

Clinical spectrum of adult patients with annular pancreas: Findings from a large single institution cohort

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ABSTRACT

Background and aims: Annular pancreas (AnnP) is a rare congenital abnormality that results from the presence of a complete or partial ring of pancreatic tissue surrounding the descending portion of the duodenum. While the clinical presentation and management of AnnP in neonates and infants has been well described, the complete spectrum of clinical presentation of AP in adults is not very clear. We aimed to describe the clinical spectrum of presentation and management of adult patients with AnnP.

Methods: Using the electronic medical record, we identified 198 patients with radiologically and/or surgically confirmed AnnP evaluated at Mayo Clinic between 1995 and 2017.

Results: The mean age of the study population at diagnosis was 55.1 (± 18.3) years (60% female). 60% of patients did not have symptoms attributable to pancreatic disease at the time of diagnosis and were diagnosed incidentally. Computed tomography (CT) was the most common modality (64%) of diagnosis. Among symptomatic patients, abdominal pain (50%), duodenal obstruction (31%) and acute pancreatitis (16%) were the most common symptoms (non-exclusive). While most patients with duodenal obstruction required surgery, all patients with acute pancreatitis could be managed conservatively in the absence of competing indications for intervention.

Conclusion: AnnP may remain asymptomatic well into adulthood and be incidentally detected on abdominal imaging done for other indications. While surgery remains the mainstay of treatment in patients presenting with duodenal obstruction, a majority of these adult symptomatic patients with AnnP, including those with acute pancreatitis require no further treatment.

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Introduction

Annular pancreas (AnnP) is a congenital abnormality thought to be caused by a malrotation of the ventral pancreatic bud during embryonic development. It was first reported in 1818 and manifests as a complete or partial ring of pancreatic tissue surrounding the descending portion of the duodenum (Figs. 1 and 2) [1,2]. The

prevalence of AnnP was estimated to be about 1 in 20,000 cases based on autopsy studies [3,4]. However, recent radiology based series have estimated a higher prevalence of approximately 1 in 1000 Refs. [5–7].

The clinical presentation and management of AnnP in the pediatric population has been well described [8,9]. These patients typically present with duodenal obstruction, often requiring surgery in the neonatal period [10–12]. The description of AnnP in the adult population is largely limited to case reports, case series and studies on symptomatic adults [6,12–25]. Despite data suggesting that AnnP may be as common in adults as in the pediatric population [12], the spectrum of clinical presentation and management strategies of AnnP in adults remain poorly understood.

In this large single-institution study we aimed to describe the

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Abbreviations

AnnP	Annular Pancreas
CT	Computed tomography
ERCP	endoscopic retrograde cholangiopancreatography (ERCP)
FAP	familial adenomatous polyposis
HNPCC	hereditary non-polyposis colon cancer
HCC	hepatocellular carcinoma
IPMN	intraductal papillary mucinous neoplasm
PDAC	pancreatic ductal adenocarcinoma
RCC	renal cell cancer



Fig. 1. Images from a computed tomography (CT) showing a band of pancreatic tissue (arrow) surrounding and compressing the descending part of the duodenum (D2) (arrowhead).

clinical spectrum and outline management strategies for adult patients with AnnP.

Patients and methods

Case ascertainment

The study was approved by the Institutional Review Board at Mayo Clinic. The Mayo Clinic electronic medical record was searched for patients seen at Mayo Clinic, Rochester between 1995 and 2017 who had:

- A diagnosis or billing ICD-9 code 751.7, (anomalies of pancreas) or the word “annular pancreas” in the text of the clinical notes, OR
- Any radiology report that mentioned the word ‘annular pancreas’

