Background: Owing to increased awareness and the widespread use of abdominal ultrasonography and computed tomography, an increasing number of cystic neoplasms are being identified. Cystic neoplasms of the pancreas are divided into the following 4 main groups: serous cystic neoplasms, mucinous cystic neoplasms, solid pseudopapillary neoplasms, and intraductal pancreatic mucinous neoplasms.

Objective: To review our experience with cystic neoplasms of the pancreas at our institution from January 1992 through September 2002.

Methods: Medical records were reviewed for age, sex, clinical signs and symptoms, diagnosis, surgical treatment, morbidity, mortality, and histologic features.

Results: Seventy-three patients (49 women and 24 men) underwent surgical resection of a cystic neoplasm of the pancreas from January 1992 through September 2002. The most common presenting symptom was abdominal pain. Other symptoms included nausea, emesis, weight loss, jaundice, and pancreatitis. Most patients (73%) had no complications. The most common complication (10%) was pancreatic fistula. There were 3 deaths.

Conclusions: Cystic neoplasms of the pancreas are an increasing entity. Long-term survival of patients with these tumors is generally better than that of patients with adenocarcinoma of the pancreas and mandates aggressive resectional therapy in most patients. Resection of these tumors can be done with resultant low morbidity and mortality rates.

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central pancreatectomies, and 2 total pancreatectomies. One patient under went a biliary bypass for a serous cystadenoma that was too large for resection. The cystic tumors included 26 serous cystadenomas, 18 IPMNs, 15 mucinous cystadenomas, 9 solid pseudopapillary neoplasms, and 5 mucinous cystad-enocarcinomas (Table 1).

POSTOPERATIVE COMPLICATIONS

The most common postoperative complication was pancreatic fistula that occurred in 7 patients (10%); 3 in patients undergoing Whipple procedures, and 2 each in patients undergoing distal pancreatectomy and central pancreatectomy. All fistulas closed spontaneously. Two patients had an intra-abdominal abscess, 1 had a wound infection, and 1 had hemorrhaged from the cut end of the pancreas requiring reoperation. This was the only patient requiring reoperation. Seven patients had miscellaneous complications including stroke, deep venous thrombosis, urinary tract infection, delayed gastric emptying, and aspiration pneumonia. No complications were noted in 53 patients (73%). Overall mortality was 4% (3 patients). All deaths occurred in the IPMN category and include 2 patients who underwent total pancreatectomy and 1 patient with a T3 N1b tumor who committed suicide following discharge from the hospital (Table 2).

NEOPLASMS

There were 26 patients diagnosed as having a serous cystadenoma, 17 (65%) were female, 21 (80%) presented with abdominal pain, and 5 (19%) presented with weight loss. A mass was palpated on examination in 3 patients (12%). Four patients (15%) were asymptomatic and their tumors were discovered incidentally. The most common form of resection was distal pancreatectomy that was performed in 18 patients, all but 2 with splenectomy. Whipple procedure was performed in 5 patients and a central resection in 2 patients. One patient underwent a biliary bypass after an unsuccessful attempt at resection of a 14-cm tumor in the head of the pancreas. Fifteen patients (58%) who underwent resection for serous cystadenoma had an uncomplicated recovery. The most common complication in this group of patients was pancreatic fistula; it occurred in 7 patients. One patient required reoperation for hemorrhage from the cut end of the pancreas. Two patients had an abscess. One patient each had wound infection, urinary tract infection, and deep venous thrombosis.

Twenty patients required resection for a mucinous tumor, 15 for cystadenomas and 5 for cystadendocarcinomas. Women composed 80% (16/20) of these patients. Pain was a presenting symptom in 11 patients (55%) and 3 patients (15%) either presented with or had a history of pancreatitis. Resection therapy consisted of distal pancreatectomy and splenectomy in 16 patients (80%) while 2 patients (10%) each underwent a Whipple procedure or central pancreatectomy. Only 1 patient among the 20 had a complication. This patient underwent a Whipple procedure for a cystadenocarcinoma and experienced delayed gastric emptying.

Nine patients in the series were resected for a solid pseudopapillary neoplasm, with 1 male in the group. The average age was 47 years with an age range of 20 to 85 years. The most common presenting symptom was abdominal pain (6 patients [63%]); other symptoms included weight loss (2 patients [23%]) and nausea and emesis (1 patient [11%]). A quarter of the tumors were found incidentally. Most patients (7 patients [73%]) required distal pancreatectomy with splenectomy while 1 patient each underwent a Whipple procedure and central pancreatectomy. No patient in this group had a postoperative complication.

