# Non-mucinous Cystic Lesions of the Pancreas

# 11

Kishore G. S. Bharathy and Sadiq S. Sikora

## 11.1 Introduction

Non-mucinous cystic lesions of the pancreas are a heterogeneous group comprising both benign lesions and neoplasia with variable malignant potential. These include pseudocyst, serous cystadenoma (SCA), solid pseudopapillary tumour (SPT), cystic pancreatic endocrine neoplasm (CPEN) and other rare lesions.

Few topics in medicine are as controversial as the evaluation and management of patients with cystic neoplasia of the pancreas [1]. In the late 1970s, Compagno and Oertel [2, 3] described serous and mucinous tumours as separate entities. With advances in multi-detector computed tomography (MDCT) and image acquisition protocols using magnetic resonance imaging (MRI), these lesions are being better characterized. Endoscopic ultrasound (EUS) with fine needle aspiration cytology (FNAC) provides further opportunity to characterize these tumours. Molecular markers may further clarify diagnostic dilemmas and help in selecting an appropriate treatment strategy for the individual patient. Specialists encountering these lesions should be able to make a diagnosis as well as be aware of the natural history so as to assign patients to appropriate management strategies such as reassurance, periodic follow-up or surgery. As compared to pancreatic adenocarcinoma, cystic tumours have a favourable prognosis [4].

K. G. S. Bharathy · S. S. Sikora (✉)
Surgical Services, Sakra Institute of Digestive and HPB Sciences, Sakra World Hospital, Bangalore, India



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## 11.2 Epidemiology

Cystic pancreatic lesions (CPLs) are detected incidentally in many instances, during abdominal CT or MRI performed for other indications [5]. This has led to smaller, asymptomatic tumours being identified, especially in an elderly population. There has been a 20-fold increase in the detection of CPLs over the last 15 years [6]. In imaging performed for unrelated reasons, 2% of the patients were found to have an incidental cystic lesion [7].

A single institution retrospective review of 24,000 CT scans performed over 7 years identified CPLs in 1% of patients [7]. Recently, the prevalence of CPLs has been estimated to increase to 3% using CT [8] and up to 20% using MRI [9]. One study reported prevalence of incidental CPLs on MRI to be around 13.5% and showed that the prevalence and cyst size also increased with age [10]. These findings have been corroborated at autopsy with the prevalence of cystic lesions approaching 25% [11].

## 11.3 Classification

The WHO classification (2000) describes four major types: SCA, mucinous cystic neoplasm (MCN), intraductal papillary mucinous neoplasm (IPMN) and SPT [12]. Cystic tumours of the pancreas are defined as a uni- or multilocular cavity-forming neoplasm or non-neoplastic tumours. For the sake of simplicity, CPLs can be classified as either pseudocysts or tumours. Table 11.1 provides a classification system based on the cell of origin.

## 11.4 Pancreatic Pseudocyst

A pseudocyst is defined as per the revised Atlanta guidelines as an organized acute peripancreatic fluid collection without any internal debris, which has persisted beyond 4 weeks or more from the onset of the attack of acute pancreatitis [13].

**Table 11.1** Classification of non-mucinous cystic neoplasms of the pancreas according to the cell of origin

| Cell of origin | Example |
|---|---|
| Epithelial | SCA, cystic degeneration of adenocarcinoma, lymphoepithelial cyst |
| Exocrine | Acinar cell carcinoma |
| Unknown/mixed origin | SPT, giant cell tumour, pancreatoblastoma, cystic teratoma |
| Endocrine | CPEN |
| Mesenchymal | Sarcoma, lymphoma, lymphangioma |
| Metastatic | Renal cell carcinoma, lung carcinoma, ovarian carcinoma, melanoma |

*SCA* serous cystadenoma, *SPT* solid pseudopapillary tumour, *CPEN* cystic pancreatic endocrine tumour

Presence of internal debris within a pseudocyst qualifies it to be designated as a walled off pancreatic necrosis (WOPN).

A pseudocyst occurs typically in the setting of acute pancreatitis. The incidence of development of a pseudocyst in acute pancreatitis ranges from 6% to 18.5% [14, 15]. The aetiology of pancreatitis and consequent development of pseudocyst depend upon the age of the patient. In children, the most common cause is trauma, whereas in adults the spectrum of causes is biliary (42%), alcohol induced (23%), post-endoscopic retrograde cholangiopancreatography (9.5%), medications (6.3%) and idiopathic (12%) [16]. About 5–10% of patients with chronic pancreatitis develop pseudocyst [17], which are secondary to episodes of acute pancreatitis or are retention cysts. Sometimes the history of pancreatitis is not forthcoming and in such a setting the possibility of a CPL, cystic lesion from the adrenal, spleen or a retroperitoneal cyst should be considered.

The most accepted classification of pancreatic pseudocyst is that proposed by D'Egidio and Schein [18] which classifies cyst based on underlying pancreatic pathology, pancreatic duct anatomy and communication between the pancreatic duct and cyst. *Type I* cysts are those developing in a setting of acute pancreatitis with a normal pancreatic duct anatomy without any duct communication. These cysts are amenable to either percutaneous or endoscopic drainage with good results. *Type II* cysts are those with abnormal pancreatic duct anatomy in the setting of acute or chronic pancreatitis but without any duct communication. *Type III* cysts are those with underlying chronic pancreatitis with ductal stricture and communication with the pancreatic duct. Patients with Type III cysts most often merit a surgical drainage or a complex endoscopic intervention.

### 11.4.1 Diagnosis and Imaging

Abdominal CT scanning is the investigation of choice in patients with history of pancreatitis and suspected to have a pseudocyst (Figs. 11.1 and 11.2a). A peripancreatic round or ovoid fluid collection with a thick wall that enhances on contrast administration is pathognomonic of a pseudocyst, especially in a patient with a history of acute or chronic pancreatitis. Additional features of acute pancreatitis in the form of peripancreatic stranding and oedema may be present, or there may be features of chronic pancreatitis with calcification and pancreatic duct dilatation. Abdominal CT scan has a high sensitivity of 90–100% for diagnosis of pancreatic pseudocyst [19]. MRI and magnetic resonance cholangiopancreatography (MRCP) are also sensitive imaging modalities which may provide additional information. MRI provides a better distinction between the fluid and solid components helping to distinguish a pseudocyst from a WOPN. Moreover, MRCP helps delineate pancreatic ductal pathology such as dilatation, irregularity and/or stricture. MRCP may also demonstrate the communication of the pancreatic duct with the pseudocyst and also the point of disruption of pancreatic duct in patients with pancreatic ascites or pancreaticopleural fistula. On MRI/MRCP, pseudocysts may communicate with the pancreatic duct in about 65% of the

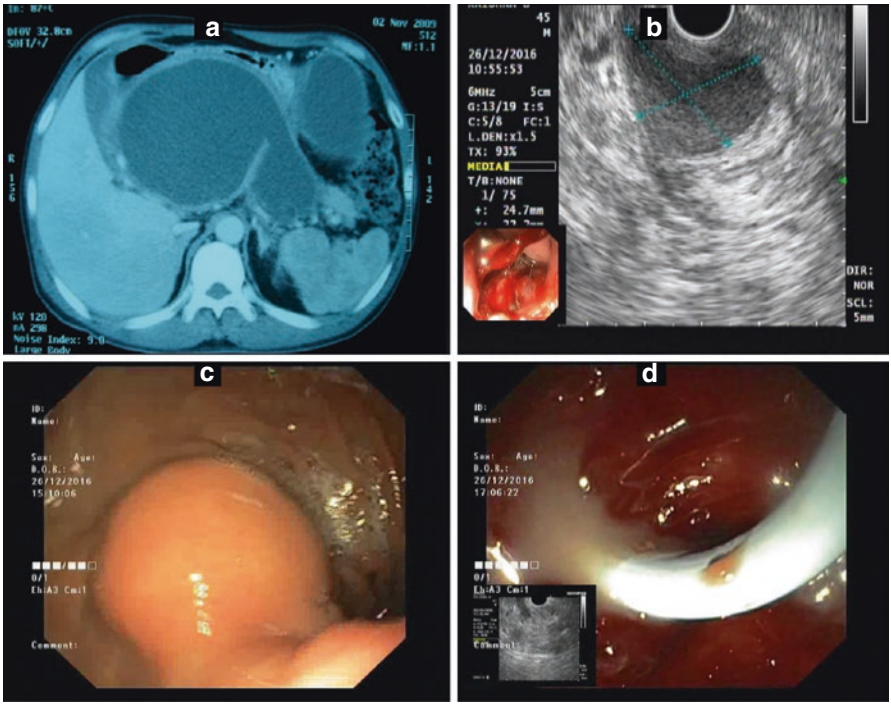


**Fig. 11.1** (**a**) Multi-detector computed tomography scan image depicting a large unilocular cystic lesion replacing the pancreas and abutting the stomach. (**b**) EUS image of a pseudocyst with impression along the gastric body proximally. (**c**) Endoscopic view which shows the bulge on the posterior wall of stomach, and (**d**) endoscopic view showing EUS-guided endoscopic puncture and drainage

