tumors, and pseudocysts from non-pseudocysts. Authors noted significantly higher CEA levels in mucinous versus non-mucinous cysts, but CEA levels did not differentiate benign from malignant mucinous cysts. Amylase levels were significantly higher in pseudocysts than non-pseudocysts and malignant mucinous cysts had significantly lower amylase levels than benign mucinous tumors. Leung et al. [68] analyzed the accuracy of fluid viscosity, CEA and CA 19-9 levels in differential diagnosis of 79 pancreatic cysts. Authors noted a significantly lower median fluid CEA level 1.0 ng/mL in benign cysts compared to 471.1 ng/mL in potentially malignant cysts. Cyst fluid CA 19-9 was not statistically significant. Increased cyst fluid viscosity was significantly associated with potentially malignant cysts. Linder et al. [69] reported that elevated CEA ≥ 480 ng/mL) and viscosity (>1.6) accurately differed mucinous cystadenomas from serous cystadenomas and pseudocysts whereas CEA levels ≥6000 ng/mL differed mucinous cystadenocarcinomas from cystadenomas. It has been reported that CEA level alone was not useful in differentiating mucinous from non-mucinous pancreatic cysts. Sawhney et al. [70] noted that molecular diagnosis improved diagnostic sensitivity. In this study, combined CEA and molecular analysis increased sensitivity to 100%. In the PANDA study [71], the accuracy of cyst fluid DNA analysis was assessed. The study included 113 patients with benign, pre-malignant and malignant pancreatic cysts. Authors concluded that increased amounts of pancreatic cyst fluid DNA, high-amplitude mutations, and specific mutation acquisition sequences were indicators of malignancy. The presence of a k-ras mutation was also indicative of a mucinous cyst. In the authors' opinion, DNA analysis should be considered when cyst cytology is negative for malignancy. Tun et al. [36] analyzed the accuracy of the secreted epidermal growth factor receptor ligand, amphiregulin (AREG), as a cyst fluid biomarker for the presence of malignancy in pancreatic cysts. Authors concluded that cyst fluid AREG levels were significantly higher in cancerous and high-grade dysplastic cysts compared to benign mucinous cysts.

3.2.2. Cytology brushing

A number studies have documented an important role of EUS-guided cytology brushing (EUS BR) in differential diagnosis of pancreatic cysts. Sendino et al. [39] reported that the EUS BR was significantly superior to the aspirated fluid for detecting diagnostic cells (73% vs. 36%)

and mucinous cells (50% vs. 18%). In this study, EUS BR increased cellular diagnosis of pancreatic cyst compared to fluid analysis, and more so in mucinous lesions. Authors did not recommend this investigation in patients under anticoagulation therapy due to a risk of haemorrhage complications. Thomas et al. [40] compared EUS-guided aspiration alone versus EUS-guided aspiration and cyst wall brushing in differential diagnosis of pancreatic cysts. In this study, the cellular yield was similar in aspiration and brushing group. Authors noted greater, but not statistically significant, proportion of patients with malignant cystic pancreatic lesions diagnosed by EUS sampling in the brushing compared to aspiration group. Al-Haddad et al. [55] compared fine-needle aspiration and brushing cytology in differential diagnosis of pancreatic cysts and reported the significantly higher accuracy of brushing cytology compared to aspiration one in detecting of intracellular mucin that would be helpful in diagnosis of mucinous lesions.

4. Management in pancreatic cysts

Management depends on the pancreatic cyst type. Therefore, above mentioned diagnosis is very important.

4.1. Pancreatic pseudocysts

4.1.1. Choice of the management type in pancreatic pseudocysts

Decision regarding pseudocyst management (conservative treatment with observation or intervention) depends on the cyst persistence, size and etiology. Most (85%) post-inflammatory (especially due to an acute pancreatitis) pseudocysts have a tendency to spontaneous resorption within 4-6 weeks [2,71]. After this period, spontaneous resorption of the cyst is unlikely. Therefore, most authors recommend the treatment of pancreatic cysts with a diameter larger than 6 cm, and persisting more than 6 weeks following pancreatitis [2,4]. Yeo et al. [5] noted that 67% of the cysts with a diameter of more than 6 cm, and only 40% of the cysts with a diameter of less than 6 cm required surgical intervention. Cysts caused by acute pancreatitis are characterized by a much greater tendency to spontaneous resorption than cysts in chronic pancreatitis, which is related to the slow process of maturation of cyst wall caused by acute pancreatitis and the presence of a mature cyst wall due to chronic pancreatitis [73-76]. In chronic pancreatitis, less than 10% of the cysts are likely to spontaneous resorption. The factors that reduce spontaneous regression tendency of pancreatic pseudocysts include: duration >6 weeks, chronic pancreatitis, pancreatic duct anomaly and a thick cyst wall [2,77]. Lankish et al. [78] indicated the following factors for the spontaneous pseudocyst resolution: no or mild symptoms (nausea, vomiting, abdominal pain) and a maximal cyst diameter of <4 cm. In authors' opinion, patients with a first severe attack of acute pancreatitis and fluid collections at discharge should be checked by ultrasonography for pancreatic pseudocysts 3 months later. In patients with a small pseudocyst and mild symptoms, therapy may be postponed for a further 3 months, since spontaneous resolution is possible. Concluding, large and symptomatic pseudocysts require intervention. The following complications are indications for the pseudocyst treatment: large vessel compression causing ischemia or peristaltic disturbance, compression on surrounding organs such as a stomach and duodenum manifested with nausea and vomiting, bile duct obstruction caused cholestasis, infection or bleeding into the cyst lumen, pancreatic-pleural fistula. The following clinical symptoms: abdominal pain, nausea and vomiting, gastrointestinal bleeding are also indications for intervention. Relative indications for the pseudocyst treatment include: diameter more than 4 cm, regression lack or progression within 6 weeks, chronic pancreatitis, pancreatic duct anomaly or lithiasis, difficulties in differential diagnosis with neoplastic cysts [2,79].