Medical records of patients identified (n = 328) from the above

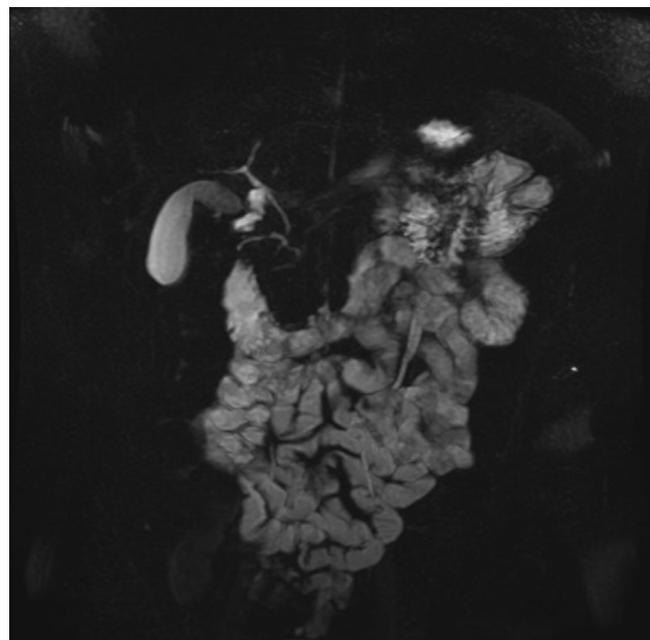


Fig. 2. Magnetic resonance cholangiopancreatography (MRCP) image showing the pancreatic duct encircling the duodenum, as seen in patient with annular pancreas.

sources were then consolidated to remove duplicates, and manually reviewed (SJSN, TP, SS, AS). The presence of annular pancreas was confirmed based on physician documentation of the diagnosis, which had to be further supported by review of surgical, endoscopic ultrasound or endoscopic retrograde cholangiopancreatography (ERCP) procedures or imaging records done at our center or outside medical facilities. Cases with ‘probable’ or ‘suspected’ AnnP and those with AnnP listed as a possible differential for duodenal obstruction but without any definitive imaging evidence of AnnP were excluded. Patients with a history of AnnP that were diagnosed or treated before the age of 18 years of age were also excluded. Overall, 198 patients met criteria for inclusion.

Data collection and statistical analysis

Study data were collected and managed using REDCap electronic data capture tools hosted at Mayo Clinic. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources. Data were exported and analyzed using JMP version 12.2 (SAS Institute, Cary NC). Wilcoxon and Chi-square tests were used for comparison between groups. A p value of less than 0.05 was defined as the threshold for significance prior to the study.

Results

Overall, 198 patients with AnnP were included in the study. The mean age of the study population at diagnosis was 55.1 (± 18.3) years. One hundred and sixteen (58.6%) of the patients were female. Information regarding race was available in 183 patients of which 173 (87.3%) patients were Caucasian, 7 (3.5%) were African American, 1 (0.5%) Asian-Indian, 1 (0.5%) Asian-Vietnamese and 1 (0.5%)

American-Indian. The median (range) follow up was 561 (0–4873) days.

Clinical presentation

The majority (n = 118; 59.6%) of patients did not have symptoms attributable to pancreatic disease at the time of diagnosis and were diagnosed incidentally. Among the 80 symptomatic patients, abdominal pain (50%), duodenal obstruction (31.3%), acute pancreatitis (11.25%) were the most indications for abdominal imaging (nonexclusive, [Table 1](#)). Patients presenting with acute pancreatitis did not significantly differ from the remaining study population in terms of age (mean age 55.6 ± 18.3) years (p = 0.88) and gender distribution (61.5% female) (p = 0.19). Thirty-five patients (17.7%) with AnnP in our series had a concomitant neoplasia. Pancreatic neoplasia was the most common type with 18 (51.4%), out of which 3 (8.6%) had pancreatic ductal adenocarcinoma (PDAC), 2 intraductal papillary mucinous neoplasm (IPMN) and 1 serous cystadenoma. Details of the other types of malignancies noted are provided in [Table 1](#).

