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Comparison of pancreas-sparing duodenectomy (PSD) and pancreatoduodenectomy (PD) for the management of duodenal polyposis syndromes

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ABSTRACT

Background: Familial adenomatous polyposis affects primarily the colon but can also involve other locations within the gastrointestinal tract, including the duodenum. The aim of this study was to describe a single center experience with pancreas-sparing duodenectomy for familial adenomatous polyposis and to compare outcomes with pancreatoduodenectomy performed for duodenal polyp disease.

Patients and Methods: A retrospective review of a prospectively maintained database identified patients who had undergone pancreas-sparing duodenectomy during the period 2001 to 2016. This population was matched 1:1 with a cohort of patients undergoing pancreatoduodenectomy for duodenal adenomas, both sporadic and familial, during the same time period. Baseline demographics and perioperative (short- and long-term) outcomes were compared.

Results: A total of 88 patients were included; 44 in each group. The pancreas-sparing duodenectomy cohort was younger (52.6 vs 64.3 years; $P < .001$) and more patients had undergone prior colectomy (100% vs 32%; $P < .001$) or additional prior abdominal surgery (27% vs 9% ($P < .001$). Median operative times were greater for pancreatoduodenectomy (391 vs 460 min; $P = .002$). There was no difference in any of the early postoperative complications. There was 1 30-day mortality in the pancreatoduodenectomy group secondary to aspiration. Late acute pancreatitis was more common after pancreas-sparing duodenectomy (16% vs 0%; $P = .012$) and exocrine pancreatic insufficiency was more common after pancreatoduodenectomy (30% vs 11%; $P = .034$).

Conclusion: Pancreas-sparing duodenectomy is a reasonable option for duodenal cancer prophylaxis in familial adenomatous polyposis with high-risk features. The perioperative safety profile is comparable to pancreatoduodenectomy done for similar indications, and pancreas-sparing duodenectomy has a favorable long-term with a lesser incidence of exocrine impairment.

Introduction

Familial adenomatous polyposis (FAP) is a well-recognized, autosomal dominant syndrome that arises in individuals that harbor the adenomatous polyposis coli germline mutation on chromosome 5q21.[1] The colonic manifestations of the disease are predictable with an adenomatous polyp to cancer progression in 90% by the age of 40 years.[2]

Adenomatous polyps typically affect other locations within the gastrointestinal tract as well, including the duodenum where polyposis has been reported in between 30 and 92% of patients.[3] Although the rate of malignant transformation is considerably less than for the colon (in the order of 5%),[4,5] this risk is 100 to 331 times the rate in the general population,[6,7] and as such, duodenal adenocarcinoma is the second most common cause of cancer-related death in patients with FAP.

The variable penetrance of disease in the duodenum makes patient selection for prophylaxis a challenge. A scoring system was developed by Spigelman and colleagues (Table I) to stratify

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Table I
Spigelman classification for duodenal polyposis in familial adenomatous polyposis (FAP)

Variables	Points		
	1	2	3
Number of polyps	1–4	5–20	>20
Polyp size (mm)	1–4	5–10	>10
Histology	Tubular	Tubulo-villous	Villous
Dysplasia	Mild	Moderate	Severe

Stage 0: 0 points, Stage I: 1–4 points, Stage II: 5–6 points, Stage III: 7–8 points, Stage IV: 9–12 points.

patient-risk based on polyp number, size, histopathology, and degree of dysplasia.[8] Patients with Spigelman stage IV polyps have a 36% risk of cancer within 10 years of diagnosis, and thereby, should be considered for prophylactic surgical intervention.[5] Likewise, some patients with Spigelman stage III polyps may also be candidates for resection and particularly if severe dysplasia is identified, because these lesions may also harbor unexpected duodenal adenocarcinomas.[9]

There are a number of options for the management of duodenal polyposis in FAP.[9] When a single or low number of polyps are present with a favorable anatomic distribution, duodenotomy with polypectomy or segmental resection may be appropriate.[10] In contrast, when the disease involves the entire duodenum including the ampulla, definitive resection of the duodenum is required. Duodenectomy may be achieved by either a pancreatoduodenectomy (PD) or by excising the duodenum alone, a pancreas-sparing duodenectomy (PSD), also known as pancreas-preserving duodenectomy.[11] The potential advantage of PSD is easier jejunal surveillance and preservation of an innocent pancreas, and as a result, its baseline endocrine and exocrine functions are preserved as well.