4.1.2. The methods of intervention in pancreatic pseudocysts

There are many treatment methods of pancreatic pseudocysts. The management includes less invasive and surgical methods. Percutaneous and endoscopic (transpapillary or transmural) drainage is less invasive treatment whereas cystgastrostomy, cystduodenostomy and cystjejunostomy by open or laparoscopic approach are performed as the surgical treatment [80-84]. All types of the treatment in pancreatic pseudocysts are presented in Table 5.

Table 5. Types of the treatment in pancreatic pseudocysts

Pancreatic cyst drainage
External drainage
Internal drainage
Endoscopic
Transmural (via the stomach or duodenum)
Transpapillary
Surgical
Cystgastrostomy
Cystduodenostomy
Roux-Y Cystjejunostomy
Pancreatic cyst resection
Enucleation
Proximal pancreatectomy (Pancretoduodenectomy)
Central pancreatectomy (Middle segment resection)
Distal pancreatectomy

4.1.2.1. Percutaneous and endoscopic drainage of pancreatic pseudocysts

Percutaneous drainage is indicated for patients with proper pancreatic duct anatomy and without communication between pancreatic cyst and pancreatic duct system [13,15]. Endoscopic drainage may be performed under EUS and endoscopy guidance. Park et al. [56] compared endoscopic ultrasound (EUS)-guided transmural drainage versus conventional transmural drainage by endoscopy. Authors concluded that both EUS-guided and conventional methods could be considered first-line methods of endoscopic transmural drainage of bulging pseudocysts whereas EUS-guided assess should be preferred for non-bulging pseudocysts. In this study, the technical success rate was significantly higher in EUS-guided assessment whereas the complication rate was comparable in both groups. In Varadarajulu's et al. opinion [85], EUS should be considered as the first-line treatment modality for endoscopic drainage of pancreatic pseudocysts given its high technical success rate. In their study, comparing EUS and endoscopy guidance in pancreatic cyst transmural drainage, the clinical success and complications rates were comparable in both methods, but the technical success rate was significantly higher in the EUS-guided group. Endoscopic drainage may be performed as so-called single-step endo-ultrasonography (EUS)-guided and two-(multi)-step EUS-guided drainage technique. Mangiavillano et al. [86] compared these two techniques in pseudocyst drainage and noted that the single-step was superior to the two-step EUS-guided drainage technique for pseudocyst drainage. Heinzow et al. [87] compared the single-step versus multi-step endoscopic ultrasonography (EUS)-guided endoscopic transmural drainage in patients with symptomatic pancreatic pseudocysts of >4 cm size. Authors noted the comparable technical (94% vs. 83%) and clinical (88% vs. 90%) success rates in both groups. The mean procedure time was significantly longer in the multi-step access (36 ± 9 min) compared to single-step asses (62 ± 12 min). In authors' opinion, the single-step assess is effective and timesaving. Ahlawat et al. [53] estimated efficacy and safety of a one-step real time EUS-guided pancreatic pseudocyst transmural drainage approach using a larger 3.8 mm channel linear array echoendoscope and cystotome. Authors concluded that this approach appeared safe and effective in managing selected patients with symptomatic pancreatic pseudocysts.

4.1.2.2. Natural orifice translumenal endoscopic surgery (notes) in pancreatic pseudocysts

Pallapothu et al. [54] described the Natural Orifice Translumenal Endoscopic Surgery (NOTES(®)) stapled cystgastrostomy as the less invasive surgical treatment. In this study, the procedure included endoscopic ultrasound (EUS)-guided puncture of the stomach just below the gastroesophageal junction to gain access to the pseudocyst, guidewire placement, and dilatation with a balloon to 18-20 mm. Endoscopic necrosectomy and debridement were performed when possible, followed by transoral surgical anastomosis under endoscopic visualization with the SurgAssist™ SLC 55 (Power Medical Interventions, Langhorne, PA) 4.8-mm stapler. Authors noted that this technique was comparable with traditional surgical internal drainage of the pancreatic pseudocysts. Moreover, this approach is less invasive than laparoscopic or open cystgastrostomy and allows for complete recovery.