Modality of diagnosis

Over half of the patients 126 (63.6%) were diagnosed with computed tomography (CT) as compared to 50 (25.2%) with magnetic resonance cholangiopancreatography (MRCP), 10 (5.1%) at surgery, 8 (4.1%) on endoscopic ultrasound (EUS) and 4 (2%) on endoscopic retrograde cholangiopancreatography (ERCP). Sixty-six (33.3%) had at least one prior investigation that missed the diagnosis of annular pancreas (non-exclusive and including 65 CTs, 10 MRIs and 4 EUS) ([Fig. 3](#)).

Management

Overall, 165 patients (83.3%) (including 47 symptomatic patients) required no further treatment, 28 (14.1%) underwent surgery and 5 (2.5%) underwent ERCP (2 underwent sphincterotomy, 1 underwent pancreatic duct dilatation with stent placement). Indications for surgery in the 28 (14.1%) patients were as follows: 21 duodenal obstructions, 3 acute or recurrent acute pancreatitis along with cystic lesions in the pancreas (which had worrisome features by themselves), 2 obstructive jaundice and 2 pancreatic mass. Details of the exact surgery performed were available for the 23 done at our institution, and included a bypass procedure in 14 patients (Gastrojejunostomy in 10, Duodenoduodenostomy in 2, Duodenojejunostomy in 2), pancreaticoduodenectomy in 7 (including 1 pylorus preserving pancreaticoduodenectomy), total

pancreatectomy in 1 and annular ring resection in 1. Indication for ERCP (n = 5; 2.5%) was as follows: 2 for obstructive jaundice, 1 each for dilated pancreatic duct, acute pancreatitis with pancreas divisum, and abdominal pain).

Duodenal obstruction

Out of the 25 patients who presented with complete or partial duodenal obstruction secondary to underlying annular pancreas, 20 underwent surgery which included 9 with gastrojejunostomy, 4 duodenojejunostomy, 1 annular ring resection, 1 with unknown type of surgery. Out of the 5 patients that did not undergo surgery, one patient had duodenal obstruction secondary to acute pancreatitis with pancreas divisum, and underwent ERCP with minor papilla sphincterotomy. Two others had partial duodenal obstruction and did not immediately require surgery as they improved with conservative management, 1 patient denied surgery and 1 was managed with duodenal dilation alone.

Acute pancreatitis

Thirteen patients presented with acute pancreatitis (4 single episode, 9 recurrent) 8 patients (2 single, 6 recurrent) with acute pancreatitis were managed conservatively. The remaining 5 patients required endoscopic (n = 1, ERCP with sphincterotomy) or surgical intervention (n = 4, [Table 2](#)). However, 3 of these also had concurrent pancreatic cystic lesions and another patient had pancreas divisum ([Table 2](#)).

A proposed management algorithm for patients with AnnP is provided in [Fig. 4](#).

Discussion

In this largest ever case series of 198 adult patients with AnnP, we provide unique insights into the clinical presentation and management of these patients. We show that the majority of patients with AnnP are asymptomatic and diagnosed incidentally. We also show that while patients with duodenal obstruction require surgery, those with acute pancreatitis require no further treatment in most situations.

In a previous study, Zyromski et al. described 54 adult patients with AnnP and compared their characteristics with children with AnnP. Although the study provides a detailed description of patients with AnnP, it is primarily focused on patients with symptoms. Our study shows that 60% patients with underlying AnnP are actually asymptomatic. Among symptomatic patients, abdominal pain was the most common presenting symptom, followed by pancreatitis. Also, most patients were diagnosed on CT imaging as compared to their study where patients were diagnosed with ERCP. Although, this could be explained by the fact that their patients were symptomatic, this likely also reflects the emerging role of imaging in diagnosis of pancreatobiliary disorders. Our data also contrasts with Zyromski et al. with regards to the management of symptomatic AnnP. A minority of our symptomatic patients (33/80) had any intervention, 28 of which underwent surgery for duodenal obstruction or pancreatitis in the presence of a cystic mass concurrent with the AnnP. In fact, most patients with AnnP in our series who developed pancreatitis (including 6 out of 9 with recurrent acute pancreatitis) were managed conservatively. The 3 other patients with recurrent acute pancreatitis, and one with a single episode of acute pancreatitis also had other indications for intervention. Therefore, no patient with pancreatitis required surgery solely based on the presence of AnnP. On the other hand, most patients with duodenal obstruction required surgery.