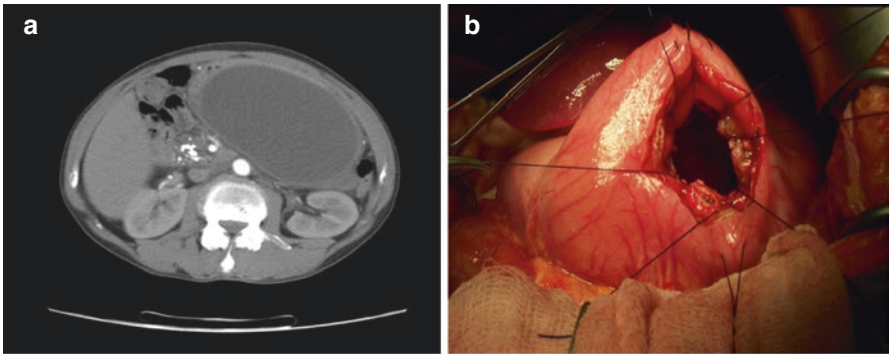


**Fig. 11.2** (**a**) Multi-detector computed tomography scan image depicting a chronic pseudocyst. Calcification is seen in the head of the pancreas. (**b**) Operative picture of a wide surgical cystogastrostomy

cases [20]. The limitation of cross-sectional imaging modalities are their inability to definitively differentiate between pseudocyst and cystic tumours of the pancreas. On serial scans, decrease in the size of the lesion may suggest a pseudocyst as cystic tumours are unlikely to regress. It is important to differentiate pseudocysts from IPMNs which can also present with a history of pancreatitis with an associated pancreatic ductal dilatation. In the absence of prior imaging, identification of a cyst in a patient with pancreatitis should lead one to suspect that it may be a case of a cystic tumour causing pancreatitis. Serial imaging where available may suggest the natural history of the disease and differentiate a pseudocyst from a cystic tumour [21].

### 11.4.2 Natural History of a Pseudocyst

Pseudocysts following an episode of pancreatitis may remain asymptomatic, resolve spontaneously or become symptomatic with or without complications. Size and duration of the pseudocyst are important considerations in the natural history of pancreatic pseudocyst. Cysts <4 cm usually resolve spontaneously without complications. Traditionally, cysts larger than 6 cm and persisting beyond 6 weeks were considered as indications for surgical intervention. Studies charting the natural history of pancreatic pseudocysts have now challenged this traditional approach; 60% of pseudocysts followed over a period of 1 year showed complete resolution. The majority of the pseudocysts could be managed with expectant treatment, and only 10% developed complications with the need for operative intervention [22]. Cysts larger than 6 cm were more likely to develop complications and necessitate surgical intervention, although nonoperative management and follow-up did show resolution in this group of patients [22].

Factors associated with decreased likelihood of spontaneous resolution of pseudocyst lesions [23] are:

1. Number: multiple cysts
2. Location: tail of the pancreas
3. Thick wall (>1 cm)
4. Communication with main pancreatic duct associated with proximal stricture of the duct
5. Increase size on follow-up examination
6. Aetiology: biliary or postoperative
7. Extrapancreatic development in alcoholic chronic pancreatitis
8. Associated with severe acute pancreatitis
9. Extent of pancreatic necrosis >25%

### 11.4.3 Indications of Treatment in Pseudocysts

Large pseudocysts causing abdominal pain, vomiting and compression symptoms leading to duodenal obstruction are definite indications for intervention. Patients with jaundice due to compression or stenosis of the bile duct and splenic vein

thrombosis with portal hypertension also merit intervention and treatment. Other complications such as secondary infection of the pseudocyst, intracystic bleed due to a pseudoaneurysm and pancreaticopleural fistula are also indications for treatment.

The treatment options include percutaneous catheter drainage, endoscopic intervention or surgical treatment either by laparoscopy or open surgery. Percutaneous drainage of pseudocysts is least invasive and can be used as a temporizing measure in an infirm patient, in the presence of infection or in symptomatic expanding immature cysts [23, 24]. However it has a high failure rate (16%), high recurrence rate (24%) and a complication rate of 18% [25]. Percutaneous drainage of pseudocysts relieves symptomatic gastric outlet obstruction [26]. This comes at the cost of a controlled external pancreatic fistula in 25% of patients, one third of whom may require surgery for definitive management [26]. It is also a useful option in children with successful resolution in 72% [27]. Success of percutaneous drainage is not dependent on size or complexity of the pseudocyst [27].

The aim of endoscopic intervention is to drain the pseudocyst into the stomach or duodenum, depending on the location of the cyst, size of the cyst and proximity/bulge into the gastrointestinal tract. The prerequisites for endoscopic drainage are a distance less than 1 cm between the pseudocyst and the gastric or duodenal wall [28], size of the pseudocyst preferably more than 5 cm and presenting as an indentation on the visceral wall [23, 29]. A mature cyst, with absence of communication with the pancreatic duct, will ensure high success rates [29]. In patients with a pancreatic duct communication, transpapillary drainage is preferred. A cystic tumour and pseudoaneurysm should be excluded before embarking on endoscopic drainage [28]. In a review of endoscopic drainage of uncomplicated pseudocysts, the technical success ranged from 71% to 100%, clinical success of 62–100%, recurrence rate of 4.8–31% and complication rates of 3–37% [30]. The use of EUS improves the technical success rate and decreases the complications (Fig. 11.1b–d). Of all pseudocysts, only 35–40% are ideally suited for endoscopic drainage; 60% have communication with pancreatic duct and 39% have necrotic debris in the cyst; both of these factors may decrease the success of endoscopic drainage. The complications of intervention include infection in 0–15%, bleeding in 0–9%, stent displacement in 4–6% and rarely retroperitoneal perforation; 10–50% of patients may require surgery for failure or complications of endoscopic drainage [31, 32]. In a randomized trial of endoscopic drainage versus surgical drainage [33], of the 110 patients, only 40 (36%) fulfilled the inclusion criteria. The inclusion criteria consisted of a diagnosis of pancreatic pseudocyst on CT, pseudocyst measuring 6 cm in size and located adjacent to the stomach, documented history of acute or chronic pancreatitis, persistent pancreatic pain requiring narcotics or analgesics and symptomatic gastric outlet or bile duct obstruction induced by the pseudocyst. Presence of necrosis on CT, cyst not adjacent to the stomach, multiloculated cyst/multiple cysts, portal hypertension and pregnancy were some of the exclusion criteria. Twenty each were randomized to the endoscopy and surgical arms. There was no difference in the technical success, treatment failure and recurrence rates in the two arms. The hospital stay and cost were higher in the surgical arm [33]. It is clear that in selected patients, endoscopic drainage has equivalent results to surgery in the hands of skilled endoscopists especially with aid of EUS.