4.1.2.3. Surgical (laparoscopic and conventional) treatment of pancreatic pseudocysts

The laparoscopic assessment as an alternative less invasive approach for traditional surgery in pancreatic pseudocysts is a safe and effective treatment. According to the literature, it associated with a low postoperative complication rate and an effective permanent result. Compared to endoscopic internal drainage, some difficulties can be avoided, particularly bleeding [88]. In some cases, especially uncertain pancreatic cysts that are difficult to differentiate from pancreatic cystic neoplasms, traditional surgical treatment including internal drainage and resection is required [2]. Internal drainage (cystgastrostomy, cystduodenostomy or cystjejunostomy) is recommended for un-complicated pancreatic pseudocysts. Roux-Y cystjejunostomy is the most common surgical drainage. Pancreatic resection is required in chronic pancreatitis, multiple synchronic cysts, gastrointestinal bleeding due to spurious aneurysm, bile duct or duodenum compression, or technical impossibility of surgical drainage of the cyst within the uncinate process [2,74]. The pancreatic resection type (proximal, central, and distal pancreatectomies or enucelation) depends commonly on cyst location, size and presence of other pathology within the pancreas [2].

4.2. Management in serous cystic neoplasms

4.2.1. Management in serous cystadenoma and cystadenocarcinoma

Serous cystadenomas are characterized by a low malignant potential. The management depends commonly on clinical presentation, tumor size and patient's general condition such as the age and co-morbidities. According to Kashab et al. [89], large tumor size and head location predicted aggressive behavior, therefore these two factors should be considered in SCA management. Small and asymptomatic tumors in elderly patients with

co-morbidities (that make the preoperative risk higher) do not require surgery, but these patients should be carefully observed including a least TUS every 6 to 12 months. A serous cystadenocarcinoma is reported in 3% of serous cystadenomas. Therefore, in case of the conservative management careful observation should be performed. Surgery should be considered in low-risk patients with symptomatic tumors, with tumors at least 4 cm in maximum size, or in those with worse diagnosis of malignancy that cannot be excluded. Most patients undergo pancreatic resection for symptomatic or doubtful SCA when preoperative differential diagnosis is uncertain. New symptoms onset, clinical worsening or rapid tumor enlargement are also indications for surgery. According to the tumor location, different pancreatic resection types are performed: pancreatoduodenectomy (for SCAs located within the pancreatic head), central pancreatectomy (for SCAs located within the pancreatic isthmus or body), distal pancreatectomy (for SCAs located within the pancreatic body or tail). Simple cystic enucleation (for peripherally located SCAs), in order to preserve pancreatic parenchyma, has been described in the literature. Kiely et al. [90] compared enucleation and resection (proximal and distal pancreatectomy) results in 30 patients with mucinous cystic neoplasms (n=16), serous cystadenomas (n=10), and cystic islet cell tumors (n=4). Authors reported significantly shorter operative time in the enucleation group (199 vs. 298 minutes) and significantly reduced blood loss in the enucleation group (114 vs. 450 ml) compared to the resection group. Pancreatic fistula rates (27% vs. 26%) and length of hospital stay (12.6 vs. 15.7 days) were comparable in both groups. Generally, short-term results of the surgical treatment depend on the pancreatic resection type. Pancreatoduodenectomy is associated with the highest morbidity and mortality rates. Therefore, in doubtful tumors, decision is easier in case of distal pancreatic location (within pancreatic the body or tail) than in proximal location (within the pancreatic head). The follow-up is satisfactory and recurrence after surgery is not typical for SCAs [20,91-93].

4.2.2. Management in mucinous cystic neoplasms

4.2.2.1. Management in mucinous cystadenoma and cystadenocarcinoma

Mucinous cystadenomas have a higher malignant potential compared to serous cystadenomas. Therefore, patients with these tumors require surgery. Sometimes, differential diagnosis between a mucinous cystadenoma and pseudocyst is very difficult. In patients without pancreatitis in their medical history and other pancreatitis features within the pancreas, mucinous cystadenoma should be suspected and surgical cyst resection is required. Similarly to SCAs, pancreatic resection type depends on tumor location. So, the following pancreatic resections are performed: proximal, central, distal and total pancreatectomies. The tumor enucleation in small peripheral lesions located within the pancreatic uncinate process or head is possible [20]. Talamini et al. [94] compared cystic enucleation performed in 10 (28%) patients and pancreatic resection performed in other patients for MCAs. Authors concluded that enucleation had taken significantly less time and had been associated with less blood loss compared to resection. They reported a significantly higher rate of pancreatic fistula in enucleation group compared to resection group. However, the incidence of major complications and recurrence rate were comparable in both analyzed groups. Authors concluded that enucleation might be safe and effective alternative for patients with benign MCAs. MCAs are also mentioned and cited in Kiely's et al. study [90]. Similarly to the SCAs, short-term results of the surgical treatment depend on the pancreatic resection type. Long-term results in the MCAs treatment are good. The recurrence is very rare, but possible. In cases of cystadenocarcinomas, long-term results are worse compared to MCAs, but better compared to pancreatic adenocarcinomas [20].