A number of case reports and case series have reported an

Table 1
Indications for abdominal imaging among symptomatic patients with annular pancreas (n = 80) (non-exclusive).

	Number of cases	%
Abdominal pain	39	48.8
Duodenal obstruction	25	31.3
Acute pancreatitis	13	16.3
Single Episode	4	5
Recurrent	9	11.3
Other ^a	8	10.0
Pancreatic mass/pancreatic cancer	5	6.3
Suspected chronic pancreatitis	4	5.0
Early satiety	4	5.0
Obstructive jaundice	4	5.0
Gastroduodenal ulceration	2	2.5

^a Includes 2 cases with bloating and 1 each with elevated pancreatic enzymes, pancreatic cyst follow up (side branch IPMN), benign cyst, Crohn's disease, focal pancreatic necrosis, and elevated liver function test.

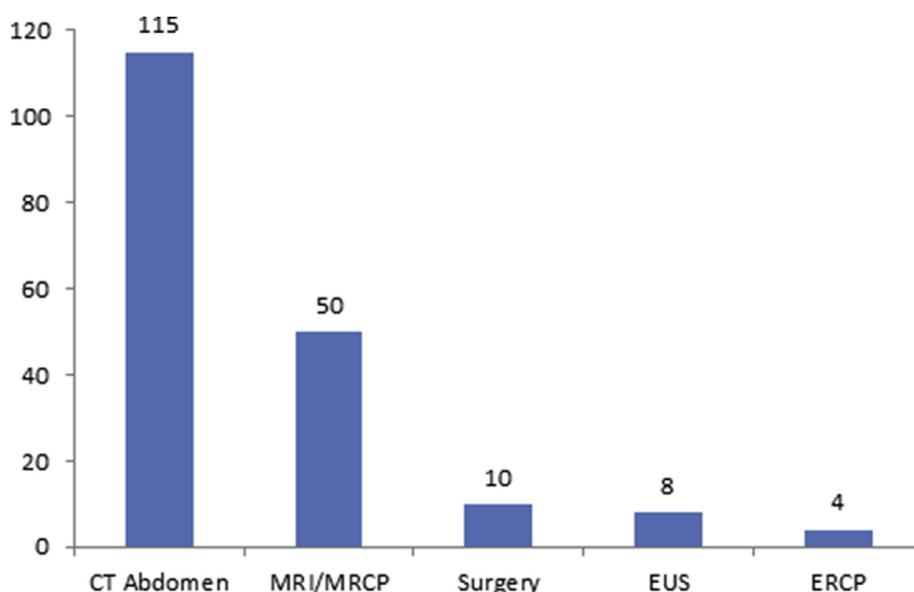


Fig. 3. Modality of diagnosis in patients with annular pancreas (n = 198).

Table 2

Characteristics of patients with AnnP who developed pancreatitis.

No.	Age	Gender	Type	Diagnosis	Management	Other confounding etiology for pancreatitis	Other significant characteristics	Long Term Outcome
1	56	F	Single episode	MRCP	Conservative	No	Roux-en-Y anatomy	Alive with no recurrence
2	87	F	Single episode	CT	Conservative	No		Alive with no recurrence
3	40	F	Single episode	CT	Duodenojejunostomy	No	Had concurrent duodenal obstruction	Alive with no recurrence
4	68	F	Single episode	EUS	ERCP with minor papilla sphincterotomy	No	Had pancreas divisum as well	Alive with no recurrence
5	37	M	Recurrent	MRCP	Conservative	No		Alive
6	89	M	Recurrent	MRCP	Conservative	Gallstones (first episode)	One episode of pancreatitis despite cholecystectomy	Dead from other causes
7	62	M	Recurrent	MRCP	Total pancreatectomy	IPMN	Total pancreatectomy for concurrent IPMNs	Alive
8	64	F	Recurrent	ERCP	Whipple	IPMN	Eventually had completion pancreatectomy for IPMN	Alive, no further recurrence
9	45	M	Recurrent	CT	Conservative	Hypertriglyceridemia	Recurrent, milder episodes despite control of triglycerides	Alive
10	48	F	Recurrent	MRCP	Conservative	No		Alive
11	47	M	Recurrent	CT	Pylorus preserving pancreaticoduodenectomy	Alcohol	Underwent surgery for 11.5 cm, multiloculated cystic head mass, found to be pseudocyst	Alive, no further recurrence
12	44	F	Recurrent	MRCP	Conservative	Hypertriglyceridemia		Alive, no further recurrence
13	56	F	Recurrent	MRCP	Conservative	No		Alive, no further recurrence