Surgical treatment is certainly more versatile, applicable to a much wider spectrum of patients. It provides a wide, durable, long-term drainage. The choice of surgical procedure depends on the location of the cyst (head, body or tail). The cyst can be drained into the stomach (cystogastrostomy), duodenum (cystoduodenostomy) or in the jejunum (cystojejunostomy), ensuring a wide anastomosis in the most dependent area of the cyst (Fig. 11.2b). Additional procedures such as cholecystectomy and/or correction of the pancreatic duct strictures can be performed. A possibility of a CPL, if suspected, can be confirmed by a biopsy of the wall. Surgical drainage can be accomplished with a long-term success rate of 91–97% with 10–15% morbidity. In the era of minimally invasive surgery, laparoscopic drainage has a success rate of 98%, recurrence rate of 3% and complication rate of 9% [34]. A large single-centre series of 108 patients of pancreatic pseudocyst undergoing laparoscopic drainage had 93% success rate and recurrence rate of 0.9% at a mean follow-up of 54 months [34]. In patients with *Type III* cysts, surgical treatment is the option of choice which addresses the pancreatic duct drainage along with drainage of the cyst with or without the head coring (Frey's procedure).

In uncomplicated pseudocysts that require drainage, endoscopy should be the first line of management as it less costly, associated with lesser hospital stay and not inferior to surgery. EUS-guided drainage offers high rates of success and decreases the chances of complications such as bleeding. Surgery may be the first choice in the presence of portal hypertension with extensive collaterals or when concomitant procedures such as a cholecystectomy are needed. For surgical management of a pseudocyst, a laparoscopic approach is feasible in most instances when expertise is available. It is of note that apart from case reports, till date, minimally invasive surgery for pancreatic pseudocysts has been reported only in 253 patients [23].

## 11.5 Serous Cystadenoma (SCA)

### 11.5.1 Incidence

SCA accounts for around 20–30% of pancreatic cystic tumours [35]. SCA comprised 16% of 851 CPLs resected over 33 years at the Massachusetts General Hospital [36].

### 11.5.2 Pathogenesis

Mutation in the Von Hippel-Lindau (VHL) gene plays a central role in the development of SCA. Sporadic cases of SCA have intragenic mutations of VHL (located in the short arm of chromosome 3) or loss of heterozygosity in this gene or close to it [37]. The cysts seen in VHL disease are identical to SCAs; however they are irregularly scattered around the pancreas rather than forming a discrete lesion. The entire pancreas may be replaced with multiple cysts which may be SCA, NET (neuroendocrine tumours) or simple cysts. The frequency of pancreatic involvement in VHL syndrome varies from 17% to 77.2%, and SCAs are reported in about 2.7–9.5% of patients with VHL [38].

### 11.5.3 Clinical Features

SCAs occur predominantly in females (70%) aged 60–65 years. They can occur anywhere in the pancreas. In the largest multinational study comprising of 2622 SCAs, 61% were asymptomatic [39]. Non-specific abdominal pain was reported in 27% of cases, diabetes mellitus in 5% and biliopancreatic symptoms, including typical pancreatic pain, acute pancreatitis, jaundice and steatorrhoea, in 9% of cases [39]. Common symptoms and signs when present are abdominal pain, weight loss and a palpable mass [40]. Jaundice due to bile duct compression is uncommon [41]. SCAs may present acutely owing to tumour rupture or haemoperitoneum [42]. Tumours more than 4 cm are more likely to be symptomatic when compared to smaller tumours (72% vs. 22%, $p < 0.001$) [42]. A study which followed up 145 patients with annual MRI showed growth rates of 0.1 cm/year for the first 7 years and 0.6 cm/year for the next 3 years [43]. These patients had minimal or no symptoms and hence were initially managed conservatively. Only 23 of them required surgery, at a median of 4 years after diagnosis. Patients with oligocystic SCA and those with a history of extra pancreatic primary malignancy had higher growth rates [43].

Serous cystadenocarcinoma is a malignant variant of the benign SCA. None of the patients developed a serous cystadenocarcinoma on final histopathology. Around 30 cases have been described in literature, and it is extremely rare. There are no factors that can predict malignant behaviour which is solely characterized by invasion of surrounding structures. The risk of malignancy in SCAs has been reported to be around 3% [44].

### 11.5.4 Cross-Sectional Imaging

Four variants are described: the microcystic, oligocystic, mixed and solid types. Microcystic SCA is the most common type and is seen in more than 70% of patients with SCAs. Typically the tumour is composed of multiple small cysts <2 cm in size arranged around a central fibrous septa giving rise to a honeycomb appearance. (Fig. 11.3a, b). The fine structure of such a lesion entails numerous small, soft-walled cysts forming a cluster around a central scar from which fibrotic bands radiate giving rise to a ‘cyst on cyst’ appearance. It is generally seen as a solitary cystic mass of 2–16 cm in diameter, usually in the pancreatic body or tail. The typical central calcification is seen in about 20–30% of the cases. On contrast-enhanced CT, late enhancement of the fibrotic bands may also help in diagnosis and can be achieved about 5 min after contrast administration [45]. On MRI, the cysts appear hyperintense in T2 phase. The central septa enhances on gadolinium administration in the T1 phase. Calcifications may not be seen on MRI. In SCA there is no pancreatic duct communication with the cyst.

The less common oligo- or macrocystic variant appears as a solitary cyst that is difficult to distinguish from pseudocysts, MCN or unifocal branch-duct IPMNs. A lesion in the pancreatic head with a lobulate contour is likely to be an oligocystic SCA; a thick cyst wall and septa, as well as eggshell calcification, are suggestive of MCN [46]. The oligocystic variant appears lobulated and composed of fewer cysts whose size can be

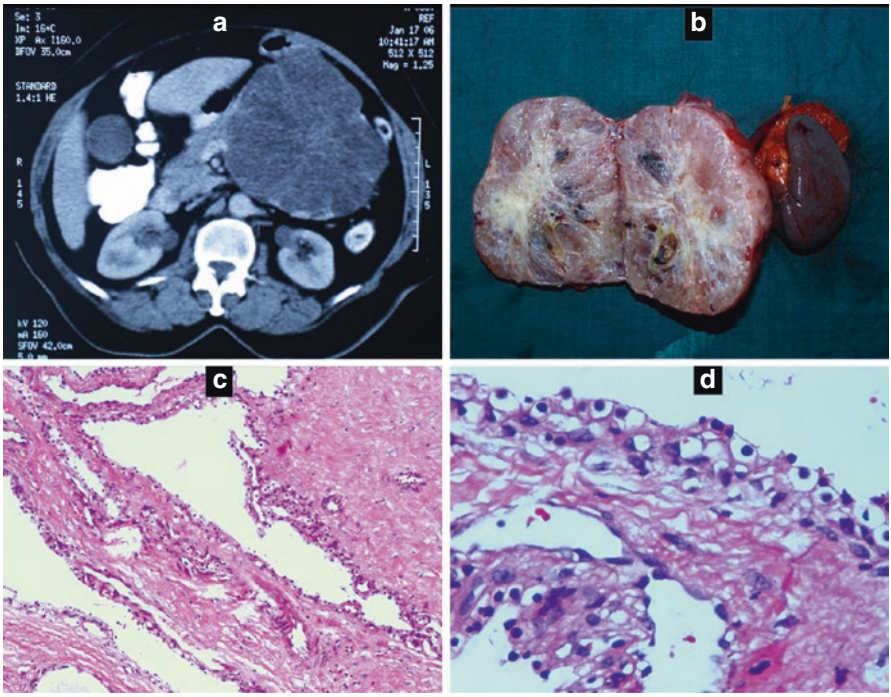


**Fig. 11.3** (**a**) Multi-detector computed tomography scan image depicting a lobulated, multicystic tumour in the tail of the pancreas with a central scar and radiating fibrous septa typical of a serous cystadenoma. (**b**) Cut section of the resection specimen with typical gross features of microcystic sponge-like lesion with radiating septa from a central stellate scar. (**c**) (10×) and (**d**) (40×): microscopic view (haematoxylin and eosin) shows the cystic spaces lined by cuboidal cells with abundant clear cytoplasm

up to 6 cm. A sponge-like pattern is found if the cysts increase in size peripherally. The mixed variant has features of both oligocystic and microcystic tumours. The solid variant appears so because of multiple small cysts interspersed with thick septa. The fluid component is not appreciated on CT, but will be seen on MRI [47].