4.2.2.2. Management in intraductal papillary mucinous neoplasms

According to the International Association of Pancreatology guidelines for the management of IPMNs, all suspected main-duct and combined IPMNs should be resected due to a high risk of malignancy. In asymptomatic patients, surgery is required if differential preoperative diagnosis between benign and malignant IPMNs is not possible [95]. So, decision regarding the IPMNs treatment depends commonly on IPMN type. The above recommendations are associated with different malignant potential depending on the IPMN type. According to the literature, carcinoma and invasive carcinoma forms are significantly less frequent in branch type IPMNs [24]. Therefore, patients with peripheral branch-types IPMNs without any malignant parameters should be candidates for a strict clinical and radiological "wait and see" follow-up. Only in such cases, surgery is not required. In the remaining patients, surgical resection is still the treatment of choice [96]. The main-duct IPMNs as the tumors with a high malignancy potential require surgical resection, whereas asymptomatic <3 cm in size and without radiologic features of malignancy (i.e. mural nodules) branch-duct IPMNs can be observed due to their lower malignant potential [93]. The type of pancreatic resection also depends on tumor location and involves: proximal pancreatectomy (pancreatoduode-

nectomy) (for IPMNs located in the head, uncinate procces or isthmus), central pancreatectomy (for IPMNs located in the pancreatic isthmus), distal pancreatectomy (for IPMNs located in the pancreatic body or tail) and total pancreatectomy (for IPMNs diffusely involving the pancreas or those involving the head and extending into the pancreatic body) with lymphadenectomy [23,96-98]. Total pancreatectomy is the treatment of choice in patients in good general condition with extensive involvement of IPMNs [99]. Enucleation can be also performed in some cases of IPMNs. Hwang et al. [97] compared efficacy of enucleation and pancreatoduodenectomy for small (<3 cm) branch-duct type IMPNs located within the pancreatic head and uncinate process. Authors reported that the mean operation time and blood loss were significantly lower in the enucleation group compared to the resection group. Authors concluded that enucleation is safe and effective alternative surgical procedure in branch duct type IPMNs of size <3 cm that required surgery. There were no significant differences in other surgical morbidities. Intra-operative decision regarding the extent of pancreatic resection is also an important problem in IPMNs. The negative resection margins are reported in 49-81% with a 0-25% pancreatic recurrence rate in follow-up of 6 months to 11 years after the first surgical procedure. Therefore, with the exception of the total pancreatectomy, intra-operative histopathological of resection margins is very important and influence on surgeon's decision regarding the resection extent [96]. The long-term treatment results as survival are comparable in all (branch-duct, main-duct, and combined) types and all histopathological stages (adenomas, borderline neoplasms, and carcinomas in situ) IPMNs [23] Patients following surgical resection of IPMNs require careful observation due to a recurrence risk. Sohn et al. [23] recommended MDCT or MRCP as imaging investigations of choice performed in 1-year intervals. Turrini et al. [26] analyzed efficacy of adjuvant therapy in invasive IPMNs patients with poorer prognosis. Authors did not report survival benefit. In the authors' opinion, re-resection should be considered in selected patients with recurrence of invasive IPMN in the remnant pancreas.

4.2.3. Management in solid pseudopapillary neoplasms

Solid pseudopapillary tumors have a low malignant potential and are characterized by only local aggressive. Surgery is the treatment of choice even in cases with distal metastases and local recurrence. Overall 5-years survival in patients undergoing surgical resection is 97%. The surgical resection type depends on tumor location and staging. The types of surgical resection are similar to the above mentioned tumors (pancreatoduodenectomy, central and distal pancreatectomies or local resection depending on tumor location). Partial liver resection is performed in tumors with hepatic metastases [27,100-102]. Laparoscopic resection of SPTs can be performed as the safe and effective procedure. Cavallini et al. [103] described the distal pancreatectomy by laparoscopic approach with good results. Authors recommended this surgical procedure especially for young patients with SPTs.

5. Conclusions

Pancreatic cysts involve a wide spectrum of lesions from post-inflammatory pseudocysts through benign cystadenomas to malignant cystadenocarcinomas. Pancreatic pseudocysts, serous cystadenomas, mucinous cystadenomas, intraductal papillary mucinous tumors and solid pseudopapillary tumors occur most frequently. Proper differential diagnosis of pancreatic cysts is very important because it allows for the appropriate treatment. Differential diagnosis should involve imaging investigations (TUS, CT, MRCP) that should be supplemented by the cyst fluid analysis. Imaging findings should be correlated with cyst fluid cytology. The management depends on the cyst type (pseudocyst or tumor) and neoplasm type (because tumors have different malignant potential) and size. General patient's condition, age, and co-morbidities also influence on decision regarding the management. Small asymptomatic pseudocysts (that can resolve), small asymptomatic serous cystadenomas and branch-duct IPMNs should be carefully observed, whereas symptomatic large or doubtful serous cystadenomas and cystadenocarcinomas, mucinous cystadenomas and cystadenocarcinomas, main-duct IPMNs and large branch-duct IPMNs with malignant features (mural nodules), and solid pseudopapillary tumors require surgery. Pseudocysts are usually drained. Complicated and uncertain pseudocysts and all cystic tumors require surgical resection. The type of surgery depends on cyst location and size and includes proximal, central, distal, total pancreatectomies and enucleation.