Table 3

Type of neoplasia in patients with annular pancreas.

Type of neoplasia	Number of Patients	Details
Pancreas	6	3 PDAC, 2 IPMN, 1 serous cystadenoma
Other GI	12	1 Jejunal, 2 HCC, 2 cholangiocarcinoma, 1 colon, 1 esophageal, 1 FAP, 1 hepatic adenoma, 1 HNPCC, 2 rectal
Renal	3	3 renal (bilateral RCC counted as one patient)
Urologic	5	3 prostate, 2 urothelial
Breast	1	unknown type
Lung	1	adenocarcinoma
Thyroid	1	medullary cancer
Abdominal	2	retroperitoneal liposarcoma, retroperitoneal sarcoma

PDAC: pancreatic ductal adenocarcinoma, IPMN: intraductal papillary mucinous neoplasm, HCC: hepatocellular carcinoma, FAP: familial adenomatous polyposis, HNPCC: hereditary non-polyposis colon cancer, RCC: renal cell cancer.

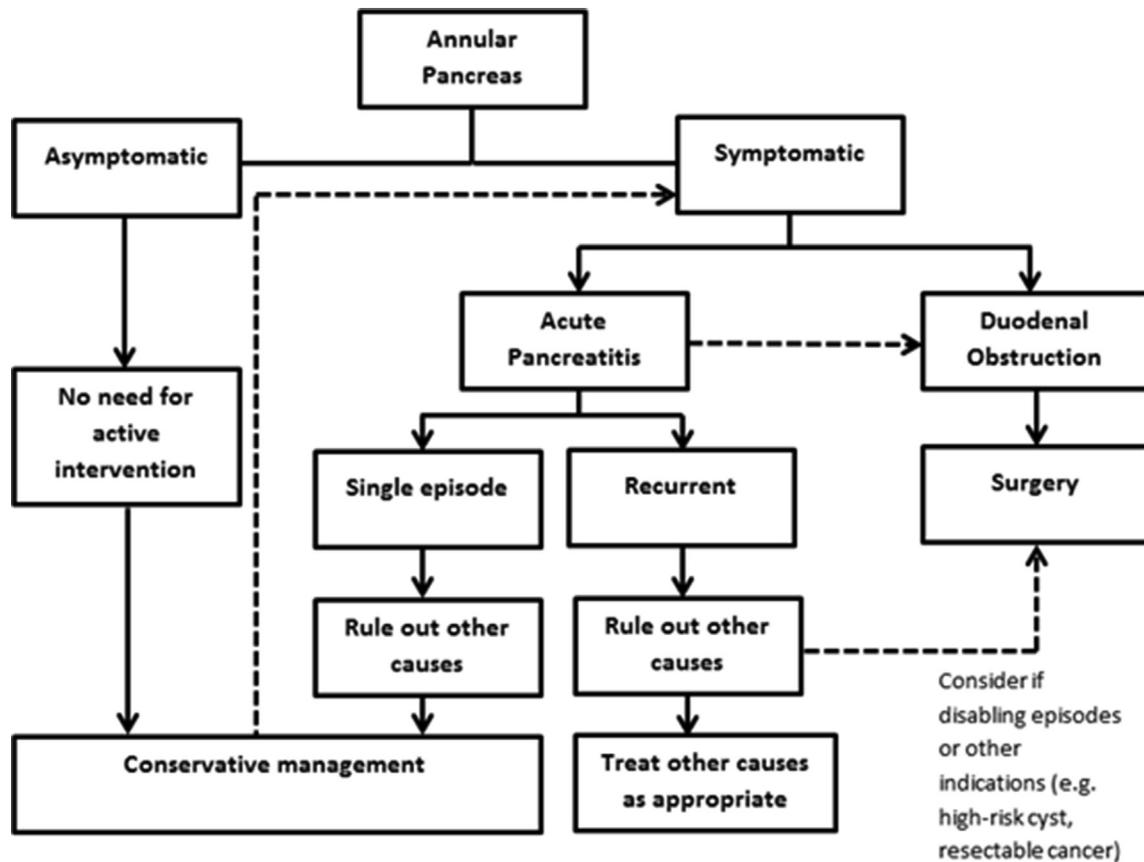


Fig. 4. Proposed management algorithm for patients with annular pancreas.

increased association of AnnP with neoplasia, pancreatic and extrapancreatic [12,17,26]. In our series 35 (17%) patients had some form of neoplasia and AnnP, 3 of which were pancreatic adenocarcinomas. This number is slightly higher than that reported by Zyromski et al., primarily due to the exclusion of pediatric cases in our series. Amongst cancers reported in patients with AnnP, cancers of the ampulla are most common, followed by pancreatic head tumors and cholangiocarcinoma [27–29]. This has been postulated to be secondary to chronic inflammatory changes secondary to the annular pancreas which is why tumors in the body may be rare, or possibly not even associated with AnnP [27], although it is also possibly related to the higher incidence of other congenital malformations and genetic defects in patients with AnnP, and the increased incidence of neoplasia is merely an association, not due to the underlying AnnP [12].

Surgical management for AnnP is necessary for patients with AnnP presenting with a duodenal obstruction but a dilemma exists in patients with pancreatitis with AnnP without intestinal obstruction. Conservative management provides temporary relief, but does not eliminate the risk of future attacks, chronic pancreatitis and pancreatic malignancy. Although in our series, the patients with acute pancreatitis who underwent surgery had additional indications for surgery, we