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Non-Whipple Operations in the Management of Benign, Premalignant and Early Cancerous Duodenal Lesions

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Abstract. *Aim: We reviewed our 20-year experience with non-Whipple operations (pancreas-preserving duodenectomy and transduodenal ampullectomy) for the treatment of benign, premalignant or early-stage malignant duodenal lesions. Patients and Methods: Twenty-four patients who underwent non-Whipple operations between January 1996 and December 2015 were identified from an institutional database and retrospectively analyzed. Results: Between 1996 and 2015, 10 patients underwent pancreas-preserving duodenectomy and 14 patients underwent transduodenal ampullectomy. The mean follow-up was 25.8 months (range=6-54 months) and no patient was lost to follow-up. Eighteen patients had preoperative diagnosis of duodenal adenomatosis, three patients had preoperative diagnosis of duodenal adenocarcinoma, one had a bleeding polyp and two had localized inflammation. Average operative time was 145 min (range=127-168 min) for transduodenal ampullectomy and 183 min (range=173-200 min) for pancreas-preserving duodenectomy ($p<0.05$). The estimated blood loss for transduodenal ampullectomy was 85 vs. 125 ml for pancreas-preserving duodenectomy ($p<0.05$). Early postoperative complications were noted in 13 cases (54.17%). There were no postoperative (90-day) deaths observed in this series and there were no recurrences during follow-up for the patients operated on with neoplastic lesions. Conclusion: For carefully selected patients, transduodenal ampullectomy and pancreas-preserving duodenectomy may be used in place of the Whipple operation for benign and occasionally early-stage malignant (Tis and T1) duodenal and ampullary disease.*

Duodenal tumors are rare (1, 2) and surgical resection of the duodenum is challenging due to its proximity to and common blood supply with the pancreas (3-5). Some lesions in the duodenum or at the ampulla may be resected endoscopically but this approach is limited to small (less than 2 cm) superficial lesions (6). For these reasons pancreaticoduodenectomy (PD) is the most commonly used operation for both benign and malignant duodenal lesions (7). Unfortunately, PD is often associated with postoperative complications, since postoperative pancreatic fistula (POPF) is commonly encountered in these patients due to their soft pancreatic parenchyma and small pancreatic duct (8). In addition, pancreatic head resections are often associated with significant attenuation in pancreatic endocrine and exocrine function (9). Transduodenal ampullectomy and pancreas-preserving duodenectomy are operations that have been used for resecting duodenal lesions and have been reported to have a lower morbidity and mortality than PD (10).

Transduodenal ampullectomy (TDA) is a relatively old operation mainly offered to a very narrow group of patients with ampullary adenoma who have lesions that are large enough to exclude them from having endoscopic resections

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but not so large to warrant PD (10). Emerging data indicate its potential role in resection of early ampullary tumors (11, 12) since it is a less invasive and simple technique, that could potentially provide equivalent clinical outcomes to PD for early ampullary malignancies. The success of TDA is mainly based on the absence of nodal metastasis and the achievement of R0 resection (13, 14).

In 1995 Chung *et al*. (15) published the first series of pancreas-preserving duodenectomies (PPDs) for premalignant duodenal lesions (15). To date, about 270 cases of PPD (partial and total) have been described, with low mortality and variable morbidity rates (15-56). Unfortunately, no large series of PPDs have been published (largest series fewer than 30 cases), but data available suggest that this technique is feasible, safe and may be associated with shorter operative time and reduced blood loss compared to PD (15-56). In addition, PPD enables postoperative endoscopic follow-up of the whole gastrointestinal tract, including the neo-duodenum, for patients with familial adenomatous polyposis (FAP), which account of the majority of patients currently treated with PPD (15-56).

We present a series of non-PD operations (PPD and TDA) for the treatment of benign, premalignant, and early malignant duodenal lesions. The technical aspects, and outcome of these operations are reviewed. We also review the literature concerning the outcome after non-Whipple resections of the duodenum.

Materials and Methods

Twenty-four patients who underwent PPD and TDA between January 1996 and December 2015 at Laikon General Hospital, Greece and Nicosia General Hospital, Cyprus, were identified from their institutional computer-based databases and retrospectively analyzed. Two senior surgeons performed all operations. Standard demographic and clinicopathological data were collected, including gender, age, presenting symptoms, preoperative diagnosis/indication for PPD/TDA, type of operation, postoperative histological diagnosis, postoperative mortality and morbidity, and follow-up. Intraoperative data included operative time. Operative notes provided information on treatment-related variables, such as indication for resection and specific type of resection. Clavien-Dindo classification system (57) was used to record the perioperative complications with a major complication classified as grade 3 or more. For patients with two or more complications, the most severe was taken into account. The length of hospital stay for each patient was recorded.