References

[1] Volkan Adsay N. Cystic lesions of the pancreas. Mod Pathol. 2007; 20 Suppl 1: S71-93

[2] Jabłońska B, Dudzicz B, Burkacka A, et al. Surgical treatment of pancreatic cysts - own experience. Progress in Medicine. 2011; 24, supl.1:5-10

[3] Bhosale P, Balachandran A, Tamm E. Imaging of benign and malignant cystic pancreatic lesions and a strategy for follow up. World J Radiol. 2010; 28;2(9):345-353

[4] Parks RW, Tzovaras G, Diamond T, et al. Management of pancreatic pseudocysts. Ann R Coll Surg Engl. 2000;82(6):383-387

[5] Yeo CL, Bastidas JA, Lunch-Nyhan A, et al. The natural history of pancreatic pseudocysts documented by computed tomography. Surg Gynecol Obstet 1990;170: 411-417

[6] Basturk O, Coban I, Adsay NV. Pancreatic cysts: pathologic classification, differential diagnosis, and clinical implications. Arch Pathol Lab Med. 2009;133(3):423-438

[7] Bradley EL 3rd. A clinically based classification system for acute pancreatitis. Arch Surg 1993; 128:586-590

[8] Banks PA, Bollen TL, Dervenis C, et al. Classification of acute pancreatitis--2012: revision of the Atlanta classification and definitions by international consensus. Gut. 2013 Jan;62(1):102-111

[9] Andrén-Sandberg A, Ansorge C, Eiriksson K, et al. Treatment of pancreatic pseudocysts. Scand J Surg. 2005;94(2):165-175

[10] Sarles H, Muratore R, Sarles JC. Etude anatomique des pancreatitis chroniques de l'adulte. Sem Hop 1961;25:1507-1522

[11] Sarles H, Martin M, Camatte R, Sarles JC. Le demembrement des pancreatities: Les pseudokystes des pancreatiles aiguesm et des pancreatites chroniques. Press Med 1963;5:237-240

[12] Andrén-Sandberg A, Dervenis C. Pancreatic pseudocysts in the 21st century. Part I: classification, pathophysiology, anatomic considerations and treatment. JOP. 2004;5(1):8-24

[13] Zhang AB, Zheng SS. Treatment of pancreatic pseudocysts in line with D'Egidio's classification. World J Gastroenterol. 2005;11(5):729-732

[14] D'Egidio A, Schein M. Pancreatic pseudocysts: a proposed classification and its management implications. Br J Surg. 1991;78(8):981-984

[15] Nealon WH, Walser E. Main pancreatic ductal anatomy can direct choice of modality for treating pancreatic pseudocysts (surgery versus percutaneous drainage). Ann Surg. 2002;235(6):751-758

[16] Safioleas MC, Moulakakis KG, Manti C, et al. Clinical considerations of primary hydatid disease of the pancreas. Pancreatology. 2005;5:457-461

[17] Spence RA, Dasari B, Love M, et al. Overview of the investigation and management of cystic neoplasms of the pancreas. Dig Surg. 2011;28(5-6):386-397

[18] Lahat G, Lubezky N, Haim MB, et al. Cystic tumors of the pancreas: high malignant potential. Isr Med Assoc J. 2011;13(5):284-289

[19] Acar M, Tatli S. Cystic tumors of the pancreas: a radiological perspective. Diagn Interv Radiol. 2011;17(2):143-149

[20] Le Borgne J, de Calan L, Partensky C. Cystadenomas and cystadenocarcinomas of the pancreas: a multiinstitutional retrospective study of 398 cases. French Surgical Association. Ann Surg. 1999;230(2):152-61

[21] Visser BC, Muthusamay VR, Mulvihill SJ, et al. Diagnostic imaging of cystic pancreatic neoplasms. Surg Oncol 2004; 13: 27-39

[22] Carpizo DR, Allen PJ, Brennan MF. Current management of cystic neoplasms of the pancreas. Surgeon 2008; 6: 298-307

[23] Sohn TA, Yeo CJ, Cameron JL, et al. Intraductal papillary mucinous neoplasms of the pancreas: an updated experience. Ann Surg. 2004;239(6):788-797

[24] Bernard P, Scoazec JY, Joubert M, et al. Intraductal papillary-mucinous tumors of the pancreas: predictive criteria of malignancy according to pathological examination of 53 cases. Arch Surg. 2002;137(11):1274-1278

[25] Hwang DW, Jang JY, Lim CS, et al. Determination of malignant and invasive predictors in branch duct type intraductal papillary mucinous neoplasms of the pancreas: a suggested scoring formula. J Korean Med Sci. 2011;26(6):740-746

[26] Turrini O, Waters JA, Schnelldorfer T, et al. Invasive intraductal papillary mucinous neoplasm: predictors of survival and role of adjuvant therapy. HPB (Oxford). 2010;12(7):447-455

[27] Guo N, Zhou QB, Chen RF, et al. Diagnosis and surgical treatment of solid pseudopapillary neoplasm of the pancreas: analysis of 24 cases. Can J Surg. 2011;54(6):368-374

[28] Sahani DV, Kadavigere R, Saokar A, et al. Cystic pancreatic lesions: a simple imaging-based classification system for guiding management. Radiographics. 2005;25(6):1471-1484

[29] Charlesworth M, Verbeke CS, Falk GA, et al. Pancreatic Lesions in von Hippel-Lindau Disease?