### 11.5.5 EUS Findings

On EUS, microcysts arranged around a central scar can be clearly appreciated. EUS-FNA of an SCA reveals glycogen-rich cuboidal cells. Cytological examination of EUS-FNA specimens can correctly predict SCA in only 38% of the cases of SCA [48]. When cyst glucose levels of SCAs were compared with those of lesions that were not SCAs (pseudocysts, IPMNs, MCNs and cancer), the median cyst glucose level was significantly elevated. The highest diagnostic accuracy was obtained at a cut-off of 66 mg/dl, with a sensitivity and specificity for differentiating SCAs from lesions that were not SCAs of 88% and 89%, respectively.

Similarly, SCA lesions had significant kynurenine abundance, and the area under the receiver operator characteristic curve was 0.85 (95% CI, 0.66–1.0) [49]. In a prospective study of 87 patients undergoing surgery, vascular endothelial growth factor (VEGF)-A levels of 8500 pg/mL had 100% sensitivity and 97% specificity as an SCA biomarker. VEGF-A and VEGF receptor 2 are overexpressed in SCA cyst tissue. With a cut-off set at 200 pg/mL, VEGF-C identified SCA with 100% sensitivity and 90% specificity [50]. α-Inhibin immunostaining can be useful in detecting a SCA [51]. While cyst fluid assay of glucose, kynurenine, VGEF and α-inhibin are useful adjuncts, they have not found use in routine clinical practice.

A promising development in the assessment of SCA is the use of needle confocal laser endomicroscopy (nCLE) at the time of EUS. nCLE utilizes a microprobe attached to a 19-guage needle and provides microscopic pictures of SCA. A prospective multicentre French study (CONTACT) [52] has found that the detection of a superficial vascular network is a histological feature of SCA, which can be highlighted by nCLE. In a preliminary series of 18 cases, nCLE achieved an overall accuracy of 83%, with a sensitivity of 62.5% and a specificity of 100% for the diagnosis of SCA, with an excellent intraobserver and a good interobserver agreement [52].

In clinical practice, EUS is performed only when the diagnosis of a SCA is not clear after cross-sectional imaging. EUS-FNA and fluid analysis are done in select cases with atypical morphological features when it can differentiate SCA from a mucinous neoplasm, pseudocyst.

### 11.5.6 Indications for Surgery

Surgical treatment should be considered only if the diagnosis of the CPL remains uncertain despite a complete workup, if the patient has significant symptoms due to the lesion, or there remain concerns, following evaluation, for the coexistence of an underlying malignancy [39]. It is generally agreed that SCAs are benign (1% rate of malignancy) and surgery is indicated in patients who are symptomatic or have tumours larger than 4 cm [53, 54]. It is unclear if the tumour size has any direct impact on malignant potential, but larger tumours are more likely to be symptomatic over a period of time [55]. Location of the tumours in the head of pancreas and size >6 cm are independent risk factors for aggressive behaviour; therefore, surgery is advocated by some authors in this setting [54].

### 11.5.7 Histopathology

These lesions comprise multiple cysts (usually >6) measuring <2 cm and separated by thin septa lined by epithelial cells. SCA cysts are lined by glycogen-rich cuboidal epithelium (Fig. 11.3c, d). The cysts are filled with serous fluid, and the larger cysts are typically located peripherally, contributing to the lesion's lobulated contour.

### 11.5.8 Prognosis and Follow-Up

A multinational, retrospective study involving 58 centres in 18 countries showed that the postoperative mortality reported in patients who underwent pancreatic surgery for SCA was 0.8%, while the SCA-related mortality was 0% in patients with a median follow-up period of 3.1 years [39]. The inference drawn from this is that it is safe to 'wait and watch' in patients in whom the diagnosis of an SCA is confirmed beyond doubt. In asymptomatic patients, imaging every 6 months for 2 years and then yearly for 5 years is recommended [5]. After resection, there is no need to follow up the patient as the risk of recurrence in SCA is virtually non-existent.

## 11.6 Solid Pseudopapillary Tumour (SPT)

### 11.6.1 Incidence

SPT was first described by Franz in 1959 [56] and comprises 3% of resected CPLs [36]. SPTs are rare and comprise of 0.1–2.7% of all primary pancreatic tumours [57]. They appear to be unique to the pancreas with no tumours of similar lineage reported elsewhere in the body [58]. *Pathogenesis* β-catenin gene mutations are believed to be central to the development of SPT and are commonly observed in most patients [59]. In contrast to patients with pancreatic adenocarcinoma, K-ras, p53 or DPC4 gene mutations are not seen in SPTs [60].

### 11.6.2 Clinical Features

SPT is found almost exclusively in young women (>80%) with a mean age of 30 years [61].

Less than 10% of the patients with SPT are men [62]. Adjacent organs such as the stomach, duodenum and spleen may be involved, but the common bile duct is usually spared [63]. Obstructive jaundice is a rare feature even in tumours arising from the head of the pancreas [64]. Metastases are described in about 20% of the patients and may occur in the liver, peritoneum or even skin [65].

### 11.6.3 Cross-Sectional Imaging

SPT predominantly occurs in the body/tail of pancreas. Haemorrhage and necrosis contribute to the solid components in SPT. Calcification is seen in 30% of the patients and is usually peripheral but may be central (Fig. 11.4a) [61]. In SPT, the solid tissue components are generally noted at the periphery, with central areas of haemorrhage and cystic degeneration. After contrast administration, the capsule

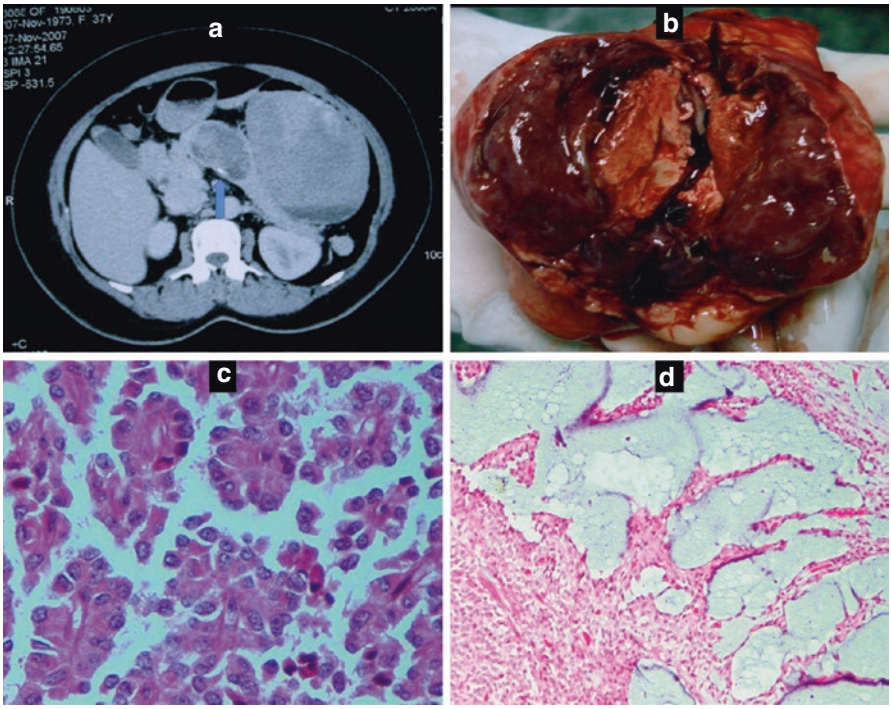


**Fig. 11.4** (**a**) Multi-detector computed tomography axial section demonstrating a heterogeneous lesion in the neck and body of the pancreas with peripheral calcification in the capsule (blue arrow). (**b**) The cut section of operative specimen showing cystic areas of haemorrhage, necrosis with solid tumour components. (**c**) Microscopic section (haematoxylin and eosin) shows tumour cells arranged in a pseudopapillary pattern (40×). (**d**) Microscopic section (haematoxylin and eosin) showing the extracellular myxoid stroma characteristic of SPT (10×)

and solid components enhance [66]. A key diagnostic finding of SPT is the presence of a fibrous capsule that encompasses the tumours. Generally, an encapsulated CPL in a young female containing internal haemorrhage is a SPT until proven otherwise (Fig. 11.4b) [67]. On T1-weighted MRI, haemorrhage may be seen as bright areas, while on T2-weighted images, the peripheral fluid component appears bright.