Definition of POPF and other short term outcomes. POPF was defined as drain output on or after postoperative day 3 with amylase content at least three times that of the serum amylase level (58). Fluid collection was defined as that identified through computerized tomographic scan or ultrasound greater than 5 cm in diameter, with or without clinical relevance. Acute pancreatitis was defined as a threefold increase of normal serum amylase or lipase values after the third postoperative day, confirmed by computed tomographic scan findings and clinical course. Early postoperative hemorrhage and delayed gastric emptying (DGE) were defined according to the International Study Group of Pancreatic Surgery (58-60).

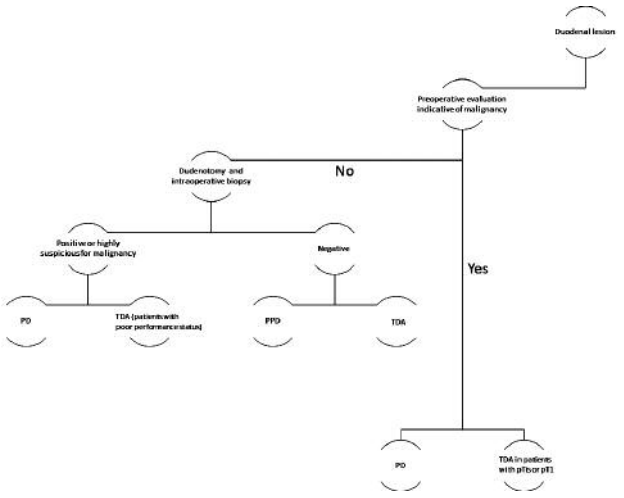

Figure 1. *Algorithm of decision-making on duodenal lesions. TDA: Transduodenal ampullectomy, PD: partial duodenectomy, PPD: pancreas-preserving duodenectomy, Tis: tumor in situ.*

Pre- and postoperative management of patients undergoing PPD and TDA. All patients with benign or early-stage duodenal cancer who were being considered for PPD and TDA were routinely investigated preoperatively with endoscopic ultrasound and biopsies (61) and magnetic resonance cholangiopancreaticography (47). Any case of provisionally benign disease that could not be treated by endoscopic means (median of two endoscopic attempts) was deemed appropriate for PPD or TDA. In most cases where there was an intraoperative suspicion of an invasive disease after frozen section, a PD was performed. Exceptions to this included three cases in which patients had poor performance status and could not undergo PD. They were offered TDA. In addition, patients with poor performance status with pT1 or pTis disease were offered TDA instead of PD. Figure 1 illustrates our decision-making algorithm for patients with duodenal lesions.

Postoperatively, standardized management included clinical evaluation twice daily and daily analyses of blood and drain-fluid samples as described earlier (62-66). Postoperative mortality was defined as death occurring within 90 days after surgery or during hospital stay.

Operative techniques. TDA: After an extended right subcostal incision, the peritoneal cavity is carefully explored to exclude systematic spread. The second portion of the duodenum is palpated in a bimanual fashion to identify the lesion and the ampulla of Vater. Two-stay sutures (Vicryl 3-0) are placed and a 3-4 cm longitudinal incision is made along to the lateral wall of the second portion of the duodenum opposite the ampullary tumor. In order to achieve better retraction of the lesion, a figure-of-eight suture [polydioxanone (PDS) 4-0] is placed through the mass. A submucosal injection of dilute epinephrine (1:10,000) beneath the mass is performed to prevent bleeding during the resection and to increase the distance