A Systematic Review and Meta-synthesis of the Literature. J Gastrointest Surg. 2012;16(7):1422-1428
[30] Gaujoux S, Brennan MF, Gonen M, et al. Cystic lesions of the pancreas: changes in the presentation and management of 1,424 patients at a single institution over a 15-year time period. J Am Coll Surg. 2011;212(4):590-600
[31] Sewkani A, Purohit D, Singh V, et al. Lymphoepithelial cyst of the pancreas: a rare case report and review of literature. Indian J Surg. 2010;72(6):427-432
[32] Venkatesh PG, Navaneethan U, Vege SS. Intraductal papillary mucinous neoplasm and acute pancreatitis. J Clin Gastroenterol. 2011;45(9):755-758
[33] Arlix A, Bournet B, Otal P, et al. Long-term clinical and imaging follow-up of nonoperated branch duct form of intraductal papillary mucinous neoplasms of the pancreas. Pancreas. 2012;41(2):295-301
[34] Asari S, Matsumoto I, Toyama H, et al. Repeating regional acute pancreatitis in the head of the pancreas caused by intraductal papillary mucinous neoplasms in the tail: report of a case. Surg Today. 2012;42(4):398-402
[35] Paramhans D, Shukla S, Mathur RK, et al. Large mucinous adenoma of pancreas presenting with recurrent pancreatitis. Turk J Gastroenterol. 2011;22(1):98-100
[36] Tun MT, Pai RK, Kwok S, et al. Diagnostic accuracy of cyst fluid amphiregulin in pancreatic cysts. BMC Gastroenterol. 2012 14;12(1):15
[37] Thosani N, Thosani S, Qiao W, et al. Role of EUS-FNA-based cytology in the diagnosis of mucinous pancreatic cystic lesions: a systematic review and meta-analysis. Dig Dis Sci. 2010;55(10):2756-2766
[38] van der Waaij LA, van Dullemen HM, Porte RJ. Cyst fluid analysis in the differential diagnosis of pancreatic cystic lesions: a pooled analysis. Gastrointest Endosc. 2005;62(3):383-389
[39] Sendino O, Fernández-Esparrach G, Solé M, et al. Endoscopic ultrasonography-guided brushing increases cellular diagnosis of pancreatic cysts: A prospective study. Dig Liver Dis. 2010;42(12):877-881
[40] Thomas T, Bebb J, Mannath J, Ragunath K, et al. EUS-guided pancreatic cyst brushing: a comparative study in a tertiary referral centre. JOP. 2010;11(2):163-169
[41] Lee LS, Saltzman JR, Bounds BC, et al. EUS-guided fine needle aspiration of pancreatic cysts: a retrospective analysis of complications and their predictors. Clin Gastroenterol Hepatol. 2005;3(3):231-236
[42] Brugge WR, Lewandrowski K, Lee-Lewandrowski E, et al. Diagnosis of pancreatic cystic neoplasms: a report of the cooperative pancreatic cyst study. Gastroenterology. 2004;126(5):1330-1336
[43] Maurea S, Fusari M, Imbriaco M, et al. Pitfalls in diagnostic imaging of cystic pancreatic masses: a case of true cystic lesion mimicking a mucinous cystadenoma. JOP. 2012 10;13(1):83-86
[44] Sperti C, Pasquali C, Guolo P, et al. Evaluation of cyst fluid analysis in the diagnosis of pancreatic cysts. Ital J Gastroenterol. 1995;27(9):479-483
[45] Beyer-Enke SA, Hocke M, Ignee A, et al. Contrast enhanced transabdominal ultrasound in the characterisation of pancreatic lesions with cystic appearance. JOP. 2010;11(5):427-433
[46] Xu M, Xie XY, Liu GJ, et al. The application value of contrast-enhanced ultrasound in the differential diagnosis of pancreatic solid-cystic lesions. Eur J Radiol. 2012 Jul;81(7):1432-1437
[47] Volmar KE, Vollmer RT, Jowell PS, et al. Pancreatic FNA in 1000 cases: a comparison of imaging modalities. Gastrointest Endosc. 2005;61(7):854-861
[48] Ahmad NA, Kochman ML, Lewis JD, et al. Can EUS alone differentiate between malignant and benign cystic lesions of the pancreas? J Gastroenterol. 2001;96(12):3295-3300
[49] Dumonceau JM, Polkowski M, Larghi A, et al. Indications, results, and clinical impact of endoscopic ultrasound (EUS)-guided sampling in gastroenterology: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. Endoscopy. 2011;43(10):897-912
[50] Sahai AV, Chua TS, Paquin S, et al. Analysis of variables associated with surgery versus observation in patients with pancreatic cystic lesions referred for endoscopic ultrasound. Endoscopy. 2011;43(7):591-595
[51] Hong SK, Loren DE, Rogart JN, et al. Targeted cyst wall puncture and aspiration during EUS-FNA increases the diagnostic yield of premalignant and malignant pancreatic cysts. Gastrointest Endosc. 2012;75(4):775-782
[52] Park WG, Mascarenhas R, Palaez-Luna M, et al. Diagnostic performance of cyst fluid carcinoembryonic antigen and amylase in histologically confirmed pancreatic cysts. Pancreas. 2011;40(1):42-45
[53] Ahlawat SK, Charabaty-Pishvaian A, et al. Single-step EUS-guided pancreatic pseudocyst drainage using a large channel linear array echoendoscope and cystotome: results in 11 patients. JOP. 2006;7(6):616-624
[54] Pallapothu R, Earle DB, Desilets DJ, et al. NOTES(®) stapled cystgastrostomy: a novel ap-

