



Research article

Transduodenal resection for duodenal adenomas may be an underutilized tool – A single institution experience

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ABSTRACT

Background: Duodenal adenomas are pre-malignant lesions. Transduodenal resection and pancreaticoduodenectomy remain the only two surgical options. The optimal surgical management remains controversial between these two strategies.**Methods:** A retrospective review was conducted to identify patients who underwent intervention for duodenal adenomas. Patient were stratified by type of procedure, pancreaticoduodenectomy or transduodenal resection, and their demographic data as well as perioperative outcomes were compared.**Results:** 26 patients underwent surgery for duodenal adenomas. 11 underwent a pancreaticoduodenectomy (PD) (42.3%) and 15 underwent a transduodenal resection (TDR) (57.7%). Median operative time, median estimated blood loss, and mean length of stay were longer in the PD vs TDR group. Two patients (13.3%) in the TDR group developed recurrent adenomas.**Conclusion:** Transduodenal resection should be considered in patients who are suspected to harbor benign duodenal tumors. Duodenal tumors with high grade dysplasia or invasive cancer should undergo an oncologic procedure. Endoscopic surveillance appears to be indicated after transduodenal resection.

1. Introduction

Despite making up the largest proportion of mucosal surface along the GI tract, tumors of the small bowel are only estimated to comprise 3% of GI tumors. The majority of these adenomas and adenocarcinomas of the small intestine occur in the duodenum, and commonly involve the ampulla [1]. These tumors are being recognized more due to better imaging techniques and increasing endoscopic surveillances. Nearly 5% of upper endoscopies incidentally discover duodenal polyps [2]. Of these, adenomas remain the most frequently encountered types of polyps [3]. The progression of ampullary neoplasms, as first documented by Cattell and Pylrtek [4], from premalignant adenomas to adenocarcinomas is well established, much in the same way as the malignant transformation of colon polyps to colon cancer. Thus, prompt recognition, diagnosis and removal of these lesions has become the standard of care.

Endoscopy has the dual advantage of being a diagnostic and therapeutic tool. Improvement in techniques and tools have allowed skilled endoscopists to perform majority of these duodenal tumors in a minimally invasive manner [5]. However, in cases where the whole adenoma is unable to be removed endoscopically, or in cases where the diagnosis is unclear due to partial removal, or the biopsy results yield a premalignant or malignant pathology, surgical intervention is warranted. There have been previous studies comparing different surgical procedures for duodenal adenocarcinoma, but there is a lack of research comparing surgical procedures for adenomas. Some authors believe that duodenal and especially ampullary tumors should be treated by pancreaticoduodenectomy (PD) due to high risk of recurrence and that an endoscopic biopsy gives only a piece of the tumor, which cannot rule out malignancy [6]. Another surgical option is transduodenal resection (TDR), and there is still controversy on where in the treatment algorithm

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this procedure belongs, if at all. Transduodenal resection can be technically challenging, and in some ways the PD is an easier option. However, PD in these patients often involves work on a soft pancreas with a small duct, the definition of a high-risk pancreatic anastomosis [7].

The objective of this study was to examine the role of local transduodenal resection of ampullary tumors not amenable to endoscopic resection and description of how this procedure is carried out at our institution. We report perioperative evaluations and surgical outcomes for patients that underwent either transduodenal ampullectomy or pancreaticoduodenectomy for duodenal adenomas, the majority of them being ampullary adenomas, and share our experience with recommendations for future management of these lesions.

2. Materials and methods

We performed a retrospective review of duodenal resection procedures performed by our institution from 2012-2016 after IRB Approval was obtained from the Methodist Health Systems Institutional Review Board. These surgeries took place at either Methodist Dallas or Methodist Richardson Medical Centers. From our patient database, we identified 26 patients with an ampullary mass seen on EGD from 2012-2016. Of these patients, 15 were diagnosed with either tubular adenoma or tubulovillous adenoma on EGD biopsy and underwent a transduodenal resection with curative intent. The majority of the lesions were ampullary. The rest of the patients either had invasive cancer or high grade dysplasia and underwent pancreaticoduodenectomy. Perioperative data was collected for both groups. Patients' charts and follow up images and/or endoscopic surveillances were analyzed for recurrences. Univariate analysis was performed using a chi-squared test and student's t-test to compare demographic and perioperative data between each group. Statistics were analyzed using JASP (Version 0.15).

2.1. Operative technique of ampullectomy

The authors start with an upper midline incision. After thorough exploration for any peritoneal diseases, an Omni retractor is placed. Then a complete Kocherization of the duodenum is completed. We place two 2-0 Silk stay sutures for retraction and open up the duodenum in a longitudinal fashion at the D2/3 area. The ampullary mass in question is identified. If the patient still has his/her gallbladder intact, the gallbladder is separated from the gallbladder fossa in a dome down approach. The cystic artery is controlled with ties and clips and ligated. The cystic duct is skeletonized. A partial cystic ductotomy is made and a 5Fr pediatric feeding tube (or a small Fr red rubber tube) is fed through the cystic duct until it enters the duodenum via the ampulla. We then

place 4-0 PDS sutures laterally to the adenoma and then shave the adenoma off, taking the mucosal and submucosal layer but not penetrating the muscular layer (Figure 1). Specimen is sent to pathology for frozen analysis to ascertain for clean margins and to make sure no high grade dysplasia (HGD) or invasive cancer is detected. If HGD or invasive cancer is detected, a pancreaticoduodenectomy is undertaken. Cholecystectomy is completed after the cystic duct proximal to the ductotomy is tied with 2-0 Silk suture and/or clipped.

Bile duct and pancreatic duct sphincteroplasties are performed (Figure 2). Bile duct to duodenum mucosa sphincteroplasty is completed with a double armed 5-0 PDS suture. The pancreatic duct to duodenum mucosa sphincteroplasty is completed with four single armed 5-0 Prolene sutures at the 3, 6, 9 and 12 O'Clock positions. The authors often stent the pancreatic duct with a 5 Fr pediatric feeding tube prior to completion of the pancreatic duct sphincteroplasty. The duodenum is closed transversely in a single layer with multiple interrupted 2-0 silk sutures. The previously placed stay sutures provide necessary retraction for the closure. The authors often mobilize a lip of omentum and place this over the transverse closure as a flap. The omentum is secured around the incision as a patch with 2-0 silk sutures. After confirmation of hemostasis, the abdomen is closed.

3. Results

26 patients were identified that were to our center with a diagnosis of duodenal mass. Of those patients, 11 were diagnosed with either high grade dysplasia or invasive cancer and underwent a classic pancreaticoduodenectomy. Of the 11 patients, 8 (72.7%) were male. Average age was 67.2 (67.2 ± 7.8) years of age. The preoperative pathology from biopsies are listed in Table 1.

15 patients were diagnosed with either tubular, tubulovillous or villous adenoma without any dysplasia or malignancy and eventually underwent transduodenal ampullectomy. Of the 15 patients, 7 (46.7%) of the patients were male. Average age was 63.2 (63.2 ± 8.02) years of age. All of these patients initially presented to a gastroenterologist and underwent EGD with biopsy of these lesions. The most frequent reason for inability to endoscopically resect the adenomas was size of the lesion followed by depth of invasion of the lesion or involvement of too greater circumference of the duodenum, presence of high grade dysplasia, involvement of the ampulla, and presence of multiple adenomas. All lesions were referred to surgery due to experienced endoscopists feeling that they could not safely perform an endoscopic resection. 16 lesions (61.5%) involved the ampulla. All of the patients presented with peri-ampullary tumors. The preoperative pathology from biopsy are listed in Table 2. Baseline demographics including comorbidities between the two groups showed no significant difference (Table 3).

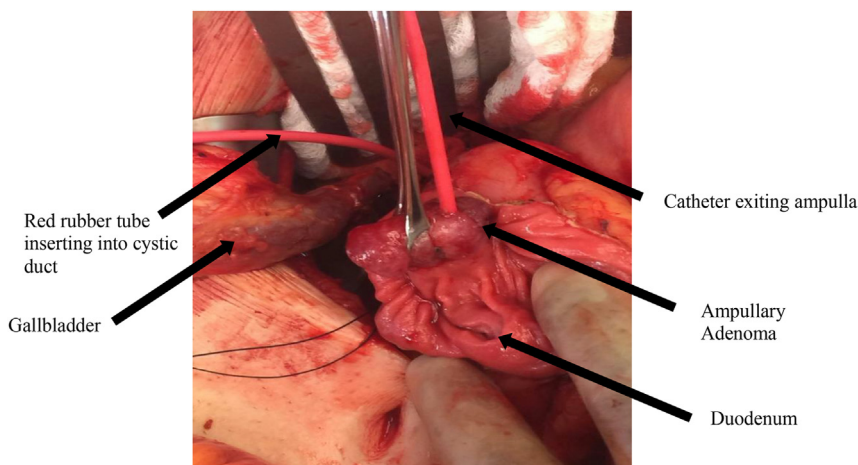


Figure 1. Duodenum is Kocherized and opened longitudinally. A small tube is inserted through the cystic duct via a small ductotomy and fed through the ampulla. The ampullary mass is grasped and shaved off, taking the mucosal layer but not penetrating into the muscular layer.

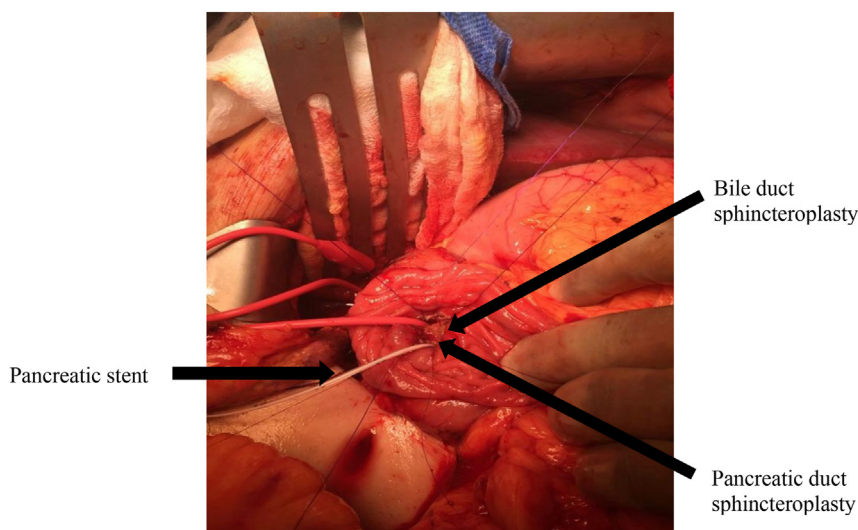


Figure 2. After the adenoma is excised, bile duct and pancreatic duct sphincteroplasties are performed. 5 Fr feeding tube is fed into the pancreatic duct as a stent prior to completion of the pancreatic duct sphincteroplasty. The duodenum is closed transversely in 1 layer.

Table 1. Preoperative pathology results from EGD and biopsy from patients that eventually underwent pancreaticoduodenectomy.

Patient #	Pathology
1	Duodenal adenoma with HGD. Invasion into muscularis propria
2	Tubulovillous adenoma with HGD
3	Concurrent pancreatic head cyst with duodenal adenoma. FNA of cyst showed mucinous epithelial cells with mild to moderate cytologic atypia
4	Tubular adenoma with HGD
5	Tubular adenoma with HGD
6	Villous adenoma with HGD
7	Tubular adenoma, focal HGD invasion
8	Tubular adenoma. First biopsy negative for HGD. Second biopsy positive for HGD
9	Ampullary mass with HGD
10	Adenoma with focal areas of adenocarcinoma
11	Two duodenal masses. 1. Tubular adenoma w HGD carcinoma in situ (intramucosal) 2. villous adenoma w HGD

HGD = High Grade Dysplasia.

Operative data including duration of surgery, length of stay (LOS), and estimated blood loss (EBL) were compared between the patients who underwent pancreaticoduodenectomy versus those that underwent transduodenal ampullectomy (Table 3). The median duration of surgery was 237.9 (SD ± 53.4) minutes for patients who underwent pancreaticoduodenectomy and 122.9 (SD ± 41.9) For those who underwent transduodenal ampullectomy (p < 0.001). Average adenoma size was 2.9 cm in the pancreaticoduodenectomy group and 2.8cm in the transduodenal ampullectomy group (p = 0.97). These sizes were estimated by the pathologist and were smaller than the in-situ lesion as the resected specimens were sometimes fragmented and shrink ex-vivo. The median estimated blood loss was three times higher for the pancreaticoduodenectomy group (300mL versus 100mL) compared to the transduodenal resection group. The data was not normally distributed for EBL and therefore was not subjected to student's t-test. Mean length of stay was almost twice as long in the pancreaticoduodenectomy group (12.2 ± 3.9 days) as compared to the transduodenal resection group (7 ± 1.6 days) (p < 0.001).

Frozen pathology analysis was obtained on all patients who underwent transduodenal ampullectomy. No HGD or invasive cancer were identified intraoperatively and the procedure was concluded without

Table 2. Preoperative pathology results from EGD and biopsy from patients that eventually underwent transduodenal ampullectomy.

Patient #	Pathology
1	Tubular adenoma negative for HGD or malignancy
2	Tubulovillous adenoma
3	Tubulovillous adenoma without evidence of severe dysplasia or malignancy
4	Tubular adenoma no dysplasia no invasive cancer
5	Duodenal adenoma negative for HGD or malignancy
6	Tubulovillous adenoma with HGD
7	Tubular adenoma
8	Tubulovillous adenoma without HGD or malignancy
9	Adenoma without dysplasia, benign adenoma
10	Tubulovillous adenoma no HGD or malignancy
11	Villous adenoma with foci of surface ulceration and reactive glandular change, no HGD or malignancy
12	Tubular adenoma without HGD
13	Tubular adenoma without Dysplasia
14	Tubular adenoma negative for HGD or malignancy
15	Villous adenoma w/o HGD or infiltrating carcinoma

HGD = High Grade Dysplasia.

conversion to pancreaticoduodenectomy. Of the patients that underwent pancreaticoduodenectomy 6 out of 11 (54.5%) patients were found to have high grade dysplasia including 1 patient (9.1%) with a focal carcinoma on final pathology. Final pathology for the 15 patients who underwent transduodenal ampullectomy is shown on Table 4. All patients were followed postoperatively. Two patients developed recurrent adenoma on surveillance (Recurrence rate of 13.3%). Both of these patients subsequently underwent pancreaticoduodenectomy. One of these patient was found to have focal high grade dysplasia within an adenoma and the other was found to have an adenoma without high grade dysplasia.

4. Discussion

Ampullary neoplasms represent an infrequently occurring tumor with an incidence rate of less than 1% [8]. However, with an increase in detection mechanisms, these neoplasms are being discovered at a more frequent rate, with an incidental discovery that has risen to nearly 1% in all patients undergoing endoscopy [9]. Therefore an algorithm for

Table 3. Demographics and perioperative outcomes comparing those who underwent pancreaticoduodenectomy versus those that underwent transduodenal resection.

Demographics and Outcomes			
Variable	Pancreaticoduodenectomy (n = 11)	Transduodenal Resection (n = 15)	
Age (years, mean)	67.2 (7.8)	63.2 (8.0)	p = 0.217
Sex			
Male	8 (72.7%)	7 (46.7%)	p = 0.184
Female	3 (27.3%)	8 (53.3%)	
Coronary Artery Disease			
Present	3 (27.3%)	1 (6.7%)	p = 0.150
Absent	8 (72.7%)	14 (93.3%)	
Diabetes			
Present	2 (18.2%)	2 (13.3%)	p = 0.735
Absent	9 (81.8%)	13 (86.7%)	
Hypertension			
Present	6 (54.5%)	5 (33.3%)	p = 0.279
Absent	5 (45.5%)	10 (66.7%)	
ASA Class			
II	2 (18.2%)	6 (40.0%)	p = 0.286
III	9 (81.8%)	8 (53.3%)	
IV	0 (0%)	1 (6.7%)	
BMI (kg/m ²) (mean ± std dev)	29.1 ± 6.2	29.5 ± 4.3	p = 0.868
Length of Stay (Days) (mean ± std dev)	12.2 ± 3.9	7 ± 1.6	p < 0.001
Duration of Surgery (min) (mean ± std dev)	237.9 ± 53.4	122.9 ± 41.9	p < 0.001
Estimated Blood Loss (mL) (median)	300	100	
Size (cm) (mean ± std dev)	2.9 ± 1.3	2.8 ± 1.3	p = 0.97
Follow up time (months) (mean and range)	37.2 (2.5–78.9)	21.3 (1.9–78.8)	p = 0.142

identifying the ideal surgical treatments for these lesions is key. We propose transduodenal resection in the absence of high grade dysplasia or malignancy with confirmation through intra operative frozen section as the initial surgical approach. This strategy appears to be associated with improved perioperative outcomes for patients with acceptably low rates of recurrence.

Pancreaticoduodenectomy represents the procedure of choice for periampullary malignant lesions or those with high grade dysplasia. Some series have suggested that a radical resection improves overall survival [10]. En bloc resection of periampullary lesions would equate to a pancreaticoduodenectomy since the lymphatic drainage in this area would be through the pancreaticoduodenal basin. Pancreaticoduodenectomy also allows more accurate staging in the face of malignancy due to harvesting of lymph nodes. More recent studies from MGH and the Mayo Clinic have identified lymph node involvement with association with adverse outcome [11]. They also report decrease in overall survival with lymph node involvement. Some groups even promote transduodenal resection for early stage malignancies. Gao et al. retrospectively analyzed a cohort of 43 patients with early stage ampullary cancer and found nearly equal overall survival rates between the two groups with lymphatic involvement also being the main prognostic indicator [12].

However in the setting of a benign lesion or a lesion without a definitive malignancy diagnosis, the optimal surgical resection technique is controversial. Advocates of pancreaticoduodenectomy even for benign lesions cite the high incidence of malignancy in ampullary tumors. They also cite high recurrence rates. Past studies have reported recurrence of villous tumors after transduodenal excision of 32% at 5 years and 43% at

Table 4. Postoperative pathology results from patients that eventually underwent transduodenal ampullectomy.

Patient #	Pathology
1	Tubulovillous adenoma, No HGD or invasive carcinoma
2	Tubulovillous adenoma, No HGD or invasive carcinoma
3	Tubulovillous adenoma, No HGD or invasive carcinoma
4	Duodenal Adenomas. No HGD or invasive carcinoma
5	Duodenal Adenomas. No HGD or invasive carcinoma
6	Duodenal Adenomas. No HGD or invasive carcinoma
7	Duodenal Adenomas. No HGD or invasive carcinoma
8	Duodenal Adenomas. No HGD or invasive carcinoma
9	Tubulovillous adenoma, No HGD or invasive carcinoma
10	Duodenal Adenomas. No HGD or invasive carcinoma
11	Duodenal Adenomas. No HGD or invasive carcinoma
12	Duodenal Adenomas. No HGD or invasive carcinoma
13	Duodenal Adenomas. No HGD or invasive carcinoma
14	Duodenal Adenomas. No HGD or invasive carcinoma
15	Duodenal Adenomas. No HGD or invasive carcinoma

HGD = High Grade Dysplasia.

10 years [13]. These lesions can recur as invasive cancer. The other advantage of performing pancreaticoduodenectomy is that after this procedure, there is no need for postoperative endoscopic surveillance. But proponents of transduodenal resection cite much less morbidity and mortality associated with this procedure compared to pancreaticoduodenectomy, which we also observe amongst patients treated at our institution as well. Some past studies have shown low recurrence rates [14] and equivocal long term survival [15]. Our study reports significantly shorter operative time, intraoperative blood loss and shorter hospital stay, which is in line with past studies [16].

The key to opting for transduodenal resection is patient selection. All of our patients had preoperative diagnosis that ruled out high grade dysplasia or invasive cancer. The authors stipulate that in cases of a tumor with high grade dysplasia or invasive carcinoma, pancreaticoduodenectomy is the right choice for the patient as long as the patient is a candidate for such radical resection. But in the face of a suspected benign lesion, transduodenal ampullectomy provides a less morbid alternative for the patient.

Intraoperative frozen section is a critical step in surgical decision making. All of our patients who underwent transduodenal ampullectomy consented for the possibility of a pancreaticoduodenectomy, with the intraoperative determination based on the frozen section. Past studies have shown that intraoperative frozen sections have a 97% sensitivity, 100% specificity [17]. True to that study, the authors' experience is that the frozen section is congruent with the final pathology report.

Recurrence after ampullectomy is uncommon but it does occur, either as recurrent benign adenomas or as invasive cancer. Our study shows a recurrence rate of 13%. Past studies have reported recurrence rates that range from 10 to 30% [5]. For the vast majority that do not recur, these patients avoid the risk of morbidity associated with pancreaticoduodenectomy. Furthermore, if recurrence does happen, the patient is still a candidate for re-excision via transduodenal method or a more radical resection. An additional technique described by Schoenberg et al (1998) is to get frozen biopsies of normal tissue 1 cm around the lesion [18]. Using this technique, this group reported a zero percent recurrence rate in 20 patients.

Our study is limited by the small sample size and the retrospective analysis of these cohort of patients. Due to the lack of prevalence of these diseases and the lack of surgeons that perform transduodenal resections, gathering a bigger sample size may be difficult. A prospective trial randomly assigning patients with suspected benign duodenal lesions to either PD or TDR could also augment this study.

5. Conclusion

We have found that TDR can be an effective and safe procedure with careful patient selection. As the identification of duodenal adenomas increases, TDR can be an important surgical tool with acceptable recurrence rates and perioperative outcomes that are improved compared to a classic PD. Although these patients do require continued endoscopic monitoring, the benefits of the procedure may outweigh the requirements of future endoscopic surveillances for many patients.

Declarations

Author contribution statement

Shankar Logarajah: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Edward E Cho and D Rohan Jeyarajah: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Peter Deleeuw: Contributed reagents, materials, analysis tools or data.

Houssam Osman: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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