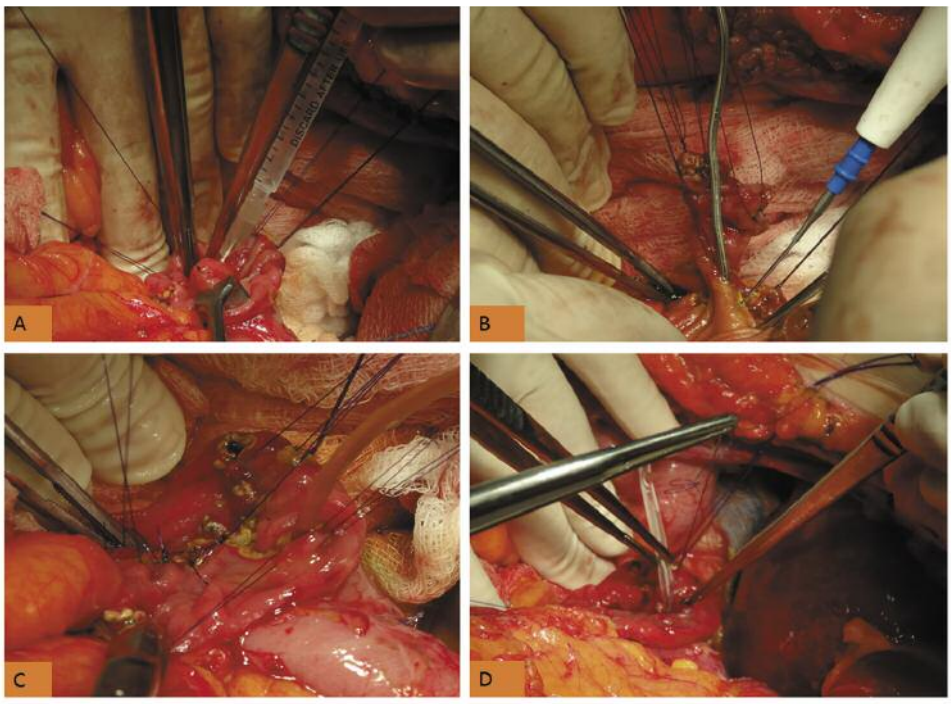

Figure 2. *Pancreas-preserving duodenectomy. A: Submucosal injection of dilute epinephrine. Two figure-of-eight PDS 4-0 stitches are placed for better retraction of the tumor. B: Excision of the lesion with the electrocautery. The ampulla is identified. C: The defect of the posterior wall of the duodenum is sutured and a nelaton catheter is inserted in the ampulla. D: The edge of a nelaton catheter is inserted in the ampulla (internal stent) after the completion of the sphinctiroplasty.*

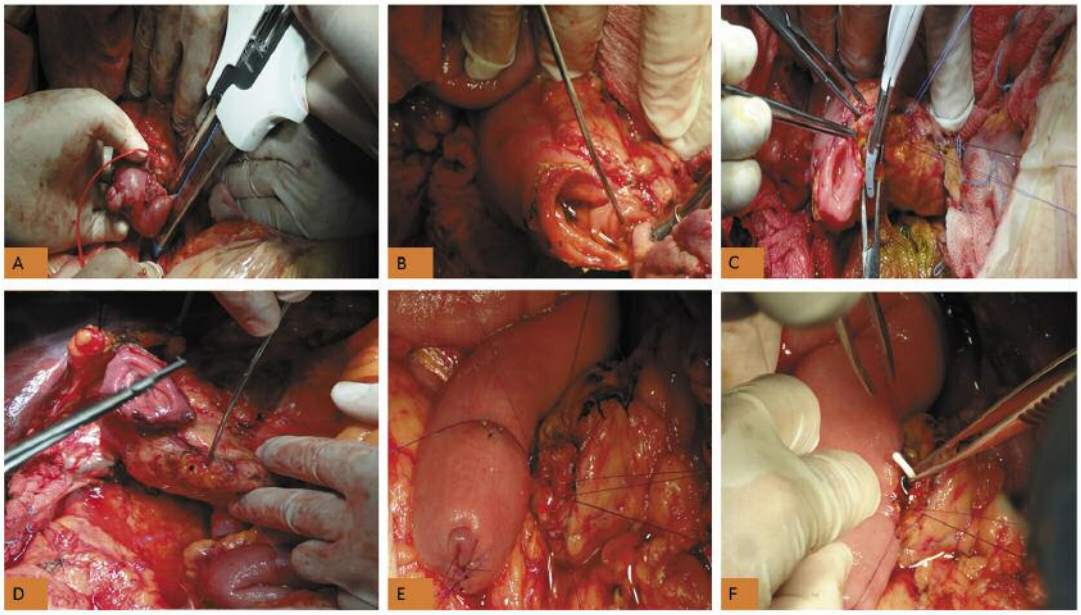

Figure 3. *Transduodenal ampullectomy. A: Division of the 4th portion of the duodenum and identification of the tumor. B: Identification of the ampulla. C: Preparation of the first and second portion of the duodenum from the pancreatic head with Ligasure (Covidien, Colorado, USA). D: Identification of the common bile duct and the main pancreatic duct. Stay sutures (PDS 5-0) are placed. E: A duct-to-mucosa anastomosis is performed. F: Insertion of a pig-tail catheter as an internal stent in the main pancreatic duct.*