proach for surgical management of pancreatic pseudocysts. Surg Endosc. 2011;25(3):883-889
[55] Al-Haddad M, Gill KR, Raimondo M, et al. Safety and efficacy of cytology brushings versus standard fine-needle aspiration in evaluating cystic pancreatic lesions: a controlled study. Endoscopy. 2010;42(2):127-132
[56] Park DH, Lee SS, Moon SH, et al. Endoscopic ultrasound-guided versus conventional transmural drainage for pancreatic pseudocysts: a prospective randomized trial. Endoscopy. 2009;41(10):842-848
[57] Melman L, Azar R, Beddow K, et al. Primary and overall success rates for clinical outcomes after laparoscopic, endoscopic, and open pancreatic cystgastrostomy for pancreatic pseudocysts. Surg Endosc. 2009;23(2):267-271
[58] Oida T, Mimatsu K, Kawasaki A, et al. Long-term outcome of laparoscopic cystgastrostomy performed using a posterior approach with a stapling device. Dig Surg. 2009;26(2):110-114
[59] Vignesh S, Brugge WR. Endoscopic diagnosis and treatment of pancreatic cysts. J Clin Gastroenterol. 2008;42(5):493-506
[60] Yasuda I, Iwata K, Mukai T, et al. EUS-guided pancreatic pseudocyst drainage. Dig Endosc. 2009;21 Suppl 1:S82-86
[61] Galasso D, Voermans RP, Fockens P. Role of endosonography in drainage of fluid collections and other NOTES procedures. Best Pract Res Clin Gastroenterol. 2009;23(5):781-789
[62] Yin Q, Wang M, Wang C, et al. Differentiation between benign and malignant solid pseudopapillary tumor of the pancreas by MDCT. Eur J Radiol. 2012;81(11):3010-3018
[63] Pongpornsup S, Piyapittayanan S, Charoensak A. MDCT imaging findings for characterization pancreatic cystic lesion: differentiation between benign and malignant pattern. J Med Assoc Thai. 2011;94(3):369-378
[64] Kim JH, Eun HW, Park HJ, et al. Diagnostic performance of MRI and EUS in the differentiation of benign from malignant pancreatic cyst and cyst communication with the main duct. Eur J Radiol. 2012;81(11):2927-2935
[65] Song SJ, Lee JM, Kim YJ, et al. Differentiation of intraductal papillary mucinous neoplasms from other pancreatic cystic masses: comparison of multirow-detector CT and MR imaging using ROC analysis. J Magn Reson Imaging. 2007;26(1):86-93
[66] Truant S, Izgarevic D, Maunoury V, et al. Pancreatic serous cystadenoma with compression of the main pancreatic duct: an unusual entity. HPB Surg. 2011;2011:574378
[67] Bhutani MS, Gupta V, Guha S, et al. Pancreatic cyst fluid analysis--a review. J Gastrointestin Liver Dis. 2011;20(2):175-180
[68] Leung KK, Ross WA, Evans D, et al. Pancreatic cystic neoplasm: the role of cyst morphology, cyst fluid analysis, and expectant management. Ann Surg Oncol. 2009;16(10):2818-2824
[69] Linder JD, Geenen JE, Catalano MF. Cyst fluid analysis obtained by EUS-guided FNA in the evaluation of discrete cystic neoplasms of the pancreas: a prospective single-center experience. Gastrointest Endosc. 2006;64(5):697-702
[70] Sawhney MS, Devarajan S, O'Farrel P, et al. Comparison of carcinoembryonic antigen and molecular analysis in pancreatic cyst fluid. Gastrointest Endosc. 2009;69(6):1106-1110
[71] Khalid A, Zahid M, Finkelstein SD, et al. Pancreatic cyst fluid DNA analysis in evaluating pancreatic cysts: a report of the PANDA study. Gastrointest Endosc. 2009;69(6):1095-1102
[72] Aljarabah M, Ammori BJ. Laparoscopic and endoscopic approaches for drainage of pancreatic pseudocysts: a systematic review of published series. Surg Endosc 2007; 21:1936-1944
[73] Aghdassi A, Mayerle J, Kraft M, et al. Diagnosis and treatment of pancreatic pseudocysts in chronic pancreatitis. Pancreas. 2008;36(2):105-112
[74] Aghdassi AA, Mayerle J, Kraft M, et al. Pancreatic pseudocysts-when and how to treat? HPB (Oxford). 2006;8(6):432-441
[75] Crass RA, Way LW. Acute and chronic pancreatic pseudocysts are different. Am J Surg. 1981;142:660Y663
[76] Rosso E, Alexakis N, Ghaneh P, et al. Pancreatic pseudocyst in chronic pancreatitis: endoscopic and surgical treatment. Dig Surg. 2003;20:397Y406
[77] Warshaw AL, Rattner DW. Timing of surgical drainage for pancreatic pseudocyst. Clinical and chemical criteria. Ann Surg. 1985;202:720Y724
[78] Lerch MM, Stier A, Wahnschaffe U, Mayerle J. Pancreatic pseudocysts: observation, endoscopic drainage, or resection? Dtsch Arztebl Int. 2009;106(38):614-621
[79] Lankisch PG, Weber-Dany B, Maisonneuve P, et al. Pancreatic pseudocysts: Prognostic factors for their development and their spontaneous resolution in the setting of acute pancreatitis. Pancreatology. 2012;12(2):85-90
[80] Sharma SS, Bhargawa N, Govil A. Endoscopic management of pancreatic pseudocyst: a long-term follow-up. Endoscopy. 2002;34(3):203-207
[81] Oida T, Mimatsu K, Kano H, et al. Laparoscopic cystogastrostomy via the posterior approach for pancre-