Intraductal papillary mucinous neoplasm was diagnosed in 18 patients. Unlike the rest of the cystic tumors, 10 (56%) of 18 patients were male. Whereas 10 patients (56%) presented with abdominal pain, only 2 patients (11%) had a previous diagnosis of pancreatitis. Other presenting symptoms included nausea and emesis (10 patients [56%]), weight loss (4 patients [22%]), and diarrhea (3 patients [17%]). Jaundice was a presenting symptom in 4 patients [22%]. No patient had a palpable mass on examination. Eleven patients underwent a Whipple procedure while 2 had total pancreatectomies, and 5 had distal pancreatectomies with splenectomy. Ten patients (56%) recovered without complication. The 3 deaths in the series all occurred as previously explained within this group. Two patients developed an abscess and 3 patients developed other miscellaneous complications.

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Table 1. Resectional Therapies

<table>
<thead>
<tr>
<th>Type of Tumor</th>
<th>Total No. of Patients</th>
<th>Sex</th>
<th>Type of Resection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Serous</td>
<td>26</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Mucinous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cystadenoma</td>
<td>15</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Cystadendocarcinoma</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>SPN</td>
<td>9</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>IPMN</td>
<td>18</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Abbreviations: BB, biliary bypass; CP, central pancreatectomy; DP, distal pancreatectomy; IPMN, intraductal papillary mucinous neoplasm; PD, pancreaticoduodenectomy; SPN, solid pseudopapillary neoplasm; TP, total pancreatectomy.

COMMENT

Serous cystadenomas are more frequent in women than men, tend to occur in individuals between 50 and 80 years of age, and may be associated with von Hippel-Lindau syndrome. Although some reports describe symptoms in only half of the patients, 58 patients (80%) in our series reported abdominal pain. On CT, these tumors generally are microcystic, and although a sunburst calcification is pathognomonic, it is evident in only 11% to 30% of the tumors. Additionally, these tumors can have solid components occasionally noted on CT. Serous cystadenomas are generally considered benign with low malignant potential and owing to their benign nature, some physicians believe that observation is adequate therapy. However, even though only a handful of these tumors has been reported as malignant, these tumors can continue to grow causing advanced local symptoms. The increase in tumor size may make resection more difficult or complicated as with the patient we described above. Additionally, unequivocally differentiating these tumors from cystic tumors with a more malignant nature can be difficult without a complete pathologic resection. Therefore, in patients with few comorbidities, resection is the treatment of choice. However, if a patient is elderly, has significant comorbidities, or both, observation may be the best route especially when the tumor would require a Whipple procedure for resection and fluid sampling determines the tumor to likely be a serous cystadenoma.
Mucinous cystic neoplasms also are more prevalent in women than men and occur in a slightly younger group, affecting individuals in their 50s and 60s. As noted in our patients, most of these tumors are symptomatic on presentation and they occur more frequently in the body and tail of the pancreas. Computed tomography usually reveals a macrocystic tumor that may have rim calcifications. Compagno and Oertel reported in 1978 that with extensive sectioning more than 80% of the mucinous cystadenomas they treated either were malignant or had histologic premalignant changes. Others believe that all of these tumors from the onset have low-grade malignant potential. Since the epithelial lining of the tumor may be discontinuous, needle biopsy specimens may be misleading if no malignant cells are seen. Owing to the possibility of malignancy or malignant transformation, complete resection is the recommended therapy for these neoplasms.

Solid pseudopapillary neoplasms occur almost exclusively in women, the majority of whom present with abdominal pain. Although most of our patients were female, we did have 1 male patient in this group. The ages of our patients (age range, 20-85 years) varied more than the frequently reported age predilection of 20s to 30s. The size of the lesion has not been found to be a predictor of resectability, nor have any pathologic factors been found to be predictive of prognosis. Although solid pseudopapillary neoplasms generally carry a favorable prognosis, metastatic disease has been reported. Differentiating between benign, malignant, or potentially malignant lesions cannot be done based on prognostic factors, making resection necessary for all of these lesions.