The aim of this study was to describe a single center experience with PSD for FAP and to compare outcomes with PD performed for duodenal polyp disease.

Patients and methods

A prospectively maintained database approved by the institutional review board was interrogated to identify all patients who had undergone PSD between 2001 to 2016. This population was matched 1:1 with a cohort of patients undergoing PD for adenomatous duodenal pathology, both sporadic and familial etiologies, during the same time period.

Perioperative variables collected included operative duration, blood loss, development of a pancreatic fistula or presence of delayed gastric emptying as defined by the international study group for pancreatic fistula[12] and international study group for pancreatic surgery[13], respectively, surgical site infection. documentation and classification of complications according to the Clavien-Dindo classification, and duration of hospital stay.

We also documented the development of long-term complications including diabetes mellitus (DM), exocrine pancreatic insufficiency (EPI), acute pancreatitis, need for revisional surgery, and 30- and 90- survival. For the purposes of this study, the presence of DM was defined as the need for hyperglycemic therapy either with an oral agent or insulin; EPI was defined by the requirement for pancreatic enzyme replacement therapy for the management of textbook symptoms of EPI, such as steatorrhea, flatulence, and malabsorption.

The technique of PSD has been described previously by our group and is highlighted in Fig 1, *A*, together with the reconstruction used in a PD in Fig 1, *B*.[14,15] Briefly, the jejunum is transected distal to the ligament of Treitz and its mesentery is divided close to the mesenteric border of the bowel working proximally to the duodenum. If the gallbladder is in situ, a cholecystectomy is performed. The cystic duct is then cannulated, and a Fogarty catheter is placed to allow identification of the ampulla. The duodenum is transected distal to the pylorus and dissection of the duodenum continues until the ampullar is encountered. The entire ampullary complex is resected, including any polyp tissue extending up the distal bile duct or pancreatic duct. The ductal reconstruction is performed by means of a single layer anastomosis between the common channel and an advanced loop of jejunum. If the common channel is narrow, the septum between the pancreatic and biliary ducts may be spatulated. An end-to-side anastomosis between the very short segment of the most proximal duodenum and the jejunum is performed just distal to the pancreaticobiliary anastomosis to allow for thorough endoscopic assessment of the jejunum during subsequent surveillance.

The resectional technique of PD is well described in the literature. We uniformly perform a pylorus-preserving PD and reconstruct intestinal continuity by creating an antecolic pancreatojejunostomy, choledochojejunostomy, and duodenojejunostomy.

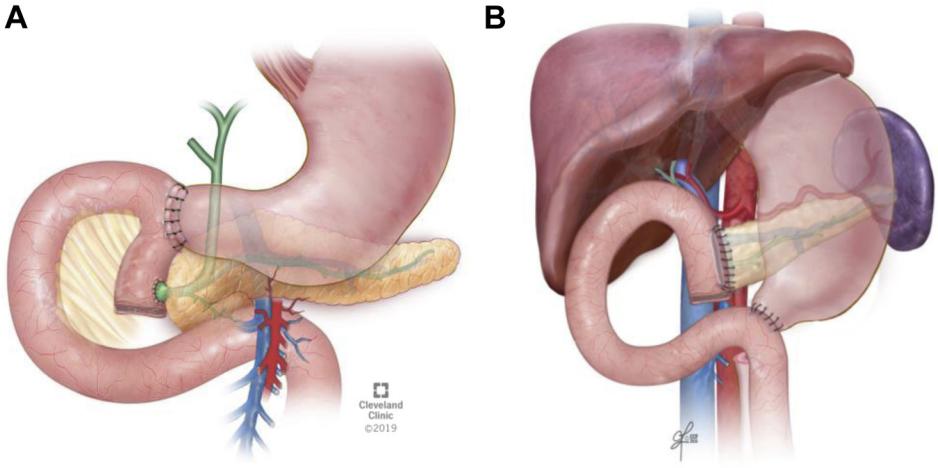

Fig 1. Diagramaphic representations after duodenectomy. (*A*) Reconstruction configuration after PSD. (*B*) Reconstruction configuration after PD.