atic pseudocyst drainage. Hepatogastroenterology. 2011;58(110-111):1771-1775
[82] Dávila-Cervantes A, Gómez F, Chan C, et al. Laparoscopic drainage of pancreatic pseudocysts. Surg Endosc. 2004;18(10):1420-1426
[83] Mathew A, Gaffney RR, Moyer MT. EUS-guided double cystgastrostomy of two infected pseudocysts in series: a novel case of endoscopic cystocystgastrostomy. Gastrointest Endosc. 2012;75(1):227
[84] Moyer MT, Gaffney RR, Mathew A. EUS-guided double cystgastrostomy of 2 infected pseudocysts in series: a novel case of endoscopic cystocystgastrostomy. Gastrointest Endosc. 2011;73(2):395-397
[85] Varadarajulu S, Christein JD, Tamhane A, et al. Prospective randomized trial comparing EUS and EGD for transmural drainage of pancreatic pseudocysts (with videos). Gastrointest Endosc. 2008;68(6):1102-1111
[86] Mangiavillano B, Arcidiacono PG, Masci E, et al. Single-step versus two-step endo-ultrasonography-guided drainage of pancreatic pseudocyst. J Dig Dis. 2012;13(1):47-53
[87] Heinzow HS, Meister T, Pfromm B, et al. Single-step versus multi-step transmural drainage of pancreatic pseudocysts: the use of cystostome is effective and timesaving. Scand J Gastroenterol. 2011;46(7-8):1004-1013
[88] Hauters P, Weerts J, Navez B, et al. Laparoscopic treatment of pancreatic pseudocysts. Surg Endosc. 2004;18(11):1645-1648
[89] Khashab MA, Shin EJ, Amateau S, et al. Tumor size and location correlate with behavior of pancreatic serous cystic neoplasms. Am J Gastroenterol. 2011;106(8):1521-1526
[90] Kiely JM, Nakeeb A, Komorowski RA, et al. Cystic pancreatic neoplasms: enucleate or resect? J Gastrointest Surg. 2003;7(7):890-897
[91] Tseng JF. Management of serous cystadenoma of the pancreas. J Gastrointest Surg. 2008;12(3):408-410 [PMID:17963014 doi:10.1007/s11605-007-0360-3]
[92] Bramis K, Petrou A, Papalambros A, et al. Serous cystadenocarcinoma of the pancreas: report of a case and management reflections. World J Surg Oncol. 2012;10:51
[93] Salvia R, Crippa S, Partelli S, et al. Pancreatic cystic tumours: when to resect, when to observe. Eur Rev Med Pharmacol Sci. 2010;14(4):395-406
[94] Talamini MA, Moesinger R, Yeo CJ, et al. Cystadenomas of the pancreas: is enucleation an adequate operation? Ann Surg. 1998;227(6):896-903
[95] Tanaka M, Chari S, Adsay V, et al. International consensus guidelines for management of intraductal papillary mucinous neoplasms and mucinous cystic neoplasms of the pancreas. Pancreatology. 2006;6(1-2):17-32
[96] Salvia R, Bassi C, Falconi M, et al. Intraductal papillary mucinous tumors of the pancreas. Surgical treatment: at what point should we stop? JOP. 2005;6(1 Suppl):112-117
[97] Hwang HK, Park JS, Kim JK, et al. Comparison of efficacy of enucleation and pancreaticoduodenectomy for small (<3 cm) branch duct type intraductal papillary mucinous neoplasm located at the head of pancreas and the uncinate process. Yonsei Med J. 2012;53(1):106-110
[98] Doi R, Fujimoto K, Wada M, Imamura M. Surgical management of intraductal papillary mucinous tumor of the pancreas. Surgery. 2002;132(1):80-85
[99] Yamaguchi K, Konomi H, Kobayashi K, et al. Total pancreatectomy for intraductal papillary-mucinous tumor of the pancreas: reappraisal of total pancreatectomy. Hepatogastroenterology. 2005;52(65):1585-1590
[100] Yu P, Cheng X, Guo J, et al. Solid pseudopapillary tumor of the pancreas: clinical analysis of 11 cases. Hepatogastroenterology. 2011;58(105):192-197
[101] Li Z, Zhang Z, Liu X, et al. Solid pseudopapillary tumor of the pancreas: the surgical procedures. Surg Today. 2011;41(1):91-96
[102] Igbinosa O. Pseudopapillary tumor of the pancreas. An algorithmic approach. JOP. 2011;12(3):262-265
[103] Cavallini A, Butturini G, Daskalaki D, et al. Laparoscopic pancreatectomy for solid pseudopapillary tumors of the pancreas is a suitable technique; our experience with long-term follow-up and review of the literature. Ann Surg Oncol. 2011;18(2):352-357