between the base of the lesion and the serosa of the posterior wall of the duodenum (Figure 2A). The dissection begins at the 11 o'clock position using the diathermy heading towards the common bile duct (CBD) (Figure 2B). When the lumen of the CBD is identified, serial 5-0 PDS sutures are placed to approximate the bile duct to the duodenal mucosa. The pancreatic duct is usually identified at the 1 or 2 o' clock position and is then approximated to the duodenal wall in the same fashion as the CBD. When the ampullary mass is completely resected, both ducts are re-approximated with two to three interrupted 5-0 PDS sutures and the specimen is sent for frozen section histopathological examination. A 6-Fr pig-tail catheter is inserted in each duct separately to maintain its patency and fixed with a 6-0 PDS suture. The mucosa of the posterior wall of the duodenum is approximated by single 4-0 PDS sutures (Figure 2C). Finally, a double-layer transverse duodenal closure is performed using 4-0 PDS interrupted sutures and an easy-flow drainage is placed near the duodenotomy (Figure 2D).

PPD: The entrance to the peritoneal cavity and the operative setting is achieved in the same manner as described above. The Treitz ligament is divided to free the fourth portion of the duodenum, and the proximal jejunum is transected with a linear GIA-stapler (Figure 3A). Then the fourth and the third portions of the duodenum are skeletonized and detached from the uncinate process and the head of the pancreas heading up to the level of the papilla (Figure 3B). The branches of the pancreatoduodenal vessels are ligated using a Ligasure™ Small Jaw Instrument (Covidien, CO, USA) and Prolene 5-0 sutures (Figure 3C). The location of the major papilla is again identified by palpation as described above. The first portion of the duodenum is transected 1.5-2 cm below the pylorus for preservation of the pyloric function (when this is feasible) and the first two portions of the duodenum are detached from the pancreatic head in the same fashion as the distal duodenum, along with regional lymph nodes. If the duct of Santorini is identified, it is ligated with 5-0 PDS sutures to reduce the risk of a POPF (Figure 3D). At the final step of the resection, the mucosal layer of the major papilla is stripped off by following the Fogarty catheter or the tip of the percutaneous transheptic biliary drainage in the distal CBD. A Billroth II method is preferred in our Department for the reconstruction of the tract.

The transected jejunal limb is brought in a retrocolic fashion to the right of the middle colic vessels to construct an end-to-side papillojejunostomy. The stapler line of the jejunal limb is reinforced with 4-0 PDS interrupted sutures (Figure 3E). A small orifice (max 5 mm) at the anti-mesenteric site of the jejunal limb is created. The mucosa of the jejunal orifice is slightly inverted with four interrupted 5-0 PDS sutures, placed in a crosswise fashion, in order to create a mucosa-to-mucosa anastomosis. The edge of a matching pig-tail catheter (6 Fr) is inserted in the main pancreatic duct and in the CBD (in the absence of a percutaneous transheptic biliary drainage catheter) and secured with a 6-0 PDS suture (Figure 3F). If the diameter of the common ostium of the CBD and the main pancreatic duct is too small, an 8 mm sphincteropapillotomy is performed on the opposite wall of the lumen of the pancreatic duct. For the construction of the single-layer papillojejunostomy, we use 10-12 5-0 or 6-0 PDS interrupted sutures. All knots of the posterior and the anterior wall remain outside of the anastomosis. Finally, the pylorus is anastomosed to the jejunum, 40-50 cm distally to the papillojejunostomy in an antecolic fashion. Two drains are placed below and above the papillojejunostomy. During PPD, we routinely perform simultaneous cholecystectomy, since patients after duodenectomy are at risk of developing gallstones due to the lack of postprandial cholecystokinin release in the duodenum (47).

Partial duodenectomy: After an extended right subcostal or midline incision, the peritoneal cavity is carefully explored to exclude systematic spread. To identify the ampulla, the second portion of the duodenum is palpated in a bimanual fashion or a Fogarty catheter is placed from the cystic duct to the CBD. For lesions located at the first duodenal portion, a subtotal gastrectomy with an end-to-side gastrojejunostomy are performed (Billroth II). The first duodenal portion is mobilized from the head of pancreas and the duodenum is transected with GIA-stapler (Covidien) distally to the tumor after safe recognition of the ampulla. A subtotal gastrectomy with a transmesocolic two-layer gastro-entero-anastomosis (Billroth II) is performed (PDS 4-0, Vicryl 4-0, running suture), which is anchored at the mesocolon in order to remain in the lower abdomen.