Table II
Demographic characteristics of PSD and PD patients

Variables	PSD (n = 44)	PD (n = 44)	*P* value
Age, mean +/- SD	52.6 ± 11	64.3 ± 14	<.001
Male, *n* (%)	26 (59)	18 (41)	.068
FAP, *n* (%)	44 (100)	14 (32)	<.001
History of colectomy, *n* (%)	44 (100)	14 (32)	<.001
History of noncolonic abdominal operation(s), *n* (%)	12 (27)	4 (9)	.051
Concomitant operative procedure, *n* (%)	12 (27)	5 (11)	.059

Statistical analysis was performed with SAS software (SAS Institute Inc; Cary, NC). Continuous and ordinal variables were assessed by the Wilcoxon rank sum test as appropriate, while categorical variables were analyzed utilizing Pearson χ^2 or Fischer exact test.

Results

Over a 16-year period (2001–2016), a total of 44 patients underwent PSD. This cohort was compared to an identical number of patients undergoing PD. The demographics of the study cohort are summarized in Table II. In the PSD group, all patients underwent an operation for FAP, while in the PD group, 14 patients had a diagnosis of FAP and the remainder had solitary duodenal adenomatous polyps ($n = 30$) without preoperative diagnosis of invasive cancer ($P < .001$). The mean age was younger in patients undergoing PSD than PD (52.6 ± 11years vs 64.3 ± 14 years; $P < .001$). Analysis of sex distribution revealed a predominance of males ($n = 26$, 59%) in the PSD group and of females ($n = 26$, 59%) in the PD group ($P = .068$).

In the PSD group, all patients had a past medical history of colectomy, and a colonic resection had also been performed for the 14 patients in the PD group who had FAP ($P < .001$). In the PSD cohort, there were greater numbers of patients who had undergone additional abdominal operations prior to presentation for duodenectomy (27% vs 9%; $P = .051$) .More patients in the PSD cohort underwent additional procedures at the time of duodenectomy (27% vs 11%; $P = .059$).

The perioperative outcomes were similar for both populations as summarized in Table III. The PSD procedure was performed in less mean time than PD (391 vs 460 minutes; $P = .002$), while median blood loss was the same in both groups at 400 mL.

For all early postoperative complications, including postoperative pancreatic fistula, acute pancreatitis, delayed gastric emptying, and surgical site infection (superficial and organ-space), there were no differences between the PSD and PD groups. Non-pancreatic leaks were more common in the PSD group ($P = .052$). There were reoperations in each cohort including laparotomy and washout (PSD $n = 2$; PD $n = 3$), leak at the duodenojejunostomy (PSD $n = 1$), and dehiscence (PSD $n = 1$; PD $n = 1$).

The median duration of hospital stay was 1 day less in the PSD group (9 vs 10 days; $P = .311$). There was a single 30-day mortality in the PD group secondary to aspiration, which was the only mortality up to 90 days ($P = .278$).

Long-term outcomes of both procedures are summarized in Table IV. The median follow-up was 107 months for PSD and 75 months for PD ($P = .01$). There was a difference in the incidence of EPI in favor of PSD (11% vs 30 %; $P = .034$) and a lesser rate of late acute pancreatitis in the PD group (0% vs 16%; $P = .012$). There were no differences in the diagnosis of new onset diabetes or the development of an incisional hernia.

The late reoperation rate for complications related to the index operation were not different between the groups. Revisional operative intervention with conversion of PSD to PD was required in 2 patients post PSD, in 1 patient for jejunal polyposis not amenable to endoscopic treatment and the other for recurrent pancreatitis in the ventral pancreas in setting of pancreatic divisum. One patient after PD required revision of the pancreaticojejunostomy for recurrent pancreatitis.

Discussion

The primary finding of the study is that both PSD and PD appear appropriate procedures for extensive polyposis that includes the ampulla. We have confirmed previous data from our institution that the morbidity of any pancreatoduodenal resection is high, but mortality is low whether for PSD or PD.[14,15] This observation