### 11.6.4 EUS Findings

EUS will typically show a heteroechoic, inhomogeneous mass in the pancreatic tail. Both solid and cystic areas can be appreciated, along with calcification if present. Fluid cytology carries 70–75% accuracy for SPT [68]. EUS-FNA cytological analysis reveals characteristic branching papillae with myxoid stroma, best seen in cell block material [69]. Immunostaining for β-catenin helps in diagnosis.

### 11.6.5 Indications for Surgery

SPTs are considered premalignant with 2–15% incidence of local invasion or metastatic disease [70]. As these lesions occur mainly in young women and have a malignant potential, the general consensus is to resect these lesions [71, 72]. Presence of metastases is not a contraindication to resection if they can be completely removed; these patients seem to do well, although the actual benefit of metastasectomy in terms of overall survival has not yet been realized.

### 11.6.6 Histopathology

On histopathology, SPTs contain loosely cohesive cells that form delicate pseudopapillae supported by capillary-sized fibrovascular cores which have an ependymoma-like appearance due to the formation of pseudorosettes (Fig. 11.4c) [59]. Mutation in E-cadherin, β-catenin results in lack of cell to cell cohesion, resulting in this appearance [73]. The stroma can be hyaline or myxoid (Fig. 11.4d). Foamy macrophages are commonly seen; sometimes periodic acid Schiff (PAS) positive globules may also be seen [59]. Adjacent to the cystic spaces resulting from necrosis are foam cells, cholesterol clefts and foreign-body giant cells [74]. Diagnosis is confirmed with immunostaining of characteristic markers, including CD56, CD10, vimentin and nuclear labelling of β-catenin [60, 71]. Neuroendocrine markers such as chromogranin, synaptophysin and pancreatic enzymes are not usually expressed but may be found focally sometimes [63, 75].

### 11.6.7 Prognosis and Follow-Up

Peritoneal, cutaneous and hepatic metastases have all been reported following SPT excision; however, nodal metastases appear to be rare [76]. A complete margin negative resection confers an excellent long-term survival. Overall, >80% of SPT patients experience long-term survival after surgery [71]. Infiltration into the surrounding pancreatic parenchyma, vascular or perineural invasion, increased mitosis, pleomorphic nuclei and necrosis are histopathological features associated with increased risk of recurrence [59, 77]. Chemotherapy has been reported to be useful in case reports in the setting of recurrent disease after surgery or in a neoadjuvant setting to downsize large tumours. There is no data to support the routine use of adjuvant chemotherapy even in high-risk tumours.

## 11.7 Cystic Pancreatic Endocrine Neoplasia (CPEN)

### 11.7.1 Incidence

CPENs occur in equal frequency in men and women and may be found anywhere within the pancreas. They are rare lesions, noted in middle-aged adults. In a

retrospective single-centre review from 1977 to 2006 [78], 29 patients (51% men, mean age 53) were found to have CPENs. They comprised 17% (29 of 170) of all pancreatic NETs and 5.4% of all resected CPLs (29 of 535) [78]. In another large series, CPENs accounted for 7% of resected pancreatic cysts (31/469) and 12% of resected pancreatic NETs (31/255). CPENs are primarily sporadic (94%), solitary (87%), non-functioning (100%) and incidentally discovered (68%) [78–80].

### 11.7.2 Pathogenesis

Whether they represent a unique tumour type or degeneration of solid tumours is debated. CPEN may also represent a possible de novo cyst formation [78, 79].

### 11.7.3 Clinical Features

In approximately one fourth of the times, there is an association between MEN syndrome and CPENs [81]. MEN-1 is 3.5 times more common in CPENs than in solid tumours (21% vs. 6%). When compared to solid pancreatic NETs, they are larger (49 mm versus 23.5 mm) and more likely to be non-functional (80% vs. 50%) [78]. Malignancy in non-functioning tumours is determined by local vascular and lymphatic invasion and presence of metastases; there are no predictive histological features [82]. When solid and CPENs were compared, no significant difference was found in location, metastasis, invasion or 5-year survival (87% versus 77%) [78].

### 11.7.4 Cross-Sectional Imaging

In contrast to solid pancreatic NETs, CPENs occur more frequently in the body and tail of the pancreas [80]. In the series by Bordeianou and colleagues, 10 (34%) were purely cystic, and 19 (66%) were partially cystic [78]. Radiologically, CPENs appear to have solid components (26%) which are hypervascular, with an irregular solid wall, and thick nodular septations (26%), and are round to oval shape, rather than being lobulated. Cyst wall enhancement or a characteristic hypervascular rim is seen in 45% of cases (Fig. 11.5a, b). [78, 79, 83].

### 11.7.5 EUS Findings

There are no reported ultrasound features that help to discriminate a cystic or necrotic endocrine tumours from other cystic or necrotic tumours of the pancreas. A correct diagnosis on cross-sectional imaging is possible only in a minority of patients (23%) [78]. EUS sampling can be helpful by demonstrating positivity for synaptophysin and chromogranin. Preoperative imaging and/or cytology suggested the diagnosis of CPEN in 61% [78, 79]. EUS-FNA has a 71% diagnostic yield for CPENs [84].

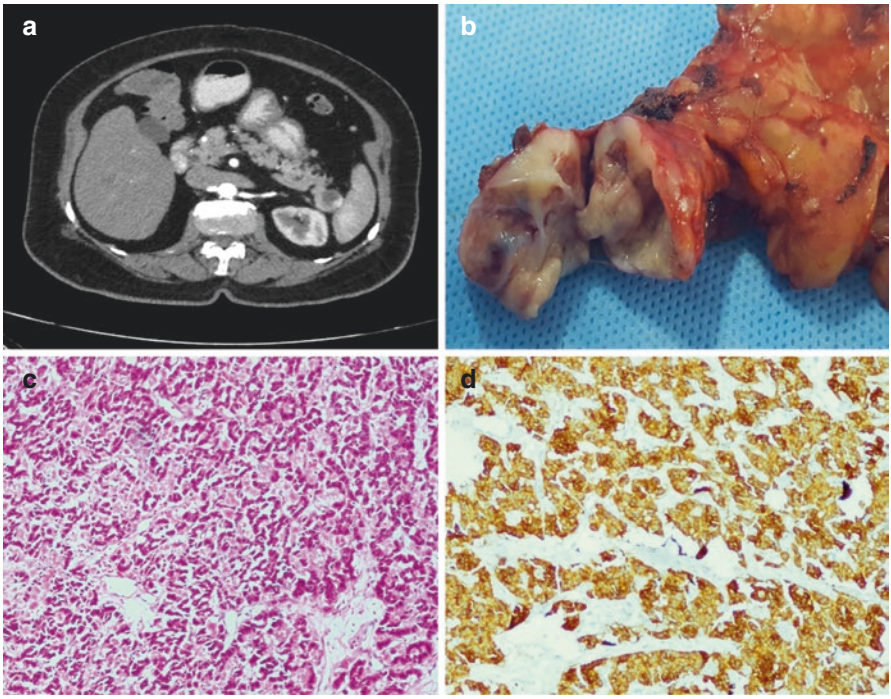


**Fig. 11.5** (**a**) Multi-detector computed tomography image showing an exophytic lesion arising from the tail of the pancreas with solid and cystic components with enhancement in the arterial phase. (**b**) The cut section of the resected specimen clearly showing solid and cystic components. (**c**) Microscopic picture (haematoxylin and eosin) shows the characteristic small monotonous round cells arranged in cords (10×). (**d**) Immunohistochemistry (40×) showing diffuse synaptophysin positivity in tumour cells

### 11.7.6 Indications for Surgery

CPENs portend an 11–14% risk of malignancy and 8–14% risk of nodal or distant metastases, necessitating surgical resection as the only potential curative treatment [85]. Resection is recommended in all patients due to uncertain malignant potential.

### 11.7.7 Histopathology

CPENs display the characteristic monotonous round cells, rosette patterns and a unique pattern of nuclear chromatin when sampled in their solid areas (Fig. 11.5c). They typically express synaptophysin (100%) (Fig. 11.5d), chromogranin (82%), frequently pancreatic polypeptide (74%) and infrequently cytokeratin (CK)-19 (24%) [78]. Unlike SPT, CPENs stain negative for β-catenin.