recommend that a pylorus preserving Whipple's procedure can be considered in exceptional cases recurrent, disabling attacks for acute pancreatitis on a case-by-case basis. Surgical resection of the pancreatic annular ring was supported by initial reports on AnnP, but is best avoided as it was later found to be associated with an increased risk of complications such as the formation of pancreatic fistulae and pancreatitis [30–33]. In our patient that underwent annular ring resection, the main

indication for surgery was a perforated gastric ulcer, and the annular pancreas was noted after its repair. Given the anastomosis, the surgeons felt the field would be a contaminated field, and elected not to perform a gastrojejunostomy and performed an annular ring resection instead.

Despite being the largest study on this condition in the adult population, our study has a few limitations. As the study relied on searching the radiologic databases for possible annular pancreas, it is possible that not all patients who had annular pancreas were included. To reduce the impact of this limitation, we also searched the clinical charts to confirm if there was a diagnosis or clinical documentation of a confirmed annular pancreas. However, it is still possible that a few cases of AnnP were not captured. Those patients are very likely to be asymptomatic and it is possible that the true proportion of patients with AnnP who are asymptomatic is higher. Secondly, as all our patients that underwent surgery had another indication for surgery, it is difficult to identify precisely which patients with AnnP require surgery in the absence of other indications such as bowel obstruction.

In conclusion, AnnP may remain asymptomatic well into adulthood and be incidentally detected on abdominal imaging done for other indications. No intervention is necessary in asymptomatic patients. While surgery remains the mainstay of treatment in patients presenting with duodenal obstruction, the majority of adult symptomatic patients with AnnP, including those with recurrent acute pancreatitis require no further treatment.

Conflicts of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pan.2018.12.009>.

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