Table III
Perioperative outcomes of PSD and PD patients

Variables	PSD (n = 44)	PD (n = 44)	*P* value
Operative time (min), median (IQR)	391(340–429)	460 (368–558)	.002
Estimated blood loss (mL), median (IQR)	400 (200–450)	400 (213–538)	.283
Clavien-Dindo classes 1–4, *n* (%)	38 (86)	34 (77)	.269
Clavien-Dindo classes 3–4, *n* (%)	13 (30)	7 (16)	.127
Pancreatic fistula			
Biochemical leak (Grade A), *n* (%)	12 (27)	18 (41)	.177
Grades B/C, *n* (%)	6 (14)	5 (11)	.342
Early acute pancreatitis, *n* (%)	3 (7)	1	.616
Non-pancreatic anastomotic leak, *n* (%)	6 (14)	1	.052
Delayed gastric emptying, *n* (%)	13 (30)	11 (25)	.632
Surgical site infection			
Superficial, *n* (%)	10 (23)	6 (14)	.269
Organ space, *n* (%)	6 (14)	9 (21)	.395
Early reoperations, *n* (%)	4 (9)	4 (9)	>.999
Duration of stay (days), median (IQR)	9 (8–16)	10 (9–15)	.311
30-day mortality, *n* (%)	0	1	.728
90-day mortality, *n* (%)	0	1	.728

IQR, interquartile range.

Table IV
Long-term outcomes of PSD and PD for duodenal polyp disease

Variables	PSD (n = 44)	PD (n = 44)	*P* value
Median follow up (mo)	107	75	.01
Late acute pancreatitis, *n* (%)	7 (16)	0 (0)	.012
Exocrine pancreatic insufficiency, *n* (%)	5 (11)	13 (30)	.034
New onset diabetes mellitus, *n* (%)	3 (7)	5 (11)	.458
Late reoperation related to index, *n* (%)	2 (5)	1	>.999
Incisional hernia, *n* (%)	6 (14)	6 (43)	>.999

reinforces the need to select the best patients to benefit from prophylaxis of what is potentially a lethal cancer.

Our data demonstrate that perioperative morbidity is similar between PSD and PD in similar disease groups, yet long-term outcomes differ. Review of the literature identified 3 previous series comparing outcomes of PD and PSD in patients with duodenal pathology, although not in patients with FAP.[16-18] Two studies demonstrated statistically significant decreases in both operating time and blood loss in the PSD group,[16,17] and 1 reported a decrease in complications including pancreatic fistula.[16] In the current series, we reported a decrease in operative time but saw no difference in blood loss or perioperative complication rates. For several grade Clavien-Dindo classes 3 and 4, early postoperative acute pancreatitis and non-pancreatic leaks were more prevalent in the PSD, while organ-space surgical site infections were more common in the PD group.

There are 2 published series other than our own institution reporting experience of PSD in patients with FAP.[19,20] Their operative experience was similar to the figures in our current data with median operative times of 370 and 396 minutes, and blood losses of 340 mL and 480 mL. Perioperative complications were also similar to our experience. One unexpected finding was the fact that the median operative time for PD was greater than for PSD at 460 vs 391 minutes. Given the universal performance of prior colectomy in the PSD cohort and the greater prevalence of consecutive procedures in this group, this is difficult to explain. The PD cases in this series were not performed laparoscopically or robotically, indeed such cases were excluded, because no PSDs were performed using minimally invasive techniques and so not explained by a minimally invasive learning curve.

A major morbidity of both PSD and PD is the development of pancreatic fistula. Both procedures have a biliary anastomosis directly in continuity with the pancreatic anastomosis, or in very near proximity that may complicate the severity of the pancreatic fistula. The risk of developing a pancreatic fistula after PD has been predicted with some risk score accuracy by the combination of factors.[21] This clinical risk score calculator includes the characteristics of the gland parenchyma, underlying disease, duct size, and excessive blood loss as predictors of development of a fistula. We intentionally compared PD and PSD in patients with similar risks of developing a pancreatic fistula. The presence of a normal soft gland and normal duct predicted a relatively high risk of fistula that was similar in both patient groups. Another major perioperative complication seen commonly after PSD and PD is delayed gastric emptying. We advocate for placement of bridled naso-jejunal feeding tubes to maintain enteric access in these patients should they develop delayed gastric emptying after either operation.

Of note is the different patient demographics in the PSD and PD cohorts. The former was younger and male dominant. The younger age is related to the presence of FAP and the surveillance this cohort undergoes. In relation to patient's sex, the St Mark's group demonstrated equal sex distribution but noted a dominance of males undergoing colorectal surgery, which they attributed to a referral bias.[5] Extensive review of the literature on duodenal polyposis in FAP revealed no evidence of a bias according to patient sex and, therefore, the origin of the male predominance is unclear.[3–10]

All of these operations in the current series were performed open via laparotomy, although case reports of minimally invasive (laparoscopic and/or robotic) PSD have been reported,[22] and there is a growing body of literature on minimally invasive PD, including at our own center.[23] The majority of the patients in this series had prior open colectomies (all PSD and 14 PD), but with the current increase in laparoscopic colectomies, more consideration should be given to managing duodenal polyposis with a minimal access PSD or PD. While the operative approach should not alter the indication for duodenectomy, the broader experience with minimally invasive PD may favor that approach in FAP.

The decision to proceed with duodenectomy based on extent of the disease appears to be valid, and stratification by the Spigelman score also seems justified. The majority of patients had Spigelman scores of IV, and there was ampullary involvement by polyps. Overall, a quarter of patients with FAP had a preoperative pathologic diagnosis of high-grade dysplasia, and only rarely was this found to be associated with an undiagnosed carcinoma in the duodenectomy specimen. Indeed, a high suspicion based on preoperative endoscopic findings of ulceration, jaundice, or suspicion of invasion on endoscopic ultrasonography would lead to a PD in the setting of high-grade dysplasia on biopsy. Additionally, a planned PSD can be converted to PD based on palpable findings of a firm mass or based on frozen section of the ampulla or the most suspicious duodenal polyps. Regardless, PSD seems justified for both patients with Spigelman Stage IV and/or pathologic high-grade dysplasia.

This series is unique in the number of patients undergoing PSD, a comparable group of patients undergoing PD, and the duration of follow-up. Previously published series of PSD have been small (median 12 patients [range 4–25]) with variable but usually short-term follow-up and a wide range of pathologies.[16–20] Of the 2 series including PSD patients,[19,20] there were a total of 15 patients, and the median follow-up of the 2 series were 23 and 15 months. While in our series of 44 patients undergoing PSD, the median follow-up was 107 months.

The broad use of PD for a wide range of benign and malignant disease makes it the default choice for most surgeons. This is unfortunate given that the pancreas is an innocent bystander, which becomes a victim of association. The use of PD specifically in duodenal FAP suggests worrisome outcomes. Similar to other PSD series, the reported PD series in FAP have a limited number of patients with the largest series in the literature being 38 patients reporting a morbidity rate of 76%, a pancreatic fistula rate of 42%, and a mortality rate of 5%.[24] These figures are substantially different than the standard outcome measures in PD performed for pancreatic carcinoma and reflect the soft gland and nondilated duct seen in patients with duodenal FAP.

In addition to perioperative morbidity, there are long-term consequences to pancreatic resection, primarily exocrine insufficiency requiring pancreatic enzyme replacement therapy, which was observed in almost 30% of the PD patients in the current series.

While it may be expected given pancreatic preservation that the incidence of exocrine pancreatic insufficiency should be zero, this, however, was not the case due to factors such as development of pancreatitis and also asymptomatic strictures in the PSD group. The incidence may indeed be greater than documented as no formal testing for exocrine pancreatic insufficiency was performed.

Interestingly we did not show a difference in endocrine pancreatic insufficiency between the PSD and PD cohorts. This difference is likely a reflection of normal gland function preoperatively, because patients are asymptomatic and are undergoing operations for cancer prophylaxis rather than symptoms. It should be noted, however, that we did not perform formal testing with a mixed-meal glucose tolerance testing, and thus the incidence of DM may be greater than reported.

Pancreatitis is an interesting morbidity after PSD that we identified in 18% of cases, predominantly after PSD. We have not been able to associate this with a pancreatic anastomotic stricture, which we presume is related to intermittent backwash of bile into the pancreatic duct due to proximity and loss of the sphincter. Fortunately, episodes of acute pancreatitis were mild or moderate, and no patient developed persistent organ failure or required necrosectomy. Only 1 patient required intervention which involved conversion from PSD to PD after developing recurrent pancreatitis, presumably as a result of a pancreas divisum. A PSD should not be performed when pancreatic divisum is found due to small duct size, particularly in the ventral gland. When it is discovered intraoperatively, conversion to PD is performed.

Close disease surveillance is advised after duodenal resection for the identification of both jejunal polyps and gastric cancer.[25,26] It is easier to perform endoscopic surveillance after PSD, because push or balloon extended endoscopy is required to survey the afferent limb after PD. Perhaps surprisingly, only 1 patient required conversion of PSD to PD for polyp progression, none at the neoampulla, presumably because the ampulla itself is completely resected.

The main limitation of the study is its retrospective nature. With the period chosen for analysis which excluded some of the earlier patients for which data was incomplete, we believe that this deficit is largely overcome. A second issue is the discrepancy of follow up in favor of PSD, this cohort having a more extensive duration of follow up. Because all perioperative data were captured equally, this discrepancy in follow up is only likely to impact long-term outcomes and as such may work slightly in favor of PSD. The imbalance in polyposis patients is also noteworthy. While this imbalance is unlikely to bias PSD as in looking at relevant factors such as blood loss, blood loss tended to be less in the pure polyposis syndrome PSD cohort, despite the abdomens being more hostile, and there being additional procedures performed in this group. Finally, the absence of an objective assessment of EPI might underestimate the number of patients who truly have and would have benefited from pancreatic exocrine replacement therapy.

In conclusion, PSD is a reasonable option for duodenal cancer prophylaxis in patients with FAP with high-risk features. The perioperative safety profile is comparable to PD done for similar indications, and PSD has a favorable long-term metabolic outcome profile with a lesser incidence of exocrine impairment. Long-term close endoscopic surveillance is still advised, because progression of and formation of new gastric and jejunal polyps is a risk in patients with PSD.

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Conflict of interest/Disclosure

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Discussion

Dr Marshall Baker (Maywood, IL): I want to thank the society for the opportunity to discuss this paper.

It really is an interesting topic. I think you all deserve to be congratulated on being innovators in the surgical world where I think we are having a harder and harder time being true innovators these days.

The authors present their series of pancreas sparing duodenectomy for familial adenomatous polyposis. They include 44 patients undergoing PSD and compare those to 44 matched patients undergoing pylorus preserving pancreaticoduodenectomy for isolated duodenal polyps and FAP. The primary findings are that PSD has similar rates of severities for the postoperative complications commonly seen following PPPD but is associated with shorter operative times (366 minutes vs 493 minutes) and lower rates of exocrine pancreas insufficiency (11.4 % vs 29.5%). These advantages are evident in spite the fact that the PSD cohort had on average a higher number of concomitant procedures performed than the patients in the PPPD cohort. This work is truly unique and landmark as the authors are one of the only centers in the country/world performing this operation and reporting outcomes from it.

This work is truly unique and landmark as one of the only centers in the world doing it, and I think you all deserve significant recognition for your efforts and are to be congratulated.

I have a few questions.

Number one, most of the Whipples (PPPDs) are being done for isolated duodenal polyps, and your OR times approximate 8 hours, which seems a little bit longer than you might expect for Whipples given the fact that your pathology is nonmalignant and you are probably not running into the vein issues that make our times longer these days. So, I wanted you to address that issue and to give us a sense of whether or not you think there is an advantage to the PSD in terms of the time you spent in the operating room.

Second, the other main advantage seems to be the pancreatic enzyme insufficiency benefit, and to me, that has always been one of the complications that we see following Whipple that is most subject to operator variability, meaning that we all tend to have our own practice patterns regarding how you prescribe enzymes when you do it. Some people, I think, test for fecal fat. Others start exocrine supplementation with nausea which might be related to something like delayed gastric emptying as opposed to true exocrine insufficiency, so how do you determine that and how do you decide who gets supplementation in your series?

The third question—I am going to change from the list I gave you—is about the pancreatitis issue. You all had one patient that required a revisional surgery of PD for divism after PSD. They made a revision to PD because of pancreatitis related to divism, and your pancreatitis rate is higher in your PSD group. Can you tell us more about the severity of the pancreatitis, how bad is it, how long did the folks that had it deal with it in the hospital? That was a significant issue for that cohort.

With regard to the divism, how do you work those patients up so you do not end up doing a PSD on patients that have pancreas divism?

I think you addressed all my other questions. Thank you again for the opportunity to discuss this paper. Very nice work.

Dr Gareth Morris-Stiff: Your first question is an interesting one and the finding did surprise me. The historical data was actually collected before I took over the database and we are now going back and having the operative times verified against our anesthesia department database and currently awaiting those results, because the median time for PD did appear long. There were concomitant procedures in both groups but, as you say, more in the PSD. So we are verifying that, but that is the data that we have to date, so that's how it's reported.

In terms of the EPI for this patient cohort, historically, we were giving enzymes based on symptoms postoperatively. We are now more aggressive in patients with pancreatic cancer, and we start enzymes preoperatively on the basis that if they have an obstructed duct, they have EPI by definition. However, for this cohort, we are not as aggressive as they typically do not have an obstructed pancreatic duct. We are actually checking for EPI using fecal elastase in all patients undergoing PD. It's part of an ongoing study, but it is likely to become standard of care.

In terms of the divisum, that was interesting with the 1 patient who ended up being converted from PSD to PD, and this patient had an MRI scan beforehand which failed to identify the divisum. Up until that point, all of our patients had MRIs to identify divisum. This patient's divisum was identified perioperatively, and the patient did well initially. She then developed intermittent episodes of pancreatitis, eventually developing chronic pancreatitis, and ended up having a conversion 7 years later, so went for quite a while with intermittent symptoms. We now do not perform MRIs and instead look operatively to identify a divisum, and if found we go straight to PD, and not try a PSD.

Dr Marshall Baker (Maywood, IL): The pancreatitis that you did see, how bad?

Dr Gareth Morris-Stiff: The pancreatitis severity varied. Actually, the one case I illustrated was quite an aggressive, local inflammatory process. None of the patients ended up ventilated or with other organ failure, however, the patients had prolonged hospital stays. I can't give you a precise breakdown in terms of severity for those with pancreatitis, but it was a significant issue for those that experienced it.

Dr Jeffrey Hardacre (Cleveland, OH): Congratulations, Gareth, on a great analysis on one of the largest series of these operations.

I think on one of your slides your numbers are a little small. For your Clavien Dindo III–IV complications, there was about a doubling in the PSD group versus the Whipple group. If your numbers were higher, that would clearly be a statistically and clinically significant difference, so I would like you to comment on that.

The other is with regard to the pancreatitis, do you think that etiology of that might be inadvertently suturing the pancreatic duct closed at the time of reconstruction, or is it anastomotic edema? In the handful of these that I have done, I have sutured a pancreatic duct stent with an absorbable suture just to allow it to pass after time. Might be something to consider?

Dr Gareth Morris-Stiff: In relation to the Clavien-Dindo III–IV and additional leaks, I agree 100%. This is likely a type 2 error, because although this is the largest series of PSDs to date, it is still small, and the complications are relatively uncommon. But I agree with you. The leaks do significantly prolong hospital stay when they occur, because if you have bile mixed in together with pancreatic juice, it gets messy.

In terms of the pancreatitis, I think it is due to be edema there at the anastomosis. We include a pancreatic stent in the reconstruction, so I do not think the pancreatitis is due to duct narrowing during suturing, it may be, but we are taking great care in not

suturing the pancreatic duct closed and as I said we are using stents. I think it is more likely edema, perioperative edema, the same way as you occasionally get biliary obstruction occasionally when you do a PD, when there is no true obstruction.

Dr Michael House (Indianapolis, IN): It's a great series and a lot of dedication to push this. I'm curious about the preoperative workup on these patients. It leaves us quite nervous to even leave behind a duodenal cuff in patients with known FAP, penetrant polyposis, particularly extensively in the duodenum, with any degree of dysplasia, and certainly high-grade dysplasia.

If you can help me and maybe the rest of the members of interest in the audience to know how extensively you evaluate both the proximal duodenum just beyond the pylorus, if you are going to a pylorus preserving procedure, and then alternatively, how do you evaluate the ampulla? Do you actually do have investigation of the ampulla and directed biopsy of the ampulla? Because we are also concerned with leaving behind ampullary mucosa in a patient with FAP.

Dr Gareth Morris-Stiff: The additional leaks, I agree 100%. Dr Walsh is one of the team of endoscopists, and there are a couple of advanced endoscopy gastroenterologists, so it's limited to 2 or 3 endoscopists who see all these patients, so we limited the number of individuals involved to include the standard of care. So, we have both for our analysis.

In terms of the ampulla, yes, we do selective biopsies in that region, to determine if the disease is indeed significant around the periampullary complex. In our experience we have not had a problem with recurrence in that region.