### 11.7.8 Prognosis and Follow-Up

The 1-year survival after surgical resection is reported to be 97% and the 5-year survival 87% [78]. There is a statistically similar long-term outcome after resection of CPEN or other solid pancreatic NETs (5-year disease-free survival: CPEN, 100%, vs. NETs, 86%) [78, 79]. Lymphadenectomy may be beneficial due to uncertain malignant potential [86]. Response to chemotherapy consisting of streptozocin, doxorubicin and 5-flurouracil can be seen in about 40% of patients [87].

## 11.8 Lymphoepithelial Cyst

Lymphoepithelial cysts (LECs) are rare, non-malignant 'tumours' representing 0.5% of all CPLs, seen predominantly in elderly males [88]. Their pathogenesis is unclear although one theory suggests that LECs represent squamous metaplasia in epithelial inclusions in lymph nodes adjacent to the developing pancreatic anlage [89]. An alternative hypothesis suggests that these result due to fusion of branchial cleft cysts with the developing pancreas [90]. LECs often appear as exophytic cystic lesions (unilocular or multilocular) with enhancing walls on CT scan (Fig. 11.6) [91]. The high keratin in the cysts results in a hypointense signal on T2-weighted MRI images in contrast to other pancreatic cystic neoplasia (Fig. 11.6) [92]. On EUS, it appears heterogeneous (Fig. 11.6), and EUS-guided aspiration shows typical squamous cells and sheets of lymphocytes. Due to the high keratin and cholesterol content, the cyst fluid may appear amorphous, curd like or cheesy [93]. LECs are lined by keratinized stratified squamous epithelium, with subepithelial lymphoid tissue containing T lymphocytes. The architecture is quite similar to lymph nodes with the presence of a capsule, subcapsular sinus and germinal centre [59]. Presence of symptoms or uncertainty about diagnosis is the usual indications for surgery [93].

## 11.9 Acinar Cell Carcinoma

Cystic acinar cell carcinoma is a very rare epithelial neoplasm, accounting for only 1–2% of pancreatic exocrine neoplasia. The typical presentation is of abdominal pain or an abdominal mass that can be quite large [94]. Multicentricity is common. They are reported to be more frequently encountered in males [95]. These cystic tumours are believed to be formed by the accumulation of pancreatic enzyme secretions in the lumen of the tumour acini rather than as a result in cystic degeneration of a solid tumour. They consist of neoplastic cells which form acini and prominent lumens. The cysts often contain granules rich in pancreatic enzymes [58]. Unlike their solid counterparts, acinar cell cystadenocarcinomas are not associated with elevated serum lipase and do not usually cause the subcutaneous fat necrosis, polyarthralgias and blood eosinophilia [95]. Typical radiological findings consist of well-marginated lesions often with a necrotic centre. Histologically, acinar cell cystadenocarcinomas lack clear cells and mucinous

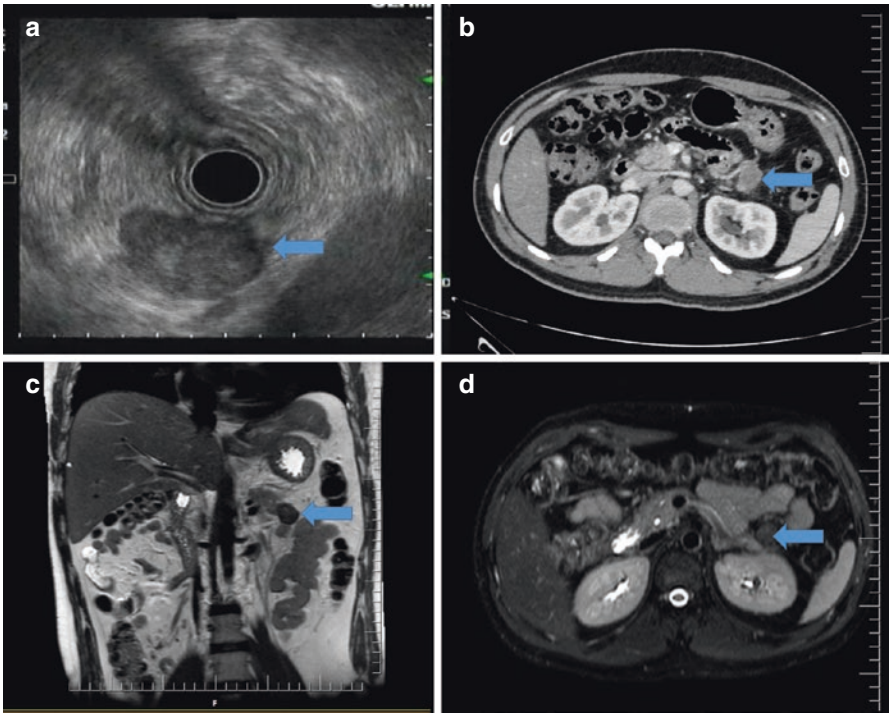


**Fig. 11.6** (**a**) Multi-detector computed tomography image showing a heterogeneous exophytic lesion in the tail of the pancreas. (**b**) EUS showing a 2 cm exophytic cyst seen in the distal body of the pancreas with solid debris and hyperechoic contents. T2-weighted MRI in coronal (**c**) and axial section (**d**) showing the hypointense cyst suggesting thick contents. These findings are consistent with a lymphoepithelial cyst (depicted by the blue arrow)

cells, differentiating them from SCA and MCNs, respectively. Cytoplasmic granules are PAS positive and diastase resistant [59]. Expectedly, acinar cell markers such as trypsin, chymotrypsin and lipase are positive on immunohistochemistry [96]. While normal acinar cells do not express cytokeratin 7, tumour cells are positive for this marker [59]. Sometimes, acinar cell cystadenocarcinoma may show prominent intraductal growth and needs to be differentiated from intraductal tubular adenocarcinoma and IPMNs [12, 59]. It has a better prognosis than ductal adenocarcinoma but is still an aggressive disease with liver metastases developing early in its presentation [97].

## 11.10 Cystic Degeneration of a Pancreatic Adenocarcinoma

Adenocarinomas can undergo cystic degeneration in around 1–8% of cases [98]. Usually large poorly differentiated cancers outgrow their blood supply and undergo cystic degeneration. They appear as heterogeneous tumours with

areas of central necrosis. Diagnosis is usually confirmed by EUS-FNA. Prognosis and treatment follow the lines of management of pancreatic ductal adenocarcinoma.

## 11.11 Tubular Adenocarcinoma

This is a special variant of adenocarcinoma where the normal pancreatic acini are replaced by large tubular glands, giving it a cystic appearance on imaging. These tumours originate from the lining of the pancreatic duct and result in obstruction and dilatation of the duct [99]. They usually arise in the head of the pancreas; the mean age of presentation is 63 years, with a male to female ratio of 1.5 [100]. Due to their intraductal nature, they resemble IPMNs. On immunohistochemistry, tubular adenocarcinomas stain positive for MUC6, MUC5A, CK7 and CK19. MUC1 and MUC2 are negative except for scattered goblet cells. CK20 and CDX2 stain negative. Prognosis is usually favourable in the absence of invasive cancer due to the slow growth of tumour [59]. Treatment is surgical resection.

## 11.12 Cystic Metastases

Since they occur in the setting of advanced disease, they may be associated with liver metastases or multiple secondaries elsewhere. Although cystic metastases to the pancreas are most commonly seen with renal cell carcinoma and lung carcinoma, they may be encountered in bowel, breast and prostate cancer. Necrotic metastases occur most often in cases of aggressive tumours such as sarcomas, melanomas or ovarian carcinomas [83, 101]. Metastasectomy of pancreatic secondaries from renal cell carcinoma can result in long-term survival [102].

## 11.13 Pancreatoblastoma

It is the most common pancreatic tumour in children in their first 10 years of life. Despite this fact, pancreatoblastomas are rare neoplasms with only about 75 cases reported in literature [103]. Patients with Beckwith-Wiedemann syndrome can develop embryonal tumours such as pancreatoblastoma, hepatoblastoma, nephroblastoma and rhabdomyosarcoma [104]. Although most patients are asymptomatic at diagnosis, abdominal pain, anorexia, weight loss, fatigue, nausea or vomiting can be present.

On cross-sectional imaging, pancreatoblastomas exert mass effect; they compress but do not invade adjacent structures. The tumours are so large that in almost half the cases, it may be difficult to discern the organ of origin. Metastases to the liver and lymph nodes may be seen in more than one-third of the cases [105].

## 11.14 Lymphangioma

Lymphangioma of the pancreas is rare, with only around 60 cases reported in literature. Though congenital in origin, lymphangiomas may occur at any age; they are more common in women and are often localized to the distal pancreas [106]. The lesion can be cavernous or capillary and is composed of multiple spongy cystic spaces which appear bright on T2-weighted images. Microscopically, lymphangiomas comprise of cystic spaces filled with proteinaceous material, lined by endothelial cells, and are positive on immunohistochemistry for endothelial markers CD31, CD34 or D2-40 [107]. Resection is indicated only in symptomatic cases. Cyst fluid from a pancreatic lymphangioma has a characteristic chylous appearance, elevated triglyceride levels and numerous benign lymphocytes [108].

## 11.15 Other Miscellaneous Rare Tumours

Rarely parasitic cysts such as hydatid cysts may be seen although isolated occurrence in the pancreas is unusual. Enterogenic, retention cysts may also be encountered in the pancreas. Adenosquamous carcinoma and undifferentiated carcinoma with osteoclast-like giant cells are rare tumours that can present with haemorrhagic degeneration [62]. Other rare cystic neoplasias include cystic choriocarcinoma; mature cystic teratoma; pancreatic cystic hamartoma; pancreatic mesenchymal tumours like inflammatory myofibroblastic neoplasm, extra-gastrointestinal stromal neoplasm and solitary fibrous neoplasm; and schwannomas [62].

## 11.16 Approach to Cystic Pancreatic Lesions

While approaching CPLs, clinical symptoms and signs rarely will lead to a definitive diagnosis. Symptoms such as pain, weight loss or jaundice should alert the clinician to the presence of malignancy and lead to consideration of surgery [109]. Cross-sectional imaging (MDCT/MRI) invariably done as part of the evaluation and interpreted in the right clinical context will often point to the diagnosis. A practical approach is to first confirm that the lesion is located anatomically within, or arising from, the pancreas. This will exclude extrapancreatic lesions such as a retroperitoneal lymphangioma, mesenteric cyst, etc. The next step is to evaluate if the lesion is a pseudocyst or a cystic tumour.

### 11.16.1 Differentiating CPLs

A single pancreatic cyst of any size detected on cross-sectional imaging is certainly a challenging clinical problem; it could be a pseudocyst, an oligocystic SCA, MCN, branch-duct IPMN, SPT, CPEN or even cystic degeneration of a pancreatic ductal adenocarcinoma. A pseudocyst appears as a well-defined cystic lesion on

cross-sectional imaging with clear fluid, minimal or no debris and absent septae or mural nodules. Imaging features are diagnostic in the setting of a typical history of acute/chronic pancreatitis/trauma. EUS may demonstrate a communication with the pancreatic duct in about *two-thirds* of the cases. EUS-guided aspiration of the fluid will show very high levels of amylase. Once a pseudocyst is ruled out, another most common non-mucinous cystic tumour is a SCA. A lobulated lesion with multiple small cysts arranged around fibrous septa with central calcification in a lady over 60 years is typical of a SCA. SPT occurs in young women (~30 years), with areas of haemorrhage and necrosis. CPEN do not have specific diagnostic features but can demonstrate a capsule which enhances on the arterial phase in about half the patients. Rarely, an adenocarcinoma in the pancreas can undergo necrosis in part leading to cystic degeneration. When definitive diagnosis is not possible on cross-sectional imaging alone, EUS is indicated to enable further characterization and direct sampling that will help in diagnosis and management decisions. Laparoscopic ultrasound offers an advantage over EUS because there is no contamination of the aspirate with gastric or duodenal epithelial cells, which can result in a false-positive cytologic analysis for mucinous cystadenoma [110]. Although it has a potential to provide additional information based on imaging findings/fluid analysis/frozen section of cyst wall, it is always desirable to come to the operation theatre with a definitive plan aided by appropriate use of preoperative diagnostic modalities.

### 11.16.2 EUS Indications and Contraindications

If the CT clearly indicates a pseudocyst, SCA, SPT or main-duct IPMN, then EUS need not be performed for diagnosis. EUS-FNA is helpful when imaging findings are inconclusive where it helps in differentiating mucinous from non-mucinous tumours and in diagnosing CPEN and SPTs [111, 112]. EUS is indicated when the diagnosis is in doubt or if it is likely to provide additional information that will alter the management decision. For instance, if the imaging features are atypical or non-contributory (e.g. a unilocular cystic lesion), EUS and FNA can contribute towards a definitive diagnosis. If the patient is elderly, infirm and not a surgical candidate, then one may not want to pursue the diagnosis with EUS-FNA even if cross-sectional imaging is not diagnostic. EUS can also be used as a surveillance tool in lesions managed nonoperatively. A raised international normalized ratio (INR) > 1.5, partial thromboplastin time >50 s, platelet count <50,000/μL, acute pancreatitis and the presence of obvious infected necrosis are contraindications to EUS [113].

### 11.16.3 Comparison of EUS with Cross-Sectional Imaging

EUS offers the advantage of clarity due to proximity of the lesion. EUS is operator-dependent; however wall thickening, nodules and ductal communication can be reproducibly demonstrated. The morphological features that can be seen on CT or MRI can be seen on EUS. Cyst morphology on EUS has an overall accuracy of

50–73%. The sensitivity and specificity for EUS amount to 56–71% and 45–97%, respectively [114]. While evaluating morphological features, not all the nodules found are precancerous. For example, the nodules seen in lymphoepithelial cysts are keratinizing squamous pearls, and mucin globules account for a large percentage of nodules seen during imaging of IPMNs. On EUS, mucin globules are hypoechoic, have smooth edges and hyperechoic rims and move when patients are repositioned or during FNA. In demonstrating multifocal cystic lesions, EUS is superior to both CT and MRI [115, 116]. Overall, the increase in diagnostic yield of EUS and fluid analysis over CT and MRI for prediction of a neoplastic cyst was reported to be 36% and 54%, respectively [117]. When EUS was compared with MRI of the pancreas and MRCP in a prospective study, however, EUS and MRI were equivalent at detecting pancreatic cyst-main duct communications [118]. The need for surgical intervention based on the presence of malignancy cannot be accurately assessed by EUS [119].

### 11.16.4 Cyst Fluid Analysis for Tumour Markers

The ability to readily perform FNA is a huge advantage of EUS over other diagnostic modalities.

Cysts that are high in amylase (usually >5000) with no mucin or carcinoembryonic antigen (CEA) and negative cytology are likely to be pseudocysts. Cysts that have no mucin, low amylase (<250) and low CEA are likely to be SCA. Cysts high in mucin with high CEA and atypical or malignant cytology are likely to be MCNs [5]. Cyst fluid CEA is the single most important study to differentiate mucinous and non-mucinous lesions. A recent prospective, multicentre study of 112 cysts diagnosed by surgical resection or positive FNA found a CEA level of 192 ng/mL to be 84% accurate in differentiating mucinous from non-mucinous pancreatic cysts (sensitivity 75% and specificity 86%) [113].

In a systematic review of 450 patients from 12 studies, cyst fluid amylase <250 U/L was diagnostic of a serious or mucinous tumour as opposed to a pseudocyst with a sensitivity of 44% and specificity of 98%. A CEA of <5 ng/ml excluded a mucinous tumour with 50% sensitivity and 95% specificity, whereas a CEA > 800 g/ml had a sensitivity of 48% and specificity of 98% for diagnosing a mucinous neoplasm [113]. An amylase level of <250 and CEA >800 essentially excludes a pseudocyst. Likewise, a CEA <5 and CA19-9 <37 virtually excludes a mucinous cyst [48, 120, 121]. Other markers like carbohydrate antigen/CA 19-9, CA 242, etc. have been studied, but their utility is limited.

### 11.16.5 Cyst Fluid Cytology

Cytology has a sensitivity of 50–60% for the diagnosis of malignancy [122]. However the specificity and positive predictive value are over 90% [112]. When detection of high-grade atypical epithelial cells is included in the diagnostic criteria, the accuracy of cyst fluid analysis increases to 85% [123]. A recently published

meta-analysis, including a total of 18 retrospective and prospective studies, evaluated the accuracy of EUS-FNA for the diagnosis of pancreatic cystic neoplasia and found that cytology has a moderate pooled sensitivity of 54% and a high pooled specificity of 93% [124]. In differentiating histopathologically confirmed mucinous and non-mucinous cysts, EUS-FNA had a pooled specificity of 0.88 (95% CI 0.83–0.93); however the sensitivity was 0.63 (95% CI 0.56–0.70), resulting in a poor negative predictive value [124].

### 11.16.6 Cyst Fluid Analysis for Molecular Markers

Molecular and genetic markers have utility in the characterization and prognostication of CPLs. Most of these are useful in the setting of mucinous tumours. DNA markers and aneuploidy assessment have been reported to have very high sensitivity and specificity (both close to 95–100%) for SCA and SPT, while having a slightly wider range of both sensitivity and specificity (75–100%) for MCNs [125]. However these are yet to find wide clinical acceptance.

## 11.17 Management

While formulating a management plan for a CPL, it is imperative to arrive at a diagnosis based on clinical features, radiology, supplemented where needed with cyst fluid analysis and cytology. Once the diagnosis is clear, the further course of action would depend on the natural history of the lesion, its malignant potential and the performance status of the patient. Management of CPLs should ideally avoid unnecessary surgery for benign lesions while also considering the personal and financial costs of prolonged radiologic surveillance in young otherwise healthy patients with premalignant lesions [126]. An important caveat in applying management recommendations for CPLs is that most of the time they are based on the histopathological subtype of the tumour; this is seldom available preoperatively [21]. Most tests including EUS-FNA have high specificity and low sensitivity; hence they will more reliably minimize false-positive results.

An algorithm for the management of CPLs is provided in Fig. 11.7 based on current recommendations available in literature. Surveillance is justified when the patient is a potential surgical candidate and the lesion has uncertain malignant potential. No follow-up is required if the lesion is clearly benign and the patient is not a surgical candidate. This strategy applies to asymptomatic lesions as symptoms generally warrant intervention. In a clearly malignant lesion, surgery is indicated. In large series, the mortality from surgery is less than the risk of malignant transformation of the lesion, justifying the current treatment approach that is adopted in high-volume centres. The mortality associated with pancreaticoduodenectomy in high-volume centres is around 1–2%, while the risk of malignant transformation in lesions initially selected for observation is reported to be around 3% [127].

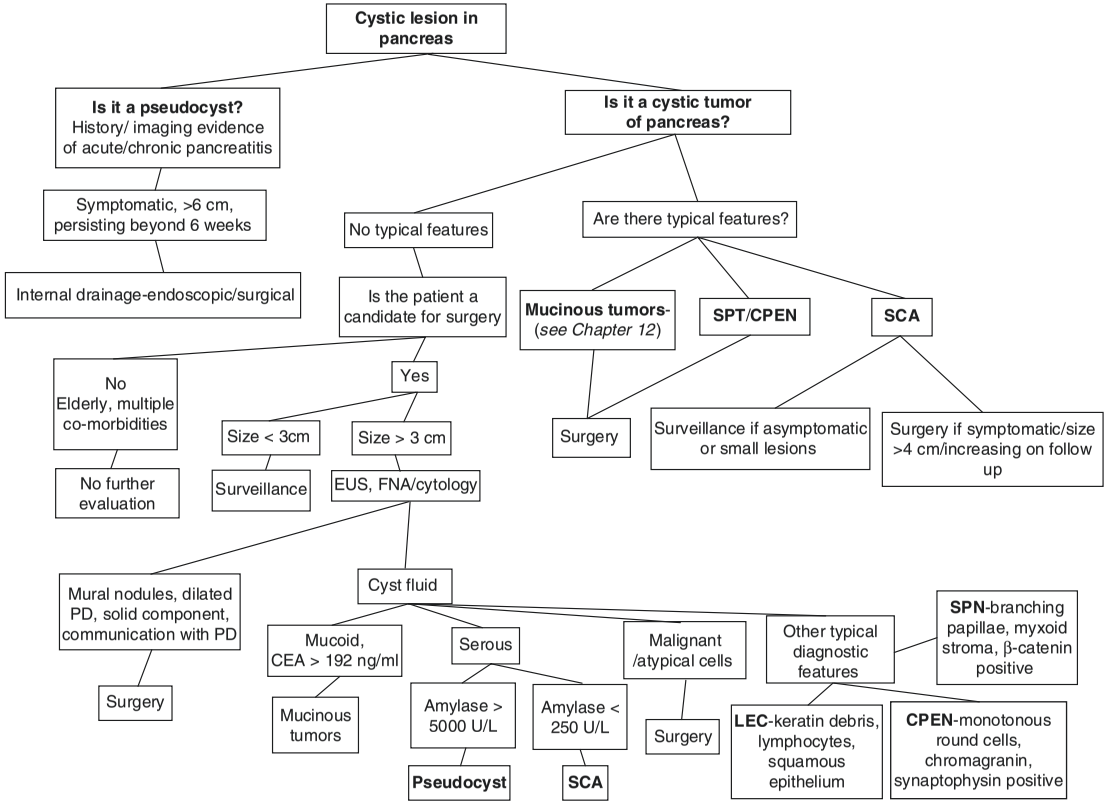


**Fig. 11.7** Algorithm depicting management of a cystic pancreatic lesion detected on cross-sectional imaging. *GIST* gastrointestinal stromal tumour, *SCA* serous cystadenoma, *SPT* solid pseudopapillary tumour, *CPEN* cystic pancreatic endocrine neoplasm, *EUS* endoscopic ultrasound, *FNA* fine needle aspiration, *PD* pancreatic duct, *CEA* carcinoembryonic antigen, *LEC* lymphoepithelial cyst

Generally the type of surgery depends on the location of the tumours. Pancreaticoduodenectomy is performed for lesions in the head. For lesions in the body/tail, distal pancreatectomy is performed. Organ-preserving strategies are employed where feasible. For example, central pancreatectomy is a good option in tumours located in the neck. Spleen preservation can be done if there is no local infiltration. Enucleation is generally not a good option as it is associated with high rates of pancreatic fistula and is not recommended on oncological grounds. A formal lymphadenectomy may be required in cystic degeneration of adenocarcinoma and SPT and is not needed in SCA or CPENs. Laparoscopic pancreatic resections, especially for lesions requiring distal pancreatectomy, are becoming the standard of care.

Multidisciplinary input from pancreatic surgeons, gastroenterologists, radiologists and pathologists can help in formulating the appropriate treatment strategy for patients with a CPL. As this entity is increasingly encountered in day-to-day practice, especially in referral centres, having a predefined institutional protocol and care pathways facilitate patient management and data accrual for audit.

## 11.18 Future Directions

The following are foreseeable developments that might improve current understanding and management strategies for CPLs. (1) Improvements in cross-sectional imaging modalities that will allow non-invasive characterization of small cystic lesions that are incidentally detected. (2) Development of molecular markers that will be available for routine clinical practice at an affordable cost, sufficient sensitivity and specificity to characterize the malignant potential of indeterminate lesions. (3) The role of metabolomics and genetic testing needs to be better defined. (4) Confocal endomicroscopy in clinical practice is under investigation and definitively represents an area of future research [37].

## 11.19 Salient Points

- CPLs are detected increasingly due to frequent use of cross-sectional imaging.
- It is important to know salient imaging features to make a definitive diagnosis.
- EUS-FNA/cytology can help characterize indeterminate lesions.
- Molecular markers may help clarify preoperative diagnosis and help in better patient selection.
- Of the non-pseudocyst, non-mucinous tumours, SCA is benign, and SPT and CPEN have malignant potential; others are rare and have to be dealt on a patient-to-patient basis.
- Surgery has good results and is the treatment of choice in large (>3 cm)/symptomatic tumours, in those with malignant potential.

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