For lesions located at the fourth duodenal portion, after identifying the ampulla, the fourth duodenal portion is mobilized. The Treitz ligament is then resected and duodenum mobilized from uncinate process. The branches of the pancreatoduodenal vessels are ligated using a Ligasure™ Small Jaw Instrument and Prolene 5-0 sutures. Finally, a duodenectomy with end-to-end or end-to-side duodeno-jejunal two-layer anastomosis is performed (PDS 4-0 and Vicryl 4-0 interrupted sutures).

Results

In the period from 1996 to 2015, 10 patients underwent PPD and 14 patients underwent TDA for benign, premalignant or early cancerous lesions. The median age of our series was 63 years (range=38-81 years). Fifteen of the patients were men. The mean follow-up was 25.8 months (range=6-54 months). No patient was lost during the follow-up period.

Twelve of the patients had anemia/upper gastrointestinal bleeding as the presenting symptom, four had pancreatitis, three had vague abdominal pain, one presented with acute abdominal pain, while the rest were incidentally diagnosed after an imaging study performed for another reason. Eighteen patients had preoperative diagnosis of duodenal adenomatosis due to FAP, three patients had preoperative diagnosis of duodenal adenocarcinoma, one had a bleeding polyp and two had localized inflammation. The average operative time was 145 min (range=127-168 min) in the TDA group and 183 min (range=173-200 min) in the PPD group ($p<0.05$). The estimated blood loss in the TDA group was 85 ml, whereas in the PPD group it was 125 ml ($p<0.05$). The total average length of stay was 15.1 days (range=8-25 days).

Postoperative histological diagnosis confirmed 14 cases of adenoma with various grades of dysplasia (one moderate, eight low and five high), six cases of adenocarcinoma, one case of plexiform fibromyxoma (67), two cases of inflammatory stenosis and one case of gastrointestinal stromal tumor. All patients had intraoperative frozen section

Table I. *Summary of the findings in patients of the present study.*

Patient	Age (years)	Gender	Indication for PPD	Type of operation	Postoperative diagnosis	Early postoperative complications	LOS (days)	Follow-up (months)
1	48	M	Villous adenoma	TDA	Adenoma with HG dysplasia	Pleural effusion	9	54
2	54	M	Villous adenoma	TDA	Adenoma with HG dysplasia	None	8	54
3	62	F	Ampullary cancer	TDA	Adenocarcinoma (pT1)	Wound infection	9	30
4	67	M	Villous adenoma	TDA	Adenoma with HG dysplasia	None	9	30
5	58	M	Villous adenoma	TDA	Unspecified Inflammation	None	10	24
6	70	F	Ampullary cancer	TDA	Adenocarcinoma (pT1)	Atelectasia & pneumonia	11	24
7	78	F	Villous adenoma	TDA	Adenoma with LG dysplasia	Duodenal leakage & delayed gastric emptying	16	24
8	47	M	Inflammation	TDA	Unspecified inflammation	Wound infection, pleural effusion	12	24
9	59	M	Villous adenoma	TDA	Adenoma with HG dysplasia	None	11	20
10	64	M	Villous adenoma	TDA	Adenoma with LG dysplasia	Pleural effusion	10	12
11	58	F	Villous adenoma	TDA	Unspecified Inflammation	Pleural effusion & pneumonia	15	6
12	68	F	Ampullary cancer	TDA	Adenocarcinoma (pT1)	None	9	25
13	51	M	Villous adenoma	PD (1st and 2nd portion)	Adenoma with HG dysplasia	None	13	24
14	78	F	Villous adenoma	PD (1st and 2nd portion)	Adenoma with LG dysplasia	None	12	27
15	79	F	Villous adenoma	PD (1st and 2nd portion)	Adenoma with LG dysplasia	None	11	26
16	53	M	Villous adenoma	TDA	Adenoma with moderate dysplasia	Fever, pleural n effusio	19	36
17	47	M	Inflammation	PD (2nd portion of duodenum)	Unspecified inflammation	Fever	13	48
18	79	M	Villous adenoma	PD (1st and 2nd portion)	Adenoma with HG dysplasia	None	11	25
19	73	F	Villous adenoma	PD (1st and 2nd portion)	Adenocarcinoma (pTis)	None	12	36
20	81	M	Villous adenoma	PPD (total)	Adenocarcinoma (pTis)	Wound infection	23	12
21	70	M	Bleeding duodenal polyp	PD (2nd portion of duodenum)	Plexiform fibromyxoma	Delayed gastric emptying, pancreatic fistula	18	18
22	80	M	Villous adenoma	TDA	Adenocarcinoma (pTis)	Fever	15	8
23	65	F	Villous adenoma	PPD (total)	GIST	Bile leak, delayed gastric emptying	20	7
24	38	M	Villous adenoma	PD (1st and 2nd portion)	Adenoma with LG dysplasia	Pleural effusion	25	25

M: Male, F: female, TDA: transduodenal ampullectomy, PD: Partial duodenectomy, PPD: pancreas-preserving duodenectomy, LG: low-grade, HG: high-grade, LOS: length of stay, GIST: gastrointestinal stromal tumor.

with negative results for malignancy. All patients diagnosed with invasive adenocarcinoma underwent PD as a finite treatment (except for the three cases where poor performance status prohibited PD as noted above).

Early postoperative complications were noted in 13 cases (54.17%). Three cases were classified as Clavien-Dindo IIIa, two as II and eight cases as I. The majority of complications included postoperative pleural effusion (five cases), fever resolving with antibiotics (three cases), wound infection (three cases) and bile leak (one case), POPF (one case) and DGE (three cases). One patient had a late complication, anastomotic stenosis treated by endoscopic means. Two patients needed a 2-day stay in the Intensive Care Unit due to comorbidities. There were no postoperative deaths (90-day). During the follow-up, there were no recurrences of duodenal neoplasia. Table I summarizes the findings of this study.

Discussion

The standard surgical approach for duodenal lesions is PD to achieve clear surgical margins and an adequate lymph node harvest (68). For unique lesions of the duodenum, several alternatives to PD have been described, including ampullectomy (TDA), partial duodenectomy, and PPD. In this report we describe a 20-year experience with these alternatives to PD in patients with benign and very early-stage duodenal malignancy.

PPD has several theoretical advantages over PD, including preservation of exocrine/endocrine function and avoiding pancreaticojejunostomy, thereby minimizing anastomotic leak and pancreatic fistula rates (69, 70). In addition, the gastrointestinal tract can be maintained in continuity to facilitate endoscopic surveillance (24, 43). Recent studies comparing PD with PPD in patients with premalignant/low-grade malignant

Table II. *Summary of current literature on pancreas-preserving duodenectomy (PPD) for duodenal lesions.*

Author	Year	Study design	Indication for PPD	Number of patients	Perioperative mortality, n (%)	Perioperative morbidity, n (%)	Median follow-up till endpoint (months)
Chung *et al.* (15)	1995	CS	FAP	5	0 (0)	3(60)	36
Kawano *et al.* (28)	1995	CR	Duodenal leiomyosarcoma	1	0 (0)	0 (0)	9
Maher *et al.* (36)	1996	RS	Adenocarcinomas, Crohn	24	1 (4.1)	6 (25)	24.2 (mean)
Tsiotos and Sarr (54)	1998	CS	FAP and broad-based villous adenomas	4	0 (0)	1 (25)	6.5 (mean)
Sohn *et al.* (49)	1998	CR	Adenocarcinoma	13	0 (0)	4 (30)	N/R
Alarcon *et al.* (17)	1999	CS	FAP	3	0 (0)	0 (0)	45.7 (mean)
Nagai *et al.* (40)	1999	CS	Trauma, MALT lymphoma, corrosive necrosis, bleeding, leiomyosarcoma and congenital stenosis.	3	2 (33.3)	1 (16.7)	7
Suzuki and Yasui (52)	1999	CR	GIST	1	0 (0)	1 (100)	N/R
Farnell *et al.* (25)	2000	CS	Duodenal adenomas, carcinoma *in situ* and invasive carcinoma	5	0 (0)	4 (80)	64 (mean)
Orda *et al.* (41)	2000	CR	GIST	1	0 (0)	0 (0)	156
Konsten *et al.* (32)	2002	CS	FAP and dysplastic	4	0 (0)	2 (50)	18
Ammori (19)	2002	CR	Benign stricture	1	0 (0)	1 (100)	3
Kalady *et al.* (27)	2002	CS	FAP	3	0 (0)	2 (66.7)	26 (mean)
Lundell *et al.* (34)	2002	CS	FAP, adenoma, lipoma	4	0 (0)	2 (50)	6
Sarmiento *et al.* (47)	2002	CS	FAP and adenoma	8	0 (0)	5 (62.5)	21
Takagi *et al.* (53)	2003	CR	Duodenal carcinoid	1	0 (0)	0 (0)	1
de Vos tot Nederveen Cappel *et al.* (23)	2003	CS	Duodenal carcinoma and adenomatosis in patients with FAP	6	0 (0)	4 (66.7)	11
Eisenberger *et al.* (24)	2004	CR	Gardner syndrome and adenoma	2	0 (0)	1 (50)	24
Imamura *et al.* (26)	2005	CS	FAP, amyloidosis, gastrinoma	3	0 (0)	0 (0)	8
Kimura *et al.* (29)	2005	CR	Retroperitoneal liposarcoma	1	0 (0)	0 (0)	2
Koninger *et al.* (30)	2005	CS	Duodenal adenomas with dysplasia	7	0 (0)	3 (42.9)	20
Mackey *et al.* (35)	2005	CS	FAP	21	0 (0)	8 (38.1)	79
Spalding *et al.* (50)	2007	CS	Early-stage adenocarcinomas and GIST	14	1 (7.1)	3 (21.4)	47
Koshariya *et al.* (33)	2007	CS	Duodenal adenomas	3	0 (0)	1 (33)	9
Konishi *et al.* (31)	2007	CS	Adenoma, cancer, carcinoid and non-epithelial tumor	16	1 (6.25)	2 (12.5)	65 (mean)
De Castro *et al.* (22)	2008	CS	FAP	26	1 (4)	16 (62)	52 (mean)
Al-Sarireh *et al.* (18)	2008	CS	Large solitary and multiple polyps	12	0 (0)	6 (50)	20
Muller *et al.* (38)	2008	CS	FAP, adenomas, NET	23	1 (4)	7 (30)	23
Wig *et al.* (56)	2009	CR	Trauma	2	0 (0)	1 (50)	22
Paluszkiewicz *et al.* (42)	2009	CR	Trauma, bleeding	2	1 (50)	1 (50)	1
Penninga and Svendsen (43)	2011	RS	Solitary and multiple adenomas, GIST	13	0 (0)	6 (46)	56 (mean)
Muroni *et al.* (39)	2012	CR	GIST	1	0 (0)	0 (0)	6
Ravoire *et al.* (46)	2012	CR	GIST	1	0 (0)	1(100)	8
Masrur *et al.* (37)	2012	CR	Angiodysplasia	1	0 (0)	0 (0)	2
Atema *et al.* (20)	2012	CS	Gastrinoma	2	0 (0)	1 (50)	18 (mean)
Cavaniglia *et al.*	2012	CR	GIST	1	0 (0)	0 (0)	N/R
Stauffer *et al.* (51)	2013	CS	Adenomas and early-stage carcinomas	10	0 (0)	2 (20)	11.3 (mean)
Waisberg *et al.* (55)	2013	CR	Carcinoid	1	0 (0)	0 (0)	39.6 (mean)
Rangelova *et al.* (45)	2015	RS	Premalignant and low-grade malignant duodenal lesions	20	0 (0)	11 (55)	24
Shimizu *et al.* (48)	2015	CR	Duodenal adenoma	1	0 (0)	0 (0)	N/R
Qadan *et al.* (44)	2015	CR	Duodenal adenomatous polyp	1	0 (0)	100 (0)	N/R
Abe *et al.* (16)	2016	CR	Tubular adenoma	1	0 (0)	0 (0)	6
Total	1995-2016	-	More than 60% suffered from FAP	274	8 (0.73)	104 (38)	-
Current study	2016	RS	Benign lesions, low-grade malignancies or early-stage carcinomas	10	0 (0)	4 (40)	24.8 (mean)

CS: Case series, CR: case report, RS: retrospective study, FAP: familial adenomatous polyposis, GIST: gastrointestinal stromal tumor, NET: neuroendocrine tumor, MALT: mucosa-associated lymphoid tissue.

Table III. *Summary of current literature on transduodenal ampullectomy (TDA) for duodenal lesions.*

Author	Year	Indication for TDA	No of patients	Morbidity, n (%)	Mortality, n (%)	Median follow-up (months)	Recurrence (%)
Gao *et al*. (83)	2016	Early ampullary cancer	22	3 (13.6)	0 (0)	75 (38–143)	31.8
Schneider *et al*. (76)	2016	Adenomas and inflammatory stenosis	83	20 (24)	1 (1.2)	54 (mean)	4.5
Lee *et al*. (82)	2016	Early ampullary cancer	18	6 (33)	1 (5.6)	50 (6-148)	33
Song *et al*. (78)	2015	Early ampullary cancer	26	11 (42.6)	0 (0)	N/R	38.5
Lai *et al*. (77)	2015	Ampullary tumors	15	2 (13.3)	2 (13.3)	N/R	13.3
Onkendi *et al*. (81)	2014	Adenomas	9	5 (58)	0 (0)	52.8 (mean)	33.3
Mathur *et al*. (11)	2014	Adenomas	32	N/A	N/A	28	13
Zhong *et al*. (12)	2013	Invasive ampullary cancer	17	N/R	0 (0)	35.6 (mean)	63
Ceppa *et al*. (10)	2013	Benign ampullary lesions	41	17 (42)	0 (0)	N/R	36.5
Kim *et al*. (80)	2011	Ampullary tumors	21	9 (42.8)	0 (0)	18 (1-72)	4.8
Marina (79)	2004	Ampullary villous adenomas and adenocarcinomas	8	2 (25)	0 (0)	28.5 (6-72)	N/R
Current study	2016	Benign lesions, low-grade malignancies or early stage carcinomas	14	8 (57.1)	0 (0)	26.5 (mean)	0

N/R: Not reported, N/A: not available.

lesions of the duodenum demonstrated that PPD was non-inferior compared to PD in terms of morbidity, with superiority in terms of POPF, Intensive Care Unit stay, reoperation, mortality rates, blood loss, operative time and cost (45, 71).

After reviewing PubMed, we found 274 cases of PPD (total or partial) (Table II). More than 60% of the cases were patients with FAP and FAP-related duodenal adenomatosis. PPD is ideally suited for patients with FAP since it is known that duodenal cancer is 100- to 300-fold more common in patients with FAP compared to the general population (72, 73). PPD is a favorable alternative to PD in this group of patients, for which mortality as high as 6.7% (74) has been reported. Other indications described for PPD are large benign duodenal villous tumors of the duodenum, gastrointestinal stromal tumors, duodenal carcinoids, gastrinoma, fibromyxoma, and rarely for duodenal trauma (42, 56). Finally, there are cases of PPD performed in patients with invasive duodenal cancer, in which there was a high rate of death due to distant metastases, while the rate of locoregional recurrence was low (31).

Our review of the literature demonstrated a very low mortality rate of PPD (less than 1%) with a relatively high perioperative morbidity rate. In total, 104 out of 274 patients suffered from some early postoperative complication, accounting for a total morbidity rate of 38%. In contrast with our study, anastomotic leakage was the most frequent early postoperative surgical complication (around 55%) with DGE and postoperative hemorrhage being less common. The majority of PPDs are performed with an open approach, but there are recent reports of minimally-invasive PPDs (robotically or laparoscopically assisted) with promising results in term of technical pitfalls associated with the meticulous dissection necessary when separating the duodenum from the pancreas (19, 37, 51, 75).

TDA is a less invasive procedure compared to PD, mainly indicated for benign lesions such as adenomas and inflammation not treatable by endoscopic means (10-14, 71, 76-83). However, recent data support a potential role of TDA in selected patients with early ampullary cancer (Tis and T1) and it is likely to provide similar clinical outcomes to PD, such as 5-year survival rate and recurrence rate, accompanied by lower surgical morbidity and mortality, estimated blood loss, intraoperative transfusion and operative time (10-14, 71, 76-83).

One issue of concern is the recurrence rate after TDA, varying from 0%, as in our series, to 40% in the literature (10-14, 71, 76-83) (Table III). Patients with Tis disease seem to have superior results compared to patients with T1 disease since the latter often have lymph node metastases (12, 82). Thus TDA is probably not appropriate for the treatment of T1 ampullary cancer (12, 82), unless the patient has a poor performance status and PD is prohibited.

Conclusion

We presented a series of 24 patients that underwent non-Whipple operations (PPD and TDA) for benign, premalignant or early cancerous duodenal lesions, with low mortality and morbidity rates. PDD is most commonly used in patients with severe duodenal polyposis as a method of removing the entire duodenum, leaving the pancreas in place and creating a reconstruction that allows follow-up endoscopy for surveillance. TDA is ideal for patients with benign duodenal lesions that are too large to be resected endoscopically.

Supportive Foundations

None.

Institutional Review Board statement

This study was reviewed and approved by the Ethics Committee of Laikon General Hospital and Nicosia General Hospital.

Conflicts of Interest

All Authors declare that they have no competing interests.

Informed Consent Statement

Patients were not required to give informed consent to the study.

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