Intraductal pancreatic mucinous neoplasms are a tumor of the epithelial lining of the pancreatic duct and are unlike other cystic neoplasms in several ways, the most notable being the male predilection. These tumors occur in all segments of the pancreas. Patients are usually between 60 and 70 years of age. Most patients are symptomatic with having a history of or presenting with pancreatitis, 15% to 60% in other series although only 11% (2) of our patients either presented with or had a history of pancreatitis. Computed tomography may reveal a pancreatic mass, but the most diagnostic test for these tumors is endoscopic retrograde cholangiopancreatography that reveals mucin extruding from the pancreatic duct. Recent reports, including our own, note an increasing number of IPMNs being diagnosed, but the reason for the increase in numbers is unknown. Since these tumors are premalignant, treatment of choice for IPMNs is resection with care to ensure negative margins. Intraoperative frozen sections are necessary as cellular changes can extend along the epithelial lining of the duct. Subclassification of this tumor into a main duct tumor or branch duct tumor has been noted by some. Kobari et al note that malignant tumors were more prevalent in the main duct type and that branch duct type more frequently required a Whipple procedure. Others recommend total pancreatectomy for all IPMNs to ensure complete tumor removal. Total pancreatectomy, however, is a more morbid procedure leading to both endocrine and exocrine insufficiency and, in 1 series, did not prevent tumor-related death. Hence, although resection is the treatment of choice, the extent of resection required has not been definitively determined. For IPMNs in the head of the pancreas, we perform a Whipple procedure and send a frozen section of the duct of the remnant pancreas. If the total frozen section reveals malignancy, then we will proceed to total pancreatectomy. However, if the margin has no malignancy, then we will cease our resection there, even if the margin contained dysplasia. We think the risk of recurrence is less than the risk of total pancreatectomy. Both of the patients in this series who underwent total pancreatectomy died: one owing to acute respiratory distress syndrome, and the other essentially from failure to thrive, no other cause was able to be discerned. Owing to the morbidity of total pancreatectomy as well as the mortality, we will leave the pancreas with dysplastic changes but no frank malignancy. Owing to the nature of this tumor, surveillance should be undergone by those who have not had a total pancreatectomy. Not all physicians support an aggressive surgical approach to cystic neoplasms. Cyst fluid analysis has been used to help differentiate mucinous neoplasms from nonmucinous cysts as well as to identify malignancy. However, differentiation of other cystic neoplasms has not been done. K-ras mutations have also been reported to help determine the malignant nature of the cystic neoplasm. These mutations, however, are in the mucinous cystic neoplasms and IPMNs, both of which are considered premalignant, if not already malignant. Thus, these mutations do not assist in the decision for resection, but rather for the extent of resection and follow-up. Some authors have also suggested the use of enucleation for resection of cystic tumors. Besides a higher incidence of fistula formation due to this resection method, analysis of K-ras mutations show that the tissue adjacent to the actual tumor may also carry the mutations, predisposing the remaining tissue to malignant changes.

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### Table 2. Postoperative Complications

<table>
<thead>
<tr>
<th>Type of Tumor</th>
<th>Total No. of Patients</th>
<th>None</th>
<th>Fistula</th>
<th>Abscess</th>
<th>Wound Infection</th>
<th>Death</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serous</td>
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<td>15</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Mucinous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cystadenoma</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cystadenocarcinoma</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SPN</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IPMN</td>
<td>18</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Abbreviations: IPMN, intraductal mucinous neoplasm; SPN, solid pseudopapillary neoplasm.
prefer central pancreatectomy to enucleation for tumors in which we wish to limit pancreatic resection.27

Cystic neoplasms of the pancreas are becoming a more common entity. Computed tomographic imaging is frequently able to distinguish between tumor types and is our diagnostic method of choice. We also used endoscopic ultrasonography to help further delineate these tumors, and endoscopic retrograde cholangiopancreatography is useful for IPMNs as these are tumors of the pancreatic duct. Since any of these tumors have the possibility of malignancy and needle biopsy is subject to sampling error, we support an aggressive approach to resection. The only patients in whom we advocate needle biopsy are those who have comorbidities that greatly increase their perioperative risk. In these patients if the needle biopsy is consistent with a serous cystadenoma, we will observe them with serial CT imaging to ensure the tumor is not enlarging, rather than bringing them directly to the operating room. In the vast majority, however, the treatment of choice for these tumors is surgical resection. Historically, pancreatic resection carried a high rate of morbidity and mortality; however, these outcomes have changed in recent decades. There have been numerous reports in recent years regarding performance of pancreatic resection with low rates of morbidity and mortality. Since long-term survival of patients with cystic neoplasms is better than survival for those with adenocarcinoma, an aggressive approach for surgical resection is advocated for these tumors. Although most tumors require a Whipple procedure or distal pancreatectomy, central pancreatectomy can be performed with limited morbidity for small tumors in the neck of the pancreas. Additionally, as jaundice was a presenting sign in 4 of our patients, a cystic neoplasm, specifically IPMN, should be part of the differential diagnosis for any patient presenting with jaundice.

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REFERENCES


DISCUSSION

John R. Potts, MD, Houston, Tex: Anyone who does pancreatic surgery will quickly recognize the value of this paper. The authors have presented a very large series of cystic neoplasms of the pancreas that were treated over a relatively short period. Their series is representative of the usual spectrum of pathologic diagnoses as well as the spectrum of operative therapy for those lesions, and they were able to resect all but one of those lesions with acceptable operative morbidity.

Their report prompts a number of questions. Cystic neoplasms of the pancreas are uncommon but must be recognized when seen so that they can be appropriately treated. This requires differentiation from pancreatic pseudocysts as well as from congenital, retention, and parasitic cysts. Along those lines, I would ask the authors the following questions:

You did not go into this in your paper but I always think it is instructive to learn the history of these patients prior to...
operation. Typically, about one third of them are misdiagnoses as pseudocysts for some period prior to operation. Were any patients so misdiagnosed in your series?

What has been the role of diagnostic ERCP [endoscopic retrograde cholangiopancreatography] or MRCP [magnetic resonance cholangiopancreatography] in your series? These studies appear to have clear value in IPMNs but do you use them in other ways as well?

In your discussion you briefly alluded to cyst fluid analysis in the diagnosis of these neoplasms but did not relate your experience with those techniques. Cyst fluid has been analyzed for viscosity, enzymes, cytology, and for relatively common tumor markers such as CEA, CA19-9, as well as the more exotic tumor markers including MCA and CA72-4. What has been your experience and what are your views on cyst fluid analysis?

My next question deals with the incidence of these tumors. They are generally considered to represent 10% to 15% of pancreatic cystic lesions and about 1% of all pancreatic neoplasms. You noted in your paper that cystic neoplasms of the pancreas are increasingly diagnosed. Do you think this represents a true increase in their incidence—perhaps owing to increased longevity or an increasingly toxic environment in which we live? Or, do you think that they are simply increasingly diagnosed because of modern imaging methods and increased awareness?

There is a great deal of variation in the pathologic terms given these lesions. For instance, I am aware of at least 5 other terms by which IPMN is known. I raise this point to ask the authors to help clarify for me the term “solid pseudopapillary neoplasm” because it is one with which I am not familiar.

Finally, I do not want to steal the thunder of the authors’ next paper on this topic but this one was devoid of any mention of long-term follow-up. Could the authors at least give us a quick overview of the long-term follow-up on these 73 patients?

Michael B. Farnell, MD, Rochester, Minn: I would like to focus on the 5 patients who underwent central pancreatectomy. I must say that is greater than my own personal experience. I am interested in considering wider application of this procedure for patients who have benign lesions of the neck of the pancreas. I would like to hear a few comments from Dr Aranha about the technical aspects of the anastomosis, how you manage the pancreatic stump, any tricks for getting access to the neck of the pancreas; unlike a Whipple resection, the stomach is intact and access to the lesser sac while one is performing central pancreatectomy. I have found this to be somewhat challenging. I would appreciate your comments.

Jose M. Velasco, MD, Skokie, Ill: What is the role, if any, of percutaneous oxygen endoscopic analysis of fluid for cytology and tumor markers? Do you have any experience? Are you for it or against it?

Mark Talamanti, MD, Chicago, Ill: I have a question about the spectrum of the disease that you described. We too are seeing an increased incidence of this in our institution, probably because anybody who comes into the emergency department with appendicitis, kidney stones, or a bowel obstruction gets a CT scan. So we find the lesions to be much smaller than the examples that you gave today, and I would like to know from your perspective if you are seeing disease earlier, smaller, and with an increasing percentage of asymptomatic patients. Along those lines we have found the use of endoscopic ultrasonography by dedicated interventional gastroenterologists to be helpful with cyst aspiration and cyst fluid analysis. I wonder if you have any experience with endoscopic ultrasonography and specifically cyst fluid analysis with endoscopic ultrasonography.

Theodore X. O’Connell, MD, Los Angeles, Calif: I have 3 questions for the authors. First, we are all seeing many more of these cystic lesions of the pancreas because they are incidental findings—“incidentalomas”—and of the 70 [sic] pa-

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just part of the duct is involved because that may tell you about what operation you want to do. Even though we have no experience with MRCP, I believe that this test is slowly becoming the standard by which cystic tumors will be diagnosed in the future.

Dr Potts also asked about analysis of cyst fluid, and we have not used it greatly. That brings up Dr Talamanti’s question I believe on endoscopic ultrasonography. Endoscopic ultrasonography is being used by some of our gastroenterologists to aspirate cystic tumors. It is a double-edged sword. Some gastroenterologists are using it to aspirate the cyst fluid but are not sending the fluid for the proper markers and I think that we should get the word to them that these tumors are best treated surgically unless as was brought up by another discussant, Dr O’Connell, they are asymptomatic serous cystadenomas in the head of the pancreas and would need a Whipple procedure. What do I do with cyst fluid analysis? I use it if I am not going to operate on a patient or the patient has a lot of comorbidities like the last patient referred to me. This patient was 68 years old, weighed 300 lb, had an ejection fraction of 10%, and a cystic tumor that was 14 cm. The aspirate just showed glycogen-rich fluid with cuboidal cells. Now this was clearly a serous cystadenoma. Why would you want to operate on this patient? The patient was sent back to the referring hospital.

The next question was whether these tumors are becoming more common or are we diagnosing them more often because we are getting a lot of CTs for any nondescript pain in the abdomen? I do not know the answer to the environment, but I think we are seeing more of these tumors because we are doing more CT scans for nondescript pain or nonspecific complaints from patients.

Dr Potts is intuitive because we wanted to present a second paper with our survival data as well as some molecular markers. I will not tell you survival data for all of the tumors, but for the mucinous cystadenocarcinomas, all 5 are alive from 23 to 129 months. For the IPMNs, 3 died postoperatively. One person is alive with recurrent tumor at 11 months. The other 13 are alive from 11 to 100 months. For the solid pseudopapillary malignancies, 1 patient is dead after 6 years. The others are alive from 1 to 62 months.

To go back to the other questions, Dr Farnell, we have done 5 central pancreatectomies. It is easy to get to the pancreas. All you need to do is use a ring end retractor, take down the gastroduodenal ligament, put the stomach on the retractors, and then mobilize the splenic artery and the vein off the pancreas. We then transect the proximal pancreas just 1 cm away with a vascular stapler, for the distal side I use sutures and cut the pancreas because on the distal side I do a Roux-en-Y pancreaticojejunostomy or a pancreaticogastrostomy.

Dr Velasco asked the cytology question which I have told you we rarely use but do when we do not want to operate on the patient. Dr Madura asked about the denominator. I am following up 5 patients, all women with serous cystadenomas of the head who I feel have high risk because of heart disease so our denominator is 78. How many patients who have had aspirations by the gastroenterologists have not been sent to us? I cannot answer that question.

And finally, Dr O’Connell asked why patients with serous cystadenomas got Whipple operations. They were symptomatic and needed that operation so we went ahead with that operation. Of the 2 patients who died after the total pancreatectomy: one died from adult respiratory distress syndrome that developed soon after an operation, and the other one we could not find a reason. The patient failed to thrive and would not get better, and eventually do-not-resuscitate orders were established.

Dr Prinz, as far as enucleation goes, all of the papers that I have seen suggest that this procedure is associated with a post-operative pancreatic fistula. I know that Dr Lillemoe has published a paper that enucleation can be used for some of these tumors. Enucleation for these tumors, especially the IPMNs since they have K-ras mutations in the surrounding tissue, would not be the appropriate operation. So we have not used enucleation as a major modality in our series. Finally, like Dr Pickleman, I am a maximally invasive surgeon and so I have no experience with laparoscopy